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THE XY MODEL FOR PHASE TRANSITIONS - SOME STATIC AND DYNAMIC RESULTS

BY

© RUTH VITERBO DITZIAN

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "The XY Model for Phase Transitions - Some Static and Dynamic Results", submitted by Ruth Viterbo Ditzian in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

Exact high temperature series expansions have been obtained for various thermodynamic quantities for the spin one half XY model of ferromagnetism or of a quantum lattice fluid.

The static quantities calculated include the initial parallel susceptibility and the fourth order fluctuation both for the face centered cubic and for the triangular lattice. Analysis of the series for these two quantities by standard ratio and Pade approximant methods yields estimates for the critical temperature variable, $K_c = J/kT_c$, and the critical indices γ and γ_2 respectively. For the face centered cubic lattice $K_c = 0.221 \pm 0.001$, $\gamma = 1.32 \pm 0.04$ and $\gamma_2 = 4.64 \pm 0.10$. For the triangular lattice $K_c = 0.67 \pm 0.01$, $\gamma = 1.50 \pm 0.02$ and $\gamma_2 = 5.4 \pm 0.5$. These results coupled with scaling theory yield all critical indices for the spin one half XY model. On the triangular lattice the results obtain if we assume a phase transition but do not constitute conclusive evidence of the existence of such a transition. The results for the face centered cubic lattice compare very well with experimental results for the λ transition in liquid helium.

The dynamical calculations have been done for two quantities, the autocorrelation and the frequency

dependent parallel susceptibility, both on the face centered cubic lattice. The autocorrelation can be expanded in a power series in time. We have calculated the first, second, third, fourth, sixth and seventh coefficients as power series in T^{-1}. We find that the first, second and third coefficients diverge at K_c with exponents $\gamma_1^A = 0.10\pm0.01$, $\gamma_2^A = 0.24\pm0.05$ and $\gamma_3^A = 0.35\pm0.05$ respectively.

The frequency dependent susceptibility can be expanded in a power series in the reciprocal of the frequency, ω^{-1}. Coefficients of odd powers vanish; coefficients of even powers have been obtained as power series in the reciprocal temperature variable, K. We find that the second moment <u>diverges</u> at K_c with exponent $\gamma_1 = 0.10\pm0.01$ and the fourth moment <u>vanishes</u> with exponent $\gamma_3 = -0.86\pm0.05$. Assuming that a relation $\chi(\omega,T) = [(T_c-T)/T_c]^{-\gamma} f(\omega/[(T-T_c)/T_c]^{\Delta_s})$ holds near T_c for all ω we find that $\Delta_s = 0.58\pm0.10$. It is important to observe that $\Delta_s < \gamma$.

ACKNOWLEDGMENTS

I would like to thank my supervisor Dr. D.D. Betts for suggesting the problems studied in this thesis, for his encouragement and for many helpful discussions and suggestions.

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CHAPTER I

INTRODUCTION

This thesis describes a study of the thermodynamical properties above the critical temperature for the spin ½ XY model. The method of exact high temperature series expansion is used. The XY model is quantum mechanical and yet calculations with it are relatively easy. The spontaneous magnetization, which is the order parameter, lies in the xy plane. Therefore the order parameter in the XY model does not commute with the Hamiltonian and can exhibit dynamical behaviour. This is not the case in the Ising and Heisenberg models, where the order parameter is constant in time and changes in the Hamiltonian have to be introduced to allow dynamical behaviour of the magnetization. Accordingly this thesis is divided into two parts. The first deals with static critical phenomena and the second treats dynamical critical phenomena.

In Section 2.2 the XY model is introduced. We shall briefly summarize here the reasons for the interest in this model. In 1956 Matsuda and Matsubara proposed the anisotropic Heisenberg model as a possible model for an interacting Bose fluid. The XY model represents a Bose fluid with hard core repulsive interaction only.

The classical anisotropic Heisenberg model has been studied by Jasnow and Wortis (1968) for various values of the anisotropy parameter. They concluded that the critical behaviour for the classical model depends only on the dimensionality of the lattice and the symmetry of the ground state. That is, the critical indices are constant over ranges of the anisotropy parameter and change discontinuously when the symmetry of the ground state changes. The XY behaviour persisted as long as the ground state was invariant under rotation in the plane. This is true when the XY part of the interaction is stronger than the Z or Ising part.

Jasnow and Wortis studied only the spin infinity, or classical, case but the conjectured behaviour is supported for the quantum mechanical case by the work of Barouch and McCoy (1969). Barouch and McCoy found, for the anisotropic XY model in one dimension, that the nature of the decay of the spin correlations changed when changes in the anisotropy parameter and in the applied field affected the symmetry of the ground state. It seems therefore reasonable to expect that the critical indices of the spin ½ anisotropic Heisenberg model will be equal to the indices of the XY model as long as the

XY interaction is dominant. The indices we obtain are expected then to fit the λ transition of liquid helium, and some insulating magnetic crystals for which $J_{\perp} >> J_{\parallel}$, that is the transverse interaction is much stronger than the parallel.

The quantities usually expanded in high temperature series are free energy, the susceptibility and the even derivatives of the free energy with respect to the field at zero field. Betts, Elliott and Lee (1970) calculated the free energy and fluctuation series for a variety of lattices. Because the magnetization and the Hamiltonian do not commute, the fluctuation , $\frac{1}{N} \langle M_x^2 \rangle$, is not equal to the susceptibility. Falk and Bruch (1969) proved however that the critical index of the fluctuation is equal to γ, the index of the susceptibility. The proof involved only rigorous thermodynamical inequalities. The equality is only asymptotically true close to the critical temperature. It is therefore of interest to calculate the susceptibility to see numerically how the coefficients approach those of the fluctuation series.

From the fluctuation series on the triangular lattice no conclusions could be drawn as to the existence of a transition and it was hoped that the static susceptibility would behave better.

The other static quantity calculated was the fourth order parallel fluctuation

$$Y_2 = \frac{1}{N} \{ \frac{3}{2} <M_x^2>^2 - \frac{1}{2} <M_x^4> \} .$$

By similar arguments to those used for the fluctuation by Falk and Bruch (1969), Y_2 diverges as the fourth derivative of the free energy with respect to the field in the x direction, thereby giving us an estimate for the gap parameter. Now two critical exponents and scaling yield estimates for all critical indices.

Before leaving the static quantities we should mention that the limit at zero frequency of the dynamical susceptibility is the quasistatic (called also adiabatic after Kubo) susceptibility while ours is the isothermal. They are equal when the system is ergodic. This question arose in the dynamical calculations for the Ising model of Allan and Betts (1968) and Essam and Garelick (1968). We shall discuss ergodicity in Chapter V but mention here the conclusion that in the XY 3-dimensional case we believe the two are equal.

Dynamic critical phenomena are at a much earlier stage of theoretical investigation than static critical phenomena.

Scaling laws have less success with static correlations than they had with the thermodynamical quantities. For the dynamical correlations the assumptions used for the static correlations are kept and generalized, therefore scaling is on a weaker basis.

There is no exactly soluble model with physical critical behaviour that can be used to check dynamical theories the way the 2d Ising model is used in static theory. The only soluble model is the one dimensional XY model. Niemeijer (1967), Barouch, McCoy and Dresden (1969) and Suzuki (1969) have calculated the time dependent correlations and magnetization of the one dimensional XY model. This model has the disadvantage of being non ergodic. The limit $t \to \infty$ yields a magnetization which is not the equilibrium magnetization in the z direction. The magnetization in the x direction can be expected to be ergodic and of interest but cannot be calculated exactly with present methods.

The kinetic Ising model in 2 dimensions was investigated by Suzuki (1969) using high temperature series expansions. Suzuki found that the critical index of slowing down is different from the index of the static susceptibility. Dynamical molecular field theory (Van Hove (1959), Suzuki and Kubo (1968)) predicts equality for the two indices.

Recently McFadden and Tahir Kheli (1970) calculated the zeroth, second and fourth moments of the spectral function as functions of the momentum transfer. Only the leading term in T^{-1} was obtained.

We have calculated the frequency dependent susceptibility $\chi(\underline{0}, \omega)$. We have obtained a double series in powers of T^{-1} and ω^{-1}. Analysis of the series is hampered by the fact that coefficients of powers of T^{-1} are infinite series in powers of ω^{-1} and vice versa. We find that the second moment of the susceptibility diverges at $T > T_c$. For the kinetic Ising model and the isotropic Heisenberg model all moments are finite, as was rigorously proved by Suzuki (1969) and Mermin and Wagner (1966) respectively. Though the proofs could not be generalized to the XY model the divergence was not expected. Assuming scaling we estimate the critical index of slowing down, and we find that in this case it is speeding up. We calculated the autocorrelation and with a scaling assumption estimate its relaxation time.

CHAPTER II

STATIC CRITICAL PHENOMENA AND THE XY MODEL

2.1 Critical phenomena and critical exponents

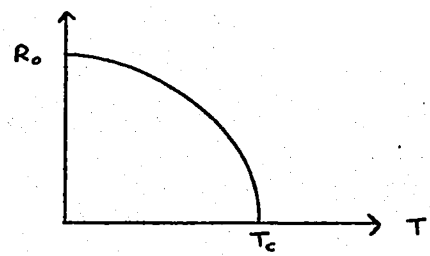
Phase transitions have been studied by physicists since the day man discovered that water boiled and froze.

A great variety of such phenomena, while of completely different origin, have a very similar quantitative behaviour and can be studied using the same mathematical models.

Some examples of critical phenomena are those which occur in monomolecular fluids near the critical point, in liquid helium near the λ temperature, in binary alloys near the order-disorder transition and in ferromagnets in the vicinity of the Curie temperature.

In all these systems by varying a thermodynamical parameter we reach a point where there is no phase transition, only one homogeneous phase exists and changes such as in density or magnetization are continuous.

For all those phenomena a long range order parameter R can be defined. At T=0 there is absolute order in the system. All spins are lined up parallel to each other in a ferromagnet, all He^4 atoms are in the ground superfluid state etc., so $R=R_o$; at infinite temperature R=0 as complete disorder must occur. In the systems with which we are concerned however the long range order disappears suddenly at and above some temperature defined as the critical point, whereas for systems which do not exhibit phase transitions R decays to zero smoothly and only at $T=\infty$; for the transitions with which we deal the behaviour of R is



For example, the order parameter for a ferromagnet is the magnetization, and for superfluid it is the density of the superfluid fraction.

In the vicinity of this critical point there are large fluctuations of all thermodynamic quantities which can become macroscopic and the relevant derivatives of the thermodynamic potential, such as specific heat and susceptibility, diverge. Such macroscopic fluctuations cannot probe deeply into the microscopic details of the forces involved and this is the reason of the quantitative similarity among such diverse phenomena.

The determination of the asymptotic laws which describe the approach to the critical point has been the main problem in the study of critical phenomena. It may be that only the dimensionality and symmetry of the system are needed to predict the asymptotic laws of the appropriate variable . This is a unifying pleasing hypothesis (Jasnow, Wortis 1968; Kadanoff 1970).

(a) Magnetic systems

Ferromagnets are defined as those crystals which have a spontaneous magnetization below the Curie temperature T_c, that is which possess a magnetic moment even in the absence of an applied magnetic field H.

$$M_o(T) = \lim_{H\to 0+} M(H, T) \tag{2.1.1}$$

Above T_c is the paramagnetic region and the magnetization varies continuously with H through the line H=0.

The magnetic exponent β is defined by

$$M_o(T) \sim (T - T_c)^{\beta} \tag{2.1.2}$$

as T approaches T_c. This behaviour is well verified by the experimental data of Heller and Benedek (1965) and Senturia and Benedek (1966) on EuS and $CrBr_3$.

The isothermal zero field susceptibility

$$\chi_T = \left(\frac{\partial M}{\partial H}\right)_{H=0} \tag{2.1.3}$$

diverges as the temperature approaches T_c

$$\chi_T \sim \begin{cases} (T-T_c)^{-\gamma} & T > T_c \\ (T-T_c)^{-\gamma'} & T < T_c \end{cases} \tag{2.1.4}$$

This relation defines the critical exponents γ and γ' and again experiments bear out this assumed behaviour for a variety of materials: Ni, Fe, Gd, $YtFeO_3$ (see Miedema et al (1963)). The critical index δ is defined on the critical magnetic isotherm

$$H \sim |m|^{\delta} \qquad T = T_c \quad . \tag{2.1.5}$$

The specific heat critical exponents α and α' are defined by

$$C_{H=0} \sim \begin{cases} (T-T_c)^{-\alpha'} & T < T_c \\ (T-T_c)^{-\alpha} & T > T_c \end{cases} \tag{2.1.6}$$

$\alpha=0$ is by definition a logarithmic singularity, for example EuO (Teaney 1966).

One more series of exponents Δ_n' can be defined (for $T < T_c$) by the relation:

$$\left(\frac{\partial^n F}{\partial H^n}\right)_T \sim (T_c-T)^{-\Delta_n'} \left(\frac{\partial^{n-1} F}{\partial H^{n-1}}\right)_T \tag{2.1.7}$$

where F is the free energy, and similarly Δ_n is defined for $T > T_c$.

For $n=1$, (2.1.7) does not define new exponents as they are related to α, β, γ' by

$$\Delta_1' = 2 - \alpha' - \beta$$

$$\Delta_2' = \beta + \gamma' \quad .$$

Above T_c odd derivatives vanish for H=0 because $M(-H,T)=-M(H,T)$. Δ_n and Δ_n' cannot be measured experimentally for $n > 2$.

The exponents ν, ν' and η refer to the behaviour of the pair correlation function $\Gamma(r)$ and correlation length ξ observed in neutron scattering, first explained by Van Hove (1945)

$$\xi \sim \begin{cases} (T-T_c)^{-\nu'} & T < T_c \\ (T-T_c)^{-\nu} & T > T_c \end{cases} \tag{2.1.8}$$

$$\Gamma_c(r) \simeq \frac{1}{r^{d-2+\eta}} \qquad \begin{matrix} T = T_c \\ H = 0 \end{matrix} \tag{2.1.9}$$

where d is the dimensionality of the system.

The spin correlation function is defined by

$$\Gamma_{\alpha\beta}(\underline{r},H,T) = \frac{<S_o^\alpha \; S_{\underline{r}}^\beta> - <S_o^\alpha><S_o^\beta>}{\frac{1}{3}\, S(S+1)} \qquad \alpha,\beta = x,y,z \tag{2.1.10}$$

and Γ is the correlation function in the preferred direction at the critical point. The quasi elastic scattering intensity for a momentum transfer $\underline{q}$ is:

$$\frac{I(\underline{q})}{I^o(\underline{q})} = 1 + \Sigma\, e^{i\underline{q}\cdot\underline{r}}\; \Gamma(\underline{r}) \quad . \tag{2.1.11}$$

The coherent scattering at zero field below T_c is

$$I_{coh}(0,T) \sim M_o^2(T) \sim (T-T_c)^{2\beta} \tag{2.1.12}$$

which gives another experimental way of measuring β.

The zero angle scattering is proportional to the susceptibility,

$$I(0) \sim \chi_T \sim (T-T_c)^{-\gamma} \qquad \begin{array}{l} H = 0 \\ T > T_c \end{array} \qquad (2.1.13)$$

Experiments were performed by Passel et al (1965), Balley et al (1967) on iron to measure γ.

From (2.1.9) and (2.1.11) we see

$$I_{critical}(\underline{k}) \sim \frac{1}{k^{2-\eta}} \qquad \text{as} \quad k \to 0 \quad . \qquad (2.1.14)$$

Jacrot et al (1962), Passel et al (1965) measured η this way.

The spin correlation function decays as

$$\Gamma(\underline{r},T) \sim \frac{e^{-\kappa r}}{r} \quad . \qquad (2.1.15)$$

The correlation length is defined by

$$\xi = \kappa^{-1} \quad . \qquad (2.1.16)$$

$\kappa_1(T)$ measures the slope of $I^{-1}(\underline{k},T)$ against k^2 as $k \to 0$

$$\kappa_1^{-2} \propto \frac{\int r^2 \, \Gamma(\underline{r}) \, d\underline{r}}{1 + V^{-1}\int \Gamma(\underline{r}) \, d\underline{r}} \quad . \qquad (2.1.17)$$

Near T_c we expect $\kappa_1 \sim \kappa$ if near the critical point only one divergent temperature dependent correlation length exists. The quantity ν that is measured is the one pertaining to κ_1.

This was a short summary of the definitions of critical indices for uniaxial ferromagnets; our interest is really in ferromagnets with a plane of easy magnetization but applying a small field in a direction lying in the plane enables us to treat that direction as the preferred axis of magnetization and all definitions still apply.

(b) Superfluid helium

At first sight the superfluid transition seems rather different from the transition in a uniaxial ferromagnet because of the existence of the λ line (see Figure 2.2). The confusion arises due to regarding the pressure on the superfluid as the analogue of the magnetic field and the density as the analogue of the magnetization. The correct analogy is between the superfluid order parameter (the square root of the superfluid density) and the magnetic order parameter (the axial magnetization). The generalized force conjugate to the superfluid order parameter and analogous to the axial magnetic field is unfortunately not physically realizable. The analogues of the density and pressure are more correctly in the uniaxial magnet, the perpendicular magnetization and the perpendicular magnetic field. We shall expect therefore

$$n_o(t) \sim (T-T_\lambda)^{2\beta} \quad . \tag{2.1.18}$$

n_o is defined by

$$n_o = |\Psi|^2 = \lim_{(\underline{r}-\underline{r}')\to\infty} \langle \Psi^\dagger(\underline{r})\Psi(\underline{r}')\rangle \tag{2.1.19}$$

$\Psi(\underline{r})$ being the wave function in second quantization formulation. Most simple theories of superfluidity assert

$$\rho_s \sim n_o$$

ρ_s being the density of the superfluid. Measurements by Clow and Reppy (1966) and Tyson and Douglass (1966) show $\rho_s(T) \sim (T_\lambda - T)^\zeta \quad T<T_\lambda$ with $\zeta \simeq 0.666 \pm 0.1$, that is $\beta \sim \frac{1}{3}$. The specific heat at constant pressure shows a logarithmic singularity (Figure 2.3). Experimental results by Fairbank and Kellers (1966), and more accurate results by Ahlers (1969), give $\alpha = 0.000 \pm 0.003$ according to one interpretation of the data and $\alpha = -0.005 \pm 0.005$ according to another.

$$C_P \sim -A \ln (1 - \frac{T}{T_\lambda}) + B \qquad T > T_\lambda \quad . \tag{2.1.20}$$

Henkel, Smith and Reppy (1969) obtained $\nu_h = 0.67 \pm 0.04$ by measuring the superfluid healing length of thin films which by the assumption of one relevant coherence length near T_λ is the same as ν.

Once the Hamiltonian is given the problem is only to evaluate the partition function

$$Z(T,N,V) = \mathrm{Tr}\ e^{-\beta \mathscr{H}_N} \tag{2.1.21}$$

and then

$$-\frac{F(T,V)}{kT} = \lim_{V\to\infty} \frac{1}{N} \ln Z \tag{2.1.22}$$

and all thermodynamical quantities follow by the usual relations. The problem of going to the thermodynamic limit in order to have any critical behaviour is at least partially solved by the rigorous proofs of Ruelle (1963) and others who showed that thermodynamical properties are the same whether obtained by canonical or grand canonical ensemble and do not depend on the shape of the sequence of volumes one uses. Still the order in which limits are taken can make a difference and caution is required.

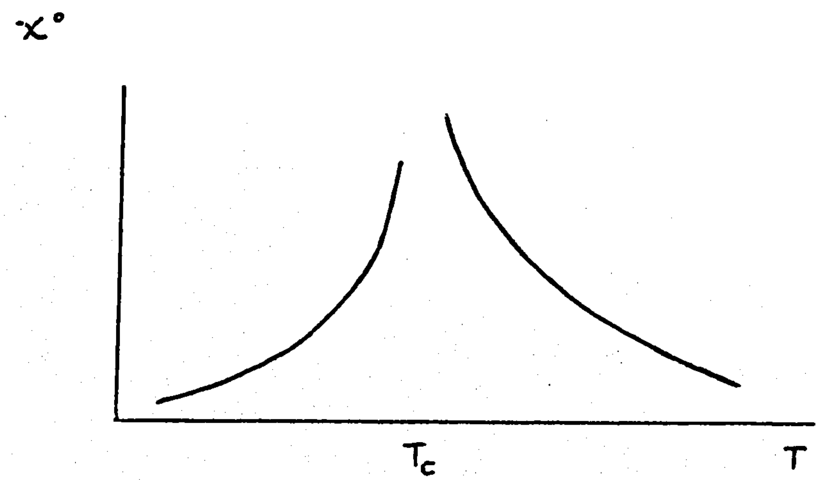


Figure 2.1

Susceptibility in a Ferromagnet

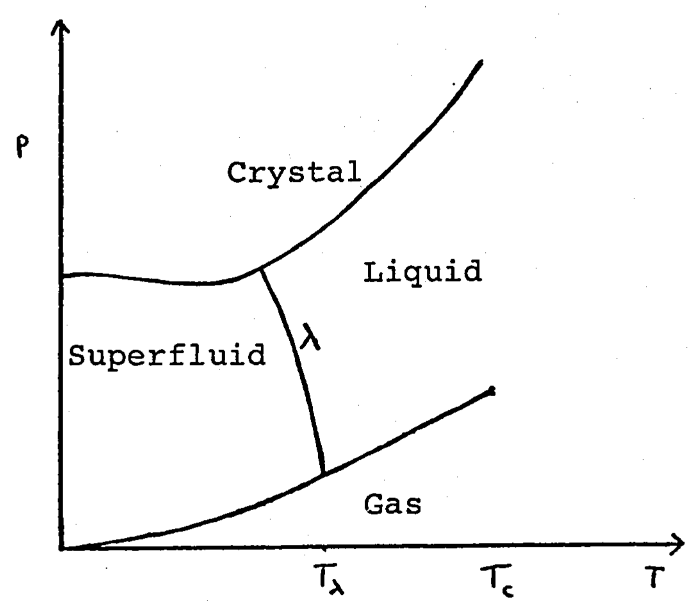


Figure 2.2

Schematic Phase diagram of ^4He

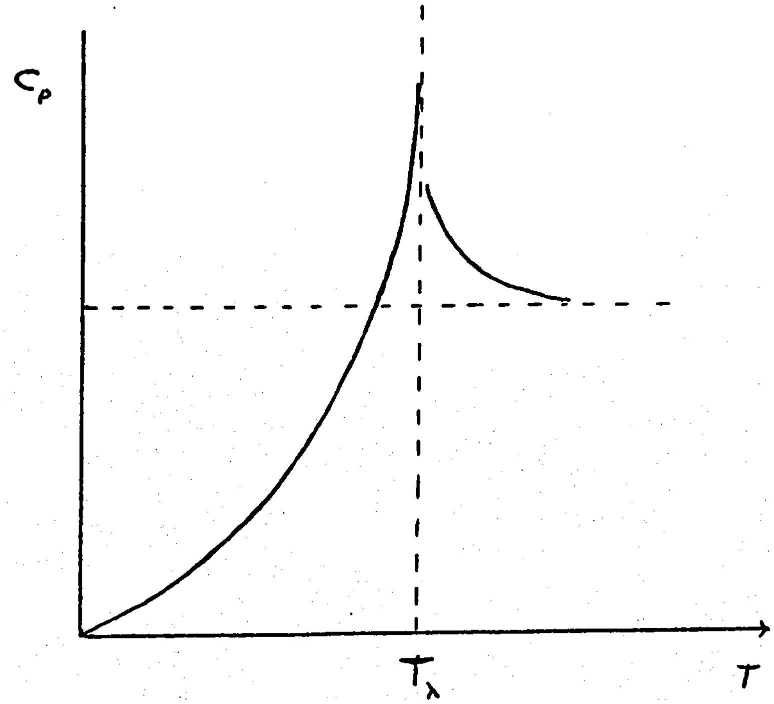


Figure 2.3

Specific heat of liquid helium

2.2 The XY model and its relation to magnetic systems and quantum fluids

The first attempt to build a model for ferromagnetism was the Weiss molecular field theory (1907). The model assumes that each particle in the system interacts equally with all other particles in the system. In spite of this rather unrealistic assumption the results were in some agreement with experiment at least in predicting a critical point, a diverging susceptibility (with $\delta=1$) and a discontinuous specific heat.

The first realistic model to be treated was the Ising model with first neighbour interactions. The spins are fixed on a lattice and the Hamiltonian describing the interaction is

$$\mathcal{H} = - J \sum_{<ij>} \sigma_i^z \sigma_j^z - m H^z \sum_i \sigma_i^z \tag{2.2.1}$$

where $<ij>$ denotes sum over pairs of nearest neighbours σ_i^z is the Pauli spin matrix and m is the magnetic moment of the atoms.

It was solved for the spin ½ case for a one dimensional chain by Ising (1920), and by Onsager (1944) for a square lattice. Series expansions gave good estimates for the critical indices in 3 dimensional lattices. Magnetic systems were found to agree with the predictions of this model, namely the cobalt tutton salts. The β brass binary alloy seems to be a good example for this model (Als-Nielsen 1969).

The Heisenberg model is based on the exchange theory of ferromagnetism. The Heisenberg Hamiltonian is

$$\mathcal{H} = -2J \sum_{<ij>} \vec{S}_i \cdot \vec{S}_j - m H^z \sum_i S_i^z \quad . \tag{2.2.2}$$

Materials like EuO and EuS satisfy both assumptions of the model, localization of spins and isotropy of interaction, and series expansion methods gave estimates for the critical indices (Rushbrooke, Wood (1958), Domb, Wood (1964), Baker, Gilbert, Eve and Rushbrooke (1967)).

The natural extension of the Heisenberg model is a model in which the assumption of isotropy is dropped. Mathematically this causes great complications, usually the most general model treated is

$$\mathcal{H} = -2 \sum_{<ij>} \{J_\perp (S_i^x S_j^x + S_i^y S_j^y) + J_{\parallel} S_i^z S_j^z\} - m \vec{H} \sum_i \vec{S}_i \tag{2.2.3}$$

which is called the anisotropic Heisenberg model even though the anisotropy is not complete. The Ising model is the extreme case of $J_\perp = 0$. The XY model is the other extreme $J_\parallel = 0$. The XY hamiltonian is

$$\mathcal{H}_{xy} = -2 \sum_{<ij>} J (S_i^x S_j^x + S_i^y S_j^y) \tag{2.2.4}$$

first introduced by Lieb, Schultz and Mattis (1961). The work done on the anisotropic Heisenberg model was to calculate χ^{zz} which for the limiting case of the XY interaction is not expected to diverge, whereas this thesis deals with a field applied in a direction in the plane of interaction.

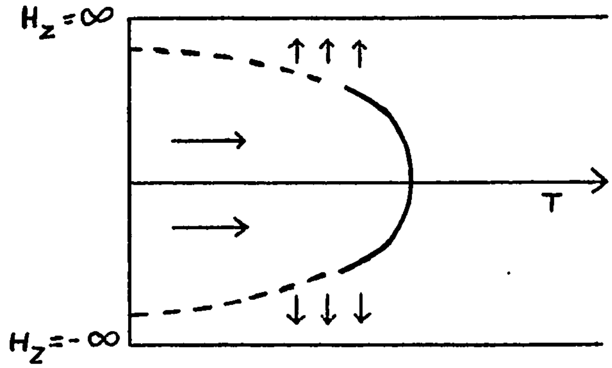
A strong inducement to study this model was the work of Jasnow and Wortis on the classical anisotropic Heisenberg hamiltonian. The classical limit is obtained by taking the limit $\vec{S} \rightarrow \infty$ but $\frac{S}{|S|} \rightarrow 1$. This gives an interaction of commuting spins which behave like classical vectors. Jasnow and Wortis studied this Hamiltonian for various anisotropies on different lattices by series expansions. Their results suggest, as mentioned in 2.1, that only the symmetry of the ground state and the dimensionality of the lattice affect the critical exponents. In particular as long as the interaction has the symmetry of the XY hamiltonian, that is as long as $|J_{\perp}|>|J_{\parallel}|$, the critical behaviour of the system is that of pure XY interaction. The indices change only when there is a change in the symmetry, and then they change discontinuously. The same result is indicated by Barouch and McCoy (1970) for the one dimensional anisotropic XY model (see 2.3). While the pure XY model is mathematically convenient, it has no possible hope of describing a physical system. However an anisotropic Heisenberg model with the XY symmetry in which $J_\perp >> J_\parallel$ is quite possible.

It was suggested by Huiskamp (1967) that materials with strongly anisotropic crystalline fields like $Gd_2(SO_4)_2 \cdot 8H_2O$ would be likely to have an XY like behaviour. It was shown by Betts, Elliott and Lee (1970) that an insulating crystal composed of high half odd spins with a strong axial crystalline field behaves much like a spin ½ XY system. The interaction being

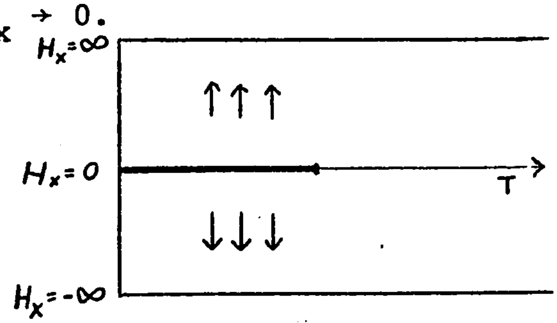
$$\mathcal{H} = + D \sum_i (S_i^z)^2 - J \sum_{<ij>} \vec{S}_i . \vec{S}_j \qquad D >> J > 0 \tag{2.2.5}$$

the strong crystalline field will cause the $S^z = \pm\frac{1}{2}$ levels to be highly populated in the critical region. Looking now only at the populated subspace $S^z = \pm\frac{1}{2}$ the ratio of the $S_i^x S_j^x + S_i^y S_j^y$ part of the interaction compared to the $S_i^z S_j^z$ part will be about S^2 to 1.

In such a material we have a dominant transverse coupling, the spontaneous magnetization vector $\vec{M}$ in zero field will lie in the xy plane. Introduction of a field in the z direction will tend to rotate the magnetization towards the z axis for large enough fields and we end with a paramagnetic phase in the xy plane. The expected phase diagram (Fisher 1968) is



where the broken line indicates the transition may not be second order any more, and we have a λ-like transition line. Introducing a field in the x direction will cause the magnetization to be in the x direction even in the limit of $H_x \to 0$.



Our calculation is a series expansion for $T > T_c$ $H_x \to 0$. We approach T_c from above on the $H_x = 0$ line. Using the equalities predicted by scaling, we can obtain the behaviour on other lines, for example the approach to $H_x = 0$ on a $T = T_c$ line.

Matsuda and Matsubara (1956) introduced the anisotropic Heisenberg model as a possible model for a quantum lattice fluid. In the following pages we bring Matsuda and Matsubara's derivation. The model for a classical fluid as proposed by Yang and Lee(1952) assumes that each atom occupies a cell i with a probability t_i which is either 1 or 0. Multiple occupancy is thus excluded and the grand partition function for the system obtained is:

$$\Xi \propto \sum_{t=0,1} \exp\left[\beta\mu \sum_i t_i - \sum_{ij} \beta\phi(\underline{r}_i-\underline{r}_j) t_i t_j\right] \qquad (2.2.6)$$

μ being the chemical potential and $\phi(\underline{r}_i-\underline{r}_j)$ the potential between atoms in cells i and j. Taking

$$\phi(\underline{r}_i-\underline{r}_j) = \begin{cases} 4J & \text{for i and j nearest neighbours} \\ 0 & \text{otherwise} \end{cases} \qquad (2.2.7)$$

the model reduces to the classical Ising model.

For a quantum fluid we work in the framework of second quantization and define creation and annihilation operators $a_i^\dagger$ and a_i respectively on each lattice site i. Since we are dealing with a Bose gas

$$(a_i^\dagger,\ a_j^\dagger) = (a_i,\ a_j) = (a_i, a_j^\dagger) = 0 \qquad (2.2.8)$$

for $i \neq j$. In order to exclude multiple occupation for $i=j$

$$\{a_i,\ a_i^\dagger\} = a_i a_i^\dagger + a_i^\dagger a_i = 1 \qquad (2.2.9)$$

$$\{a_i^\dagger,\ a_j^\dagger\} = \{a_i,\ a_i\} = 0 \qquad (2.2.10)$$

and this ensures that the number operators

$$N_i = a_i^\dagger a_i$$

will have eigenvalues 1, 0 only. These commutation relations are satisfied by

$$\begin{aligned} a_i^\dagger &= \sigma_i^x + i\,\sigma_i^y \\ a_i &= \sigma_i^x - i\,\sigma_i^y \ . \end{aligned} \tag{2.2.11}$$

The following potential energy ϕ is considered:

$$\begin{cases} v = \infty & \text{for two atoms on same lattice point (forbidden by (2.2.10))} \\ v = -v_o & \text{for nearest neighbours} \\ v = 0 & \text{otherwise .} \end{cases}$$

Therefore

$$\phi = -v_o \sum_{ij} a_i^\dagger a_i a_j^\dagger a_j \ . \tag{2.2.12}$$

As to kinetic energy it is assumed that atoms can move only to vacant nearest neighbour sites. Such a transition is generated by $a_i^\dagger a_j$ for i,j nearest neighbours. We look at the form the kinetic energy takes in the continuum

$$K.E. = \frac{\hbar^2}{2m} \int \frac{\partial \psi^\dagger}{\partial x} \frac{\partial \psi}{\partial x} dx \ . \tag{2.2.13}$$

For free particles

$$\psi(\underline{r}) = \frac{1}{\sqrt{V}} \Sigma\, a_K e^{-i\underline{K}\underline{r}} \tag{2.2.14}$$

therefore

$$K.E = \frac{\hbar^2 |K|^2}{2m} \Sigma\, a_K^\dagger a_K \tag{2.2.15}$$

if we define for the lattice fluid the operators

$$a_K = \frac{1}{\sqrt{N}} \sum_j e^{i\underline{K}\underline{r}_j} a_j$$

$$a_K^\dagger = \frac{1}{\sqrt{N}} \sum_j e^{-i\underline{K}\underline{r}_j} a_j^\dagger \quad . \tag{2.2.16}$$

One possible kinetic energy operator with the correct continuum limit would be

$$K.E = N\frac{\hbar^2 d}{2ma^2 q} \sum_{<ij>} (a_i^\dagger - a_j^\dagger)(a_i - a_j) \tag{2.2.17}$$

where we replaced $\frac{\partial}{\partial x}$ by differences, d is the dimensionality, q the number of nearest neighbours

$$K.E = \frac{\hbar^2}{2ma^2 q} \sum_{<ij>} (\sum_K (e^{i\underline{K}\underline{r}_i} - e^{i\underline{K}\underline{r}_j}) a_K^\dagger) \times$$

$$\times (\sum_{K'} (e^{-i\underline{K}'\underline{r}_i} - e^{-i\underline{K}'\underline{r}_j}) a_{K'})$$

$$= \frac{\hbar^2 d}{2ma^2 q} \sum_{KK'} a_K^\dagger a_{K'} \sum_{<ij>} (e^{i\underline{K}\underline{r}_i} - e^{i\underline{K}\underline{r}_j}) \times$$

$$\times (e^{-i\underline{K}'\underline{r}_i} - e^{-i\underline{K}'\underline{r}_j}) \tag{2.2.18}$$

In the limit $|K| << \frac{1}{a}$ for ij nearest neighbours

$$e^{i\underline{K}.\underline{r}_i} - e^{i\underline{K}.\underline{r}_j} \sim i\underline{K}.\underline{a} \quad e^{i\underline{K}.\underline{r}_i} , \qquad (2.2.19)$$

therefore

$$K.E \sim \frac{\hbar^2}{2ma^2} \sum_{KK'} a_K^{\dagger} a_{K'} \sum_{<ij>} (\underline{K}.\underline{a}) \quad e^{i\underline{K}\underline{r}_i} . e^{-i\underline{K}'\underline{r}_i} (\underline{K}'.\underline{a})$$

$$\sim \frac{\hbar^2}{2ma^2} \sum_K a_K^{\dagger} a_K \sum_{<ij>} (\underline{K}.\underline{a})^2 .$$

For a continuum limit the nearest neighbours are isotropically distributed, so $\sum_{<ij>} (\underline{K}.\underline{a})^2 \propto (K)^2 a^2 \frac{q}{d}$

$$K.E \sim \frac{\hbar^2}{2m} |K|^2 \sum_K a_K^{\dagger} a_K \quad . \qquad (2.2.20)$$

The quantum lattice gas Hamiltonian given by this heuristic arguments is

$$\mathcal{H} = (\frac{d\hbar^2}{2ma^2 q}) \sum_{<ij>} (a_i^{\dagger} - a_j^{\dagger})(a_i - a_j) - v_o \sum_{<ij>} a_i^{\dagger} a_i a_j^{\dagger} a_j \quad .$$

$$(2.2.21)$$

For spin ½

$$a_i^{\dagger} a_i = (\sigma_i^x + i\sigma_i^y)(\sigma_i^x - i\sigma_i^y) = 1/2(1-\sigma_i^z) ,$$

therefore

$$\mathcal{H} = - \left(\frac{\hbar^2 d}{q2ma^2}\right) \sum_{<ij>} (\sigma_i^x \sigma_j^x + \sigma_i^y \sigma_j^y) - v_o \sum_{<ij>} \sigma_i^z \sigma_j^z \, , \tag{2.2.22}$$

which is our anisotropic Heisenberg model. In absence of interactions this reduces to pure XY.

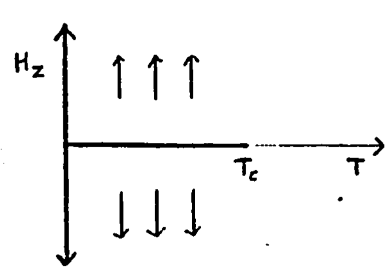
By the assumption that a strong XY interaction compared to the Ising like part yields a behaviour like the pure XY model, we can hope that a pure XY model will describe a quantum fluid with weak interaction be it repulsive or attractive.

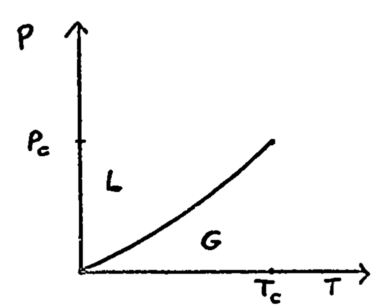
This condition that $|J_\perp| > |J_\parallel|$ is here

$$\frac{d}{v_o q} \frac{\hbar^2}{2ma^2} >> 1 \quad , \tag{2.2.23}$$

where a is the lattice spacing, d is the dimensionality, q is the number of nearest neighbours and $-v_o$ the potential energy between two neighbouring atoms.

The phase diagram for the superfluid that corresponds to this hamiltonian (2.2.22) can be formed in the same way as the classical gas diagram was formed in analogy to the uniaxial Ising magnet

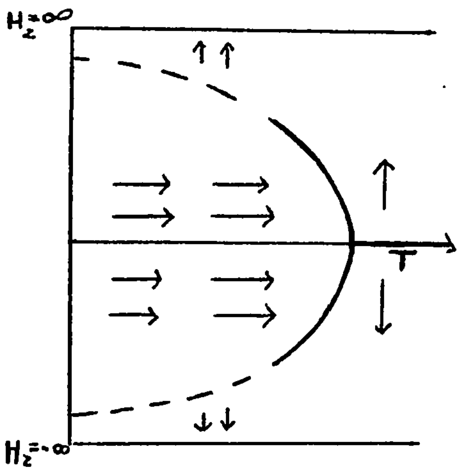


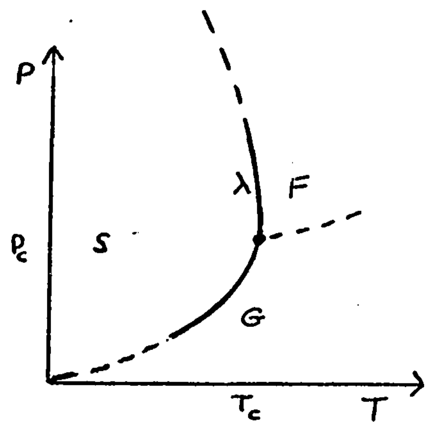


Our hamiltonian has a positive, ferromagnetic, J as it came from the kinetic energy and is

$$J = \frac{d\hbar^2}{q2ma^2} \quad .$$

The phase diagrams are





The pressure in the fluid still corresponds to a field in the z direction as it is the quantity conjugate to the density, which is $\Sigma\, a_i^\dagger a_i \sim \Sigma\, \sigma^z$. Applying a field in the z direction would not destroy the order until the field become large enough to rotate the magnetization to the z axis. The magnetic fields in the x or y direction correspond to off diagonal fields, ν_i introduced by Bogolyubov (1960), Hohenberg and Martin (1965) which have no physical realization.

$$\mathcal{H}' = - \frac{1}{\sqrt{V_o}} \sum_i (\nu_i^* a_i + \nu_i a_i^\dagger) \quad , \qquad (2.2.24)$$

then

$$\frac{\partial}{\partial \nu^*} \frac{kT}{Nv_o} \log Z = \frac{1}{\sqrt{v_o}} \langle a_o \rangle = \langle \psi \rangle \quad . \qquad (2.2.25)$$

The superfluid order parameter can be defined by

$$|\psi(T,\mu)| = \lim_{\nu,\nu^* \to 0} |\psi(T,\mu,\nu^*,\nu)| \quad . \qquad (2.2.26)$$

This is analogous to $\lim_{H_x \to 0} \langle M^x \rangle$.

2.3 Rigorous one dimensional results

Lieb, Schultz and Mattis (1961) were able to diagonalize the Hamiltonian of the anisotropic XY model in one dimension

$$\mathcal{H} = \sum_{j=1}^{N} (1+\gamma) S_j^x S_{j+1}^x + (1-\gamma) S_j^y S_{j+1}^y \qquad (2.3.1)$$

by using the transformation to fermion operators given by:

$$a_j^{\dagger} = \exp\{i\pi \sum_{K=1}^{j=1} c_K^{\dagger} c_K\}\, c_j^{\dagger} \;,\quad a_1^{\dagger} = c_1^{\dagger} \qquad (2.3.2)$$

$$a_j = \exp\{-i\pi \sum_{K=1}^{j=1} c_K^{\dagger} c_K\}\, c_j \;,\quad a_1 = c_1 \;. \qquad (2.3.3)$$

They calculated the correlation functions $< S_o^z S_1^z >$, $< S_o^x\ S_1^x >$ and proved that for the isotropic case, $\gamma=0$, the long range order vanishes even at T=0

$$\lim_{n\to\infty} < S_o^x\ S_{2n}^x > \to 0 \quad ,$$

while it does not for $\gamma \neq 0$.

Katsura (1962) independently solved the same model. He obtained also the perpendicular susceptibility χ^{zz} in finite fields and the ground state. Suzuki (1966) obtained the staggered initial susceptibility for the isotropic XY model

$$\chi_o = \frac{Nm^2}{kT} \cdot \frac{1}{\pi} \int_0^{\pi} \frac{d\omega}{\cosh^2 (K \cos \omega)} \tag{2.3.4}$$

$$\chi_o^s = \frac{Nm^2}{kT} \cdot \frac{1}{\pi} \int_0^{\pi} \frac{\tanh (K \cos\omega)}{K \cos \omega} \, d\omega \tag{2.3.5}$$

where

$$K = \frac{J}{kT} \quad . \tag{2.3.6}$$

The ground state functions were obtained by Katsura

$$\psi_o = (\prod_{K>N/4}^{N/2} A_{2K-1}^{\dagger} \, A_{-2K+1}^{\dagger}) |0> \qquad \text{for } \frac{N}{2} \text{ even} \tag{2.3.7}$$

$$\psi_o = (\prod_{K>N/4}^{N/2} A_{2K}^{\dagger} \, A_{-2K}^{\dagger}) A_N^{\dagger} |0> \qquad \text{for } \frac{N}{2} \text{ odd} \tag{2.3.8}$$

where

$$A_K = \frac{1}{\sqrt{N}} \sum_{\ell=1}^{N} a_{\ell} \exp \left[-i\pi (\frac{K\ell}{N} - \frac{1}{n})\right] \tag{2.3.9}$$

$$A_K^{\dagger} = \frac{1}{\sqrt{N}} \sum_{\ell=1}^{N} a_{\ell}^{\dagger} \exp \left[i\pi (\frac{K\ell}{N} - \frac{1}{n})\right] \quad . \tag{2.3.10}$$

The ground state energy is

$$\frac{E_o}{N|J|} = - \frac{2}{\pi} \quad . \tag{2.3.11}$$

These results show that in one dimension there is no long range order. The model behaves like an antiferromagnet with respect to a perpendicular field and the ground state is rather like that of the antiferromagnetic isotropic Heisenberg model.

A detailed study of the correlation functions in the anisotropic XY model was done by Barouch and McCoy (1969, 1970). The hamiltonian treated is:

$$\mathcal{H} = -J\,\Sigma\left[(1+\gamma)\ S_i^x S_{i+1}^x + (1-\gamma)\ S_i^y S_{i+1}^y\right] - \hbar\,\mu\,\Sigma\, S_i^z\ . \qquad (2.3.12)$$

They studied the asymptotic behaviour of the correlations in finite fields H_z: $\langle S_o^x\ S_R^x\rangle$, $\langle S_o^y\ S_R^y\rangle$, and $\langle S_o^z\ S_R^z\rangle$ as $R \to \infty$ for high and low temperatures. All correlations decay exponentially with the exponent depending on the field.

For T=0 the behaviour is different for the symmetric cases $\gamma=0$, or $\hbar\mu = J$, or $(\hbar\mu/J)^2 + \gamma^2 = 1$. When none of those conditions obtain, all correlations approach their limit exponentially rapidly; when one condition holds they approach the limiting values as some power of R. The effect of those symmetries can be seen at finite T too as the rate of the vanishing depends on the symmetry.

The parallel susceptibility has not been calculated as the solution of the XY chain with a field in the z direction used all simplifying features to the maximum; the nearest neighbour character of the interaction, the one dimensionality and the simple quadratic form of the Hamiltonian. For the parallel susceptibility addition of the appropriate Zeeman term gives the following Hamiltonian:

$$\mathcal{H} = -J \Sigma\, S_i^x S_{i+1}^x + S_i^y S_{i+1}^y - m\, H\, \Sigma\, S_i^x \quad . \tag{2.3.13}$$

Taking $x \to z$, $z \to y$, $y \to x$, we obtain

$$\mathcal{H} = -J \Sigma\, (a_i^\dagger a_{i+1} + a_i a_{i+1}^\dagger) - J' \Sigma\, a_i^\dagger a_i a_{i+1}^\dagger a_{i+1} + J'' \Sigma\, a_i^\dagger a_i \tag{2.3.14}$$

and the simple quadratic nature of $\mathcal{H}$ is destroyed.

High temperature series expansions have been done by Bonner and Fisher (1964). They calculated the energy, specific heat, susceptibility and pair correlations for the hamiltonian

$$\mathcal{H} = -2J\, \Sigma\left[S_i^z S_{i+1}^z + \gamma (S_i^x S_{i+1}^x + S_i^y S_{i+1}^y)\right] - m\, \vec{H}\, \Sigma\, \vec{S}_i \tag{2.3.15}$$

for γ=0 to 1, therefore not reaching the region of XY symmetry.

2.4 Rigorous thermodynamic inequalities and scaling laws

Thermodynamic arguments were used by Rushbrooke (1963, 1965) and Griffiths (1965) to prove rigorous inequalities for the critical exponents. Most of those proofs make use of convexity relations (Ruelle 1963, Fisher 1964 and Griffiths 1964) of the free energy

$$F(\alpha T_1 + \beta T_2, v) \geqslant \alpha F(T_1, v) + \beta F(T_2, v)$$

$$F(T, \alpha v_1 + \beta v_2) \leqslant \alpha F(T,v_1) + \beta F(T, v_2) . \qquad (2.4.1)$$

The Helmholtz free energy A(T,v) is concave in the temperature and convex in the volume. The same holds with magnetization instead of volume for a hamiltonian of the form

$$\mathcal{H} = \mathcal{H}_0 - H\,M \qquad (2.4.2)$$

or provided the magnetization commutes with the hamiltonian (our case is included in (2.4.2)), we will write the rest in magnetic language.

It follows from the convexity properties that

$$C_M = T\left(\frac{\partial S}{\partial T}\right)_M = -T\left(\frac{\partial^2 A}{\partial T^2}\right)_M \geqslant 0 \qquad (2.4.3)$$

$$\frac{1}{\chi_T} = \left(\frac{\partial H}{\partial M}\right)_T = \left(\frac{\partial^2 A}{\partial M^2}\right)_T \geqslant 0 \qquad (2.4.4)$$

$$C_H = T\left(\frac{\partial S}{\partial T}\right)_H = -T\left(\frac{\partial^2 G}{\partial T^2}\right)_H$$

$$\frac{C_H}{T} = \left(\frac{\partial S}{\partial T}\right)_H = \left(\frac{\partial S}{\partial T}\right)_M + \left(\frac{\partial S}{\partial M}\right)_T \left(\frac{\partial M}{\partial T}\right)_H$$

but $\left(\frac{\partial S}{\partial M}\right)_T = -\frac{\partial^2 A}{\partial M \partial T} = -\left(\frac{\partial H}{\partial T}\right)_M = \left(\frac{\partial H}{\partial M}\right)_T \left(\frac{\partial M}{\partial T}\right)_H$,

therefore

$$\frac{C_H}{T} = \frac{C_M}{T} + \frac{1}{\chi_T}\left(\frac{\partial M}{\partial T}\right)_H^2 \quad . \tag{2.4.5}$$

Since $C_M \geqslant 0$

$$C_H \geqslant T\left(\frac{\partial M}{\partial T}\right)_H^2 / \chi_T \qquad T \to T_c \ , \quad H = 0 \ . \tag{2.4.6}$$

Substituting the expected behaviour near the critical point from below at zero field

$$C_H \sim (T_c - T)^{-\alpha'}$$

$$\chi_T \sim (T_c - T)^{-\gamma'}$$

$$\left(\frac{\partial M}{\partial T}\right)_H \sim (T_c - T)^{\beta - 1} \ ,$$

we obtain

$$f(T)(T_c - T)^{-\alpha'} \geqslant (T_c - T)^{2(\beta-1)+\gamma'} g(T) \quad ,$$

where f and g are non-singular at T_c. Since this should hold for all T close to T_c, it follows that

$$\alpha' + 2\beta + \gamma' \geq 2 \quad . \tag{2.4.7}$$

This is usually called the Rushbrooke inequality.

The implicit assumption in the above derivation was the existence of γ', that is

$$\lim_{H \to 0} \chi_T (H, T) = \infty \qquad \text{for } T \to T_c^- \, .$$

The same assumption and use of convexity of A(T, M) yield (Griffiths 1965)

$$\alpha' + \beta(1 + \delta) > 2 \quad . \tag{2.4.8}$$

Many other inequalities were obtained such as

$$\gamma' \geq \beta(\delta - 1) \tag{2.4.9}$$

$$\gamma(\delta + 1) \geq (2 - \alpha)(\delta - 1) \, . \tag{2.4.10}$$

The assumptions made to obtain them are plausible for most systems, such as $\alpha' \leq \alpha$ or

$$\left(\frac{\partial M^2}{\partial H^2}\right)_T \leq 0 \qquad \text{for} \qquad H \geq 0 \quad .$$

Buckingham and Gunton (1969) and Fisher (1969) have proved the following inequalities

$$(2 - \eta)\nu \geq \gamma \tag{2.4.11}$$

$$d \, \frac{\delta - 1}{\delta + 1} \geq 2 - \eta \tag{2.4.12}$$

and

$$\frac{d\gamma'}{2\beta+\gamma'} \geq 2 - \eta \qquad (2.4.13)$$

where d is the dimensionality of the system.

The additional assumptions that went into those two inequalities 12, 13 are that for all temperatures and $H \geq 0$

$$\begin{aligned} &\Gamma_1 \geq 0 \\ &\Gamma_2(r) - \Gamma_1^2 \geq 0 \\ &\Gamma_4(r_1,r_2,r_3) - \Gamma_2(r_1)\ \Gamma_2(r_3 - r_2) \geq 0 \end{aligned} \qquad (2.4.14)$$

where Γ_2 is the 2 spin correlation function and therefore Γ_1 is proportional to the spontaneous magnetization,

$$\Gamma_1(T,H),\ \Gamma_2(T,H) \text{ and } \Gamma_4(T,H) \qquad (2.4.15)$$

are monotonic non-decreasing functions of H,

$$\Gamma_1(T,H),\ \Gamma_2(T,H) \text{ and } \Gamma_4(T,H) \qquad (2.4.16)$$

are monotonic non-increasing functions of T for any field $H \geq 0$. These assumptions have been proved for the Ising model (Griffiths (1967, 1970)).

The Josephson inequalities (1967) are

$$d\nu' > 2 - \alpha'$$

(2.4.17)

$$d\nu > 2 - \alpha \quad .$$

His assumptions are very general such as constant volume or constant pressure constraints.

One way of stating the basic assumption of static scaling theory (Griffiths (1968)) is to require that the singular part of the Helmholtz potential $\hat{A}$ be a homogeneous function of ε and $|M|^{1/\beta}$

$$\hat{A}(\lambda\varepsilon|\lambda^{\beta}M) = \lambda^{p}\hat{A}(\varepsilon, M) \quad . \qquad (2.4.18)$$

p is an arbitrary scaling parameter and $\varepsilon = (T-T_c)/T_c$. This means that, over the M,ε plane, the singular part of A in an area around the origin will be the same as for a larger scaled area when itself properly scaled. This was first proposed by Widom (1965) and given physical meaning by Kadanoff (1966) who derived this homogeneity for the Ising model by dividing the system into cells of L lattice sites per side, with L large but smaller than $\frac{\xi}{a}$ (ξ: the coherence length, a is the lattice spacing), obtaining the free energy and claiming that it should not depend on L.

Taking first derivative of (2.4.18) with respect to M and substituting

$$\hat{H} = -\left(\frac{\partial\hat{A}}{\partial M}\right)_T$$

we have

$$\lambda^{\beta}\ \hat{H}(\lambda\varepsilon,\ \lambda^{\beta}M) = \lambda^{p}\ \hat{H}(\varepsilon,\ M) \quad . \qquad (2.4.19)$$

Taking a second derivative with respect to M and using $\frac{1}{\hat{\chi}_T} = (\frac{\partial H}{\partial M})_T$, we obtain

$$\lambda^{\beta}\ \hat{\chi}_T^{-1}(\lambda\varepsilon,\lambda^{\beta}\ M) = \lambda^{p}\ \hat{\chi}_T^{-1}(\varepsilon,\ M) \ . \qquad (2.4.20)$$

On the critical isotherm $H \sim M^{\delta}$, setting that in (2.1.20) equating powers of λ

$$\beta + \beta\delta = p \quad .$$

Setting M=0 and $T \rightarrow T_c$ in (2.1.18) yields

$$2\beta + \gamma' = p \quad . \qquad (2.4.21)$$

For M=0, $T \rightarrow T_c^+$ we obtain $2\beta + \gamma = p$. Eliminating p gives the Widom relation

$$\gamma' = \beta(\delta - 1) \qquad (2.4.22)$$

and

$$\gamma = \gamma' \quad . \qquad (2.4.23)$$

Taking more derivatives yields more such relations.

All the rigorous inequalities we quoted in the first part of this section become equalities under the scaling hypothesis (there are others we did not mention that do not). Since A is a function of two variables we can see that only two independent critical exponents are allowed by the scaling hypothesis.

Taking the derivatives of the free energy and using the same homogeneity argument one has a relation for the gap exponents defined in (2.1.7)

$$F^{(3)}(\varepsilon) = \lambda^{2p-3\beta} F^{(3)}(\lambda\varepsilon)$$

but

$$F^{(3)}(\varepsilon) = (-\varepsilon)^{-\Delta_3'} F^2(\varepsilon) \sim (-\varepsilon)^{-\Delta_3'-\gamma'}$$

so

$$\Delta_3' = 2p - 3\beta - \gamma' = \beta + \gamma'$$

but

$$\Delta_2' = 2 - \alpha' - \beta = \beta + \gamma'$$

and

$$\Delta_2' = \beta + \gamma' \quad .$$

Similarly it can be shown that all gap parameters for $T < T_c$ and all even ones for $T > T_c$ are equal.

These results of scaling hold exactly in the 2-dimensional Ising model, and are approximately true for 3-dimensional Ising and Heisenberg models. Some discrepancies can be explained by allowing larger errors in the numerical calculations.

The Kadanoff construction applied to correlation functions yields a scaling behaviour for them which already for the 3-dimensional Ising model is outside the range predicted by numerical calculations.

Since these arguments are extendable to dynamical scaling we will deal with the correlation scaling in the dynamical section of this thesis, and mention here only that the equalities obtained for the static indices are (2.4.11) and (2.4.17) with the equality holding, that is:

$$d\nu' = 2 - \alpha' \qquad d\nu = 2 - \alpha$$

$$(2-\eta)\nu' = \gamma' \qquad (2-\eta)\nu = \gamma \tag{2.4.24}$$

$$d\,\frac{\delta-1}{\delta+1} = \frac{d\gamma'}{2\beta+\gamma'} = 2 - \eta\ .$$

When we assume scaling all those equalities will be assumed.

CHAPTER III

HIGH TEMPERATURE SERIES EXPANSIONS

3.1 General method of graphical expansions

The free energy can be expressed as a formal series in powers of T^{-1}. The method has been expounded by Domb (1960,1965) and by Fisher (1965) in their review articles. We have $Z = \mathrm{Tr}\, \exp((-\mathcal{H}/kT)$ and $-\frac{F}{kT} = \lim_{N\to\infty} \frac{1}{N} (\log Z)$, therefore

$$-\frac{F}{kT} = \lim_{N\to\infty} \frac{1}{N} \log \sum_{n=0}^{\infty} \frac{K^n}{n!} \mathrm{Tr}\, P^n \qquad (3.1.1)$$

where $K = J/kT$ and P is defined by $\mathcal{H} = -JP$. As shown by Rushbrooke and Wood (1958) the logarithm has the effect of taking only the terms linear in N. The free energy being an extensive variable this was to be expected.

$$\log Z = 2 \log N + \log (1 + \sum_{n=1}^{\infty} \mu_n \frac{K^n}{n!}) \qquad (3.1.2)$$

where $\mu_n = \frac{\mathrm{Tr}\, P^n}{\mathrm{Tr}\, I}$. For the spin ½ case $\mathrm{Tr}\, I = 2^N$, I being the direct product of N spinor unit matrices. The coefficients μ_n are polynomials in N and we assume that the logarithm is also expandable in a power series in K

$$\log (1 + \sum_{n=1}^{\infty} \mu_n \frac{K^n}{n!}) = \sum_{n=1}^{\infty} \lambda_n \frac{K^n}{n!} \qquad (3.1.3)$$

which is a definition of the coefficients λ_n. The result can be checked using

$$\lambda_n = \sum_{m=1}^{n} \frac{(-1)^{m+1}}{m} \mu_n^{(m)}$$

but has been proved generally. Hence

$$-\frac{F}{kT} = \sum_{n=0}^{\infty} \frac{K^n}{n!} \text{ Tr* } P^n \tag{3.1.4}$$

where $\text{Tr*}A = \dfrac{(\text{part linear in N of Tr A})}{\text{Tr I}}$.

Our hamiltonian, like all hamiltonians used in critical phenomena, is a sum of pairwise interactions; therefore each term in $\text{Tr*}P^n$ can be represented diagrammatically as a linear graph of n lines and $v \leqslant 2n$ vertices.

$$\text{Tr*}P^n = \sum_i w\ (g_i^n)(g_i^n\ , L)\ . \tag{3.1.5}$$

g_i^n are all possible linear graphs of n lines (i is a dummy index ordering them). (g_i^n, L) is the lattice constant of the graph g_i^n determined by the number of ways the graph g_i^n can be embedded in a lattice L. $w(g_i^n)$ is a weight assigned to the graph, independently of the lattice, depending on the interaction and the graph.

3.2 The graphical expansion method used for the XY model

The properties of the operators a_i and $a_i^\dagger$ simplify the calculations. The method used by Betts, Elliott and Lee (1970) is as follows: The general term wanted for the free energy is Tr* P^n. Each such term will be represented by graphs with n arrows as each power of P contributes a factor $a_i^\dagger a_j$ which can be seen as an arrow from i to j. Therefore a priori all linear graphs of n arrows, and v vertices $v \leq 2n$, can be expected to appear in Tr* P^n.

A non zero contribution can only be obtained when:
(a) an equal number of arrows enter and leave each site;
(b) arrow heads and tails alternate at each site.
This follows because

$$a_i a_i = a_i^\dagger a_i^\dagger = 0 \tag{3.2.1}$$

and

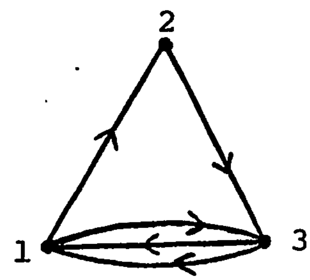
$$\text{Tr } a_i = \text{Tr } a_i^\dagger = 0 \ . \tag{3.2.2}$$

Were there an odd number of operators at a site we could reduce them, two at a time using $\{a_i, a_i^\dagger\} = 1$, to a single traceless operator.

The partition function is the sum of all ordered directed graphs satisfying (a). Several of those will correspond to one directed shadow graph. Several shadow graphs will correspond to one bare graph in which bonds replace the directed arrows.

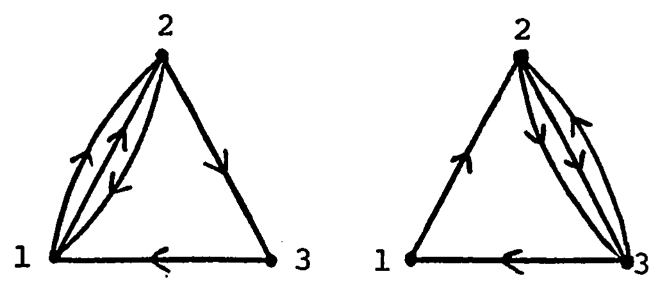
<u>Example</u>

The term Tr* $a_1 a_2^\dagger a_2 a_3^\dagger a_3 a_1^\dagger a_1 a_3^\dagger a_3 a_1^\dagger$ corresponds to the shadow graph

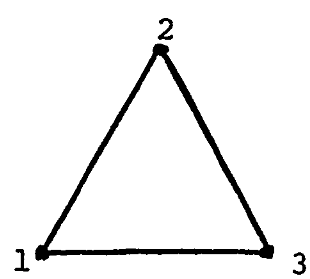


Out of 5!=120 possible orderings of the 5 arrows only 20 will give a non zero contribution and they all correspond to the same shadow graph.

This shadow graph is equivalent to 5 other shadow graphs, the following two



and those obtained from these three by reversing all arrows. All six are represented by the same bare graph



The trace of each such graph is 2^{N-s}, where s is the number of vertices of the bare graph, since for spin ½ the trace of the unit matrix is 2 while Tr $a_i^\dagger a_i =$

$\mathrm{Tr}\ a_i a_i^\dagger = 1$. This is a great simplification compared to the Heisenberg model where traces of different spin operators have to be calculated.

The horizontal weight of each shadow graph g' is defined by

$$h(g') = \varepsilon(g')\ S(g)/S(g') \tag{3.2.3}$$

where S(g) is the symmetry number of the bare graph g, S(g') is the symmetry number of the shadow directed graph g' and ε(g') equals one if g' is equivalent to the graph obtained from it by reversing all arrows. Going back to the above example, the symmetry number of the triangle is 6, and the symmetry number of our graph is 1. ε(g') = 1 as in this case interchange of two labels is the same as reversal of arrows. Equivalence of shadow graphs is defined as follows: two graphs are equivalent if their arrows and vertices are in one to one correspondence. Such a correspondence is an embedding. The number of embeddings of one graph in itself is its symmetry number.

The vertical weight v(g') is defined as the number of allowed ordered directed graphs corresponding to the shadow graph g'. In our example that number was 20. Allowed here meant giving a non zero contribution, therefore satisfying criterion (b).

All these weights are calculated by computer; for that purpose graphs are represented, as usual, by matrices or vectors. For the directed shadow graph the matrix element M(i,j) is the number of arrows from i to j. The bare graph matrix has a unit element in a location i,j if the vertices i and j are connected, and zero otherwise. For our example

$$M(g') = \begin{pmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ 2 & 0 & 0 \end{pmatrix} \quad , \; M(g) = \begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix} .$$

In order to exclude equivalent graphs, to find among a group of lattice constants the one pertaining to the bare graph and to calculate the horizontal weight the incidence matrices defined above were used.

For the vertical weight another kind of matrix representation was used. The matrix is rectangular. Rows denote order of arrows, and the columns specify vertices. The arrow in the k'th position being i-j the matrix elements in the k'th row will be N(k,i)=1, N(k,j)=-1. The vertical weight of the graph corresponds therefore to the number of permutations of rows of the matrix N that alternate 1 and -1 in each column. Full use of efficient methods of counting permutations was made in the computer program written by Dr. C.J. Elliott for the free energy calculation. This calculation being rather time consuming for higher order graphs, several theorems were proved (Betts, Elliott and Lee (1970)) which reduced noticeably the computer time required and were based on full use of the fact that there are no restrictions at vertices of order 2. We will mention those used and their generalizations for our calculations in the next section.

To summarize, the final contribution to the term $Tr^* P^n$ is

$$\sum_{g'_{n,i}} (g_{n,i}, L) v(g'_{n,i}) h(g'_{n,i}) \, 2^{-s} \qquad (3.2.4)$$

where the sum is over all inequivalent directed shadow graphs of n arrows, $g'_{n,i}$. Note that the lattice constant is that of the bare graph $g_{n,i}$ the horizontal weight giving the occurrence of the directed graph $g'_{n,i}$ for each bare graph, the vertical weight being the number of allowed orders of the arrows and 2^{-s} being the actual trace.

3.3 The series expansion method for the initial parallel susceptibility

A. The XY model is invariant under rotation in the xy plane, therefore we can choose any direction in that plane to calculate the initial parallel susceptibility. We add a Zeeman term and the resulting hamiltonian is:

$$\mathcal{H} = - J \sum_{\langle ij \rangle} (a_i^+ a_j + a_i a_j^+) - H_x M_x \quad . \tag{3.3.1}$$

The initial parallel susceptibility is defined by

$$\chi_\parallel^o \equiv \chi_o^{xx} = \frac{1}{N\beta} \frac{\partial^2}{\partial H_x^2} \log Z \Big|_{H_x=0} \quad . \tag{3.3.2}$$

For models where $[M,H] = 0$ this reduces to $\frac{1}{N} \langle M_x^2 \rangle$, which is the square of the fluctuation in the long range order. The relation between the two is discussed in Subsection 3.3B. Using the notation of the last section, $\mathcal{H} = - J P$, we have:

$$\chi_\parallel^o = \frac{1}{N\beta} \frac{\partial^2}{\partial H_x^2} \log \mathrm{Tr}\, e^{\beta(JP + H_x M_x)} \Big|_{H_x=0} \quad . \tag{3.3.3}$$

As before we use the relation

$$\frac{1}{N} \log \mathrm{Tr}\, e^{\beta A} = \sum \frac{\beta^n}{n!} \mathrm{Tr}^* A^n \tag{3.3.4}$$

and obtain:

$$\chi_{\parallel}^{o} = \frac{1}{\beta} \frac{\partial^2}{\partial H_x^2} \Sigma \frac{\beta^n}{n!} \mathrm{Tr}^*(JP + H_x M_x)^n \Big|_{H_x=0} \quad . \tag{3.3.5}$$

We take the second derivative and set $H_x=0$. This means keeping only the term proportional to H_x^2. The coefficient of H_x^2 in $\mathrm{Tr}^*(JP + H_x M_x)^n$ can be written in the following form:

$$\tfrac{1}{2}\, \mathrm{Tr}^* \sum_{k=0}^{n-2} n(JP)^k\, M_x (JP)^{n-2-k}\, M_x \quad . \tag{3.3.6}$$

We obtain (3.3.6) as follows: The term with two factors B in Tr $(A + B)^n$ is

$$\mathrm{Tr} \sum_{\ell=0}^{n-s-2} \sum_{s=0}^{n-2} A^{\ell}\, BA^{n-2-\ell-s}\, BA^{s} \quad .$$

We use the cyclic property of the trace to bring the factor A^s to the front. The last expression reduces to

$$\mathrm{Tr} \sum_{j=0}^{n-2} (j+1)\, A^j\, BA^{n-2-j}\, B \tag{3.3.7}$$

as $j = \ell+s$ can be obtained in j+1 ways by adding two integers ℓ and s. Again we invoke the cyclic property of the trace and note that $\mathrm{Tr}\, A^j\, B\, A^{n-2-j}\, B = \mathrm{Tr}\, A^{j'} B\, A^{n-2-j'} B$ for $j' = n-2-j$. We add those two terms and divide by two,

$$\tfrac{1}{2}[(j+1) + (n-2-j+1)] \ \mathrm{Tr}\ A^j\ BA^{n-2-j}\ B$$

$$= \tfrac{1}{2}\ n\ \mathrm{Tr}\ A^j\ BA^{n-2-j}\ B \quad . \tag{3.3.8}$$

For even n the sum (3.3.7) has an odd number of terms. Still the expression (3.3.8) holds because the middle term occurs for $j = \frac{n-2}{2}$ and is $\frac{n}{2}\ \mathrm{Tr}\ A^j\ BA^{n-2-j}\ B$.

Now that we have justified the use of (3.3.6) we can substitute it in (3.3.5) and obtain

$$\chi^o_{\parallel} = \frac{1}{J} \sum_n \frac{K^{n-1}}{(n-1)!} \sum_{k=0}^{n-2} \mathrm{Tr}^*\ P^k\ M_x\ P^{n-2-k}\ M_x \quad . \tag{3.3.9}$$

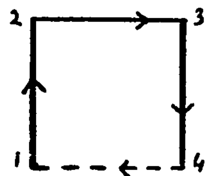
We have $M_x = \frac{m}{2} \Sigma\ (a_i^\dagger + a_i)$, hence

$$\chi^o_{\parallel} = \frac{1}{J} \sum_n \frac{K^n}{n!} \sum_{k=0}^{n-1} \sum_{i,j} \mathrm{Tr}^*(P^k a_i^\dagger P^{n-1-k} a_j + P^k a_i P^{n-1-k} a_j^\dagger) \quad . \tag{3.3.10}$$

Each term in $\mathrm{Tr}^*(P^k a_i^\dagger P^{n-1-k} a_j)$ can be represented by a graph with n-1 solid arrows and a dotted arrow. The dotted arrow represents the term $a_i^\dagger a_j$ which is not restricted to nearest neighbours. For i=j we have a graph of n-1 solid arrows and a dotted "bubble" which can be on a vertex of the graph or off the graph.

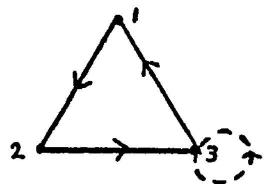
The calculation is done separately for the three cases:

(a) $i \neq j$ Each ij term occurs twice therefore the extra factor 2 in (3.3.12).



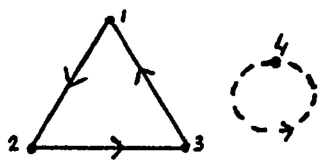
$$a_1^\dagger a_2 a_2^\dagger a_3 a_4^\dagger a_3^\dagger a_4 a_1 \;.$$

(b) $i=j$ and i is on the graph



$$a_1^\dagger a_2 a_3^\dagger a_2^\dagger a_3 a_3^\dagger a_1 a_3$$

(c) $i=j$ and i is not on the graph



$$a_1^\dagger a_2 a_2^\dagger a_3 a_3^\dagger a_1 a_4^\dagger a_4 \;.$$

Case (c) is the simplest. Since i is not on the graph g_{n-1}, $a_i^\dagger$ and a_i commute with the factors P and

$$\mathrm{Tr}^* \, (P^k a_i^\dagger P^{n-1-k} a_i + P^k a_i P^{n-1-k} a_j^\dagger) = \mathrm{Tr}^* \, P^{n-1} \;.$$

But here $\mathrm{Tr}^* \, P^{n-1}$ does not give the same contribution as g_{n-1} gave in the partition function. The lattice constant is now the separated lattice constant $(g_{n-1} \cdot ; L)$, which is $-s(g_{n-1};L)$. s is the number of vertices of g_{n-1}.

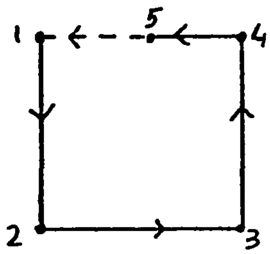
The other factors, horizontal and vertical weights and trace are the same as in the partition function.

The resulting series is:

$$\chi_{\parallel}^{o(c)} = -\frac{K}{J} \Sigma \frac{K^{n-1}}{(n-1)!} \sum_{g_{n-1}} \frac{h(g_{n-1})(g_{n-1};L) s \, V(g_{n-1})}{2^s} \qquad (3.3.11)$$

The weights are given in Table A.9 in the Appendix.

For case (a) $i \neq j$, the dotted arrow is placed with the head at the last level and we sum over all allowed levels for its tail. Since vertices of order 2 add no restrictions we introduce, for the vertical weight calculation only, a spurious vertex in the dotted arrow.



$a_1^\dagger a_2 a_2^\dagger a_3 a_4^\dagger a_5 a_3^\dagger a_4 a_5^\dagger a_1$

We allow the new arrow formed by the former tail and the spurious vertex to permute freely with the other solid arrows. The arrow formed by the spurious vertex and the tail is kept fixed at the last level.

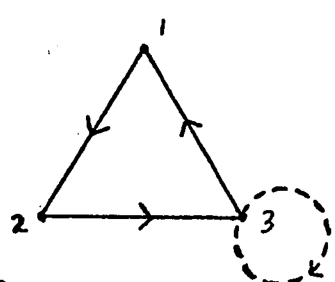
The lattice constant is calculated after deleting the dotted arrow since it is not restricted to nearest neighbours. The horizontal weight is as defined in (3.2.3). In order to keep the dotted arrow different from the others we put a minus sign in front of the matrix element $M(i,j)$. $N(i,j)$ and $N(j,i)$ become zero if no other arrow connects i and j.

The graphs were obtained by Betts, Elliott and Lee (1970) for the fluctuation series. We calculated the new vertical weights only

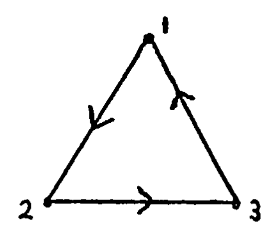
$$\chi_{\parallel}^{o(a)} = \frac{2}{J} \sum_n \frac{K^n}{n!} \sum_{g''_{n-1}} \frac{h(g''_{n-1})v(g''_{n-1})(g_{n-1},L)}{2^s} \qquad (3.3.12)$$

where g''_{n-1} is the graph with n-1 solid arrows and a dotted arrow. g_{n-1} is the bare graph with the dotted arrow removed. The weights are given in Table A.5.

In case (b) we have $i = j$, $i \varepsilon g$. The same procedure as for case (a) is followed for the vertical weight calculation. Lattice constants are those of the bare graph without the bubble. The graphs were generated by taking the partition function graph adding a "bubble" at each vertex and eliminating equivalent graphs. We kept the spurious vertex, s+1, in the generation process and the horizontal weight calculation. In order to keep the bubble different we introduced a minus sign in M(i,s+1), M(s+1,i) and set N(i,s+1)=N(s+1,i)=0, that is the bubble is deleted in the bare graph. The result is reflected in the following example



g_3^b bubble graph



g_3 corresponding bare graph

Let g_{n-1}^b be a partition function graph g_{n-1} with a bubble on, then:

$$\chi_{\parallel}^{o}\,(b) = \frac{1}{J} \Sigma \frac{K^n}{n!} \sum_{g_{n-1}^b} \frac{h(g_{n-1}^b)\,v(g_{n-1}^b)\,(g_{n-1},L)}{2^s} \quad . \qquad (3.3.13)$$

The weights can be calculated from Table A.7.

The calculation of fluctuation type vertical weights (one arrow fixed) is facilitated by the lemmas and theorems of Betts, Elliott and Lee (1970).

Lemma 1

Let g be a graph with ℓ arrows and g* is the graph obtained from g by turning one arrow into a dotted arrow. Let there be ℓ_1 arrows from vertex a to vertex b one of which is the dotted arrow. Then

$$v_{g*} = \frac{v_g \cdot \ell_1}{\ell} \quad .$$

Proof

If $\ell_1 = 1$ fixing one arrow at a level reduces the number of possible vertical orderings by $\frac{1}{\ell}$. The reason is in the cyclical property of the trace, all cyclic permutationsof an allowed permutation are allowed.
If $\ell_1 > 1$ there are ℓ_1 arrows which were indistinguishable in g and by fixing one we made them distinguishable.

Lemma 2

Let g be a graph with ℓ arrows and s vertices and let one arrow be of order 2 in both vertices. Then, one vertex of order 2 can be eliminated. The resulting graph of ℓ-1 arrows and s-1 vertices has a vertical weight v_1.

$$v = v_1 \cdot \ell \quad .$$

The procedure can be repeated and all arrows of order 2 in both vertices eliminated. The proof is obvious.

Theorem I

Let g be a disconnected shadow graph of ℓ arrows consisting of two subgraphs g_1 and g_2 having no vertices in common. If g_1 and g_2, consisting of ℓ_1 and ℓ_2 arrows respectively, have vertical weights v_1 and v_2, then the vertical weight, v, of g is given by

$$v = (\ell!/\ell_1!\ \ell_2!)\ v_1\ v_2 \quad . \qquad (3.3.14)$$

Proof

As there is no interference between the arrangements in the two subgraphs the vertical weight of the graph g is given by the product of two factors. The first is the number of ways of assigning ℓ vertical levels such that ℓ_1 are occupied by the arrows of g_1 and the remaining $\ell_2 = \ell - \ell_1$ are occupied by the arrows of g_2. The other factor is then the product of the vertical weights of the component subgraphs.

Theorem II

Let a connected shadow graph g of ℓ arrows be composed of two subgraphs g_1 and g_2 of ℓ_1 and ℓ_2 arrows respectively such that g_1 and g_2 have m common vertices of order 2 in g (hence of order 1 in each of g_1 and g_2)

and no other common vertices. Then the vertical weight, v, of g is given by the same expression as in theorem I.

Proof

As there is no restriction on head and tail vertical sequence at vertices of order 2, the vertical weight of g must be the same as that of a separated graph g' consisting of subgraphs g_1 and g_2. But the vertical weight of g' is given by (3.3.14) and so the theorem is established.

Theorem III

Consider a shadow graph g of order ℓ composed of two subgraphs g_1 and g_2 of $\ell_1 - 1$ and $\ell_2 - 1$ arrows respectively and a third subgraph g_3 consisting of a single arrow. The subgraphs g_1 and g_2 have in common m vertices of order 2 in g and no other common vertices. The subgraph g_3 (the single arrow) connects vertices of arbitrary (even) order orders r_1 and r_2 in g_1 and g_2 respectively. Then the vertical weight of g is given by (3.3.14) again. However, now v_1 and v_2 are the vertical weights of the graphs g_1' and g_2' where g_1' is a subgraph of g consisting of g_1 and g_3, and g_2' is a subgraph consisting of g_2 and g_3. It is important also to note that $\ell_1 + \ell_2 = \ell + 1$.

Proof

Observe first that the vertical weight of g is the same as that of the graph g' obtained from g by separating all the second order vertices. Next observe that in counting the number of allowed arrow configurations for any shadow graph of order ℓ we may assume that one arrow is at a fixed level and compute the number, n, of allowed configurations of the remaining arrows. Then the vertical weight, $v=\ell n$.

In g' let the arrow forming g_3 be fixed. The remaining $\ell - 1$ arrows belong either to g_1 or g_2. The ℓ_1-1 arrows may be arranged among the $\ell_1 -1$ levels assigned to g_1 in n_1 ways independently of the arrangement in n_2 ways of the $\ell_2 - 1$ arrows of g_2 among the $\ell_2 - 1$ levels assigned to g_2. The $\ell - 1$ levels may be assigned in $(\ell -1)!/(\ell_1 -1)!(\ell_2 -1)$ ways giving

$$n = n_1 n_2 (\ell-1)!/(\ell_1-1)!(\ell_2-1) \quad . \tag{3.3.15}$$

Noting that $n_1 = v_1/\ell_1$ and $n_2 = v_2/\ell_2$ the result (3.3.14) follows.

B. We discuss here the relation of the fluctuation to the intial susceptibility.

As seen in Sec. 5.4

$$\chi_T = \int_0^\beta < M\, e^{\lambda \mathcal{H}} M\, e^{-\lambda \mathcal{H}} > d\lambda \tag{3.3.16}$$

but

$$e^{\lambda \mathcal{H}} M\, e^{-\lambda \mathcal{H}} = M + \lambda\, [\mathcal{H}, M] + \frac{\lambda^2}{2!} [\mathcal{H}, [\mathcal{H}, M]] + \ldots \tag{3.3.17}$$

therefore

$$\chi_T = \beta Y + \frac{\beta^2}{2!} \langle M[\mathcal{H},M]\rangle + \ldots \qquad (3.3.18)$$

Each successive term in (3.3.18), when expanded in a high temperature series, starts its contribution at a higher power of β and its contribution is less divergent. The reason is that in a term $\langle M[\mathcal{H},[\mathcal{H},[\ldots[\mathcal{H},M]]]\ldots]\rangle$ each commutator has the effect of removing two spins.

Falk and Bruch (1969) proved that for a general thermodynamical system

$$\frac{1 - e^{-\frac{1}{2}\beta\bar{\omega}}}{\frac{1}{2}\beta\bar{\omega}} \leqslant \frac{\chi_T}{\beta Y} \leqslant 1 \qquad (3.3.19)$$

where

$$\bar{\omega} = \frac{\langle[M,[\mathcal{H},M]]\rangle}{2Y} \quad . \qquad (3.3.20)$$

The equality of the indices for Y and χ_T follows from the assumption that the numerator in $\bar{\omega}$ is finite as $T \to T_c$. Though $\langle[M,[\mathcal{H},M]]\rangle$ has been shown to be finite for the isotropic Heisenberg model by Mermin and Wagner (1966), their proof cannot be generalized to the parallel susceptibility of the XY model.

Our results indicate that $\langle[M,[\mathcal{H},M]]\rangle$, which is the first moment of the frequency dependent susceptibility is not finite. As $T \to T_c$ the first moment diverges with exponent $\alpha_2 \approx 0.09$. Nevertheless $\omega \xrightarrow[T\to T_c]{} 0$ because the fluctuation, Y, diverges much more strongly.

The proof of Falk and Bruch follows from the following expressions for the susceptibility

$$\chi_T = 2 \int_0^{\beta/2} d\lambda < e^{\lambda \mathcal{H}} M \, e^{-\lambda \mathcal{H}} M > \tag{3.3.21}$$

and

$$\chi_T = \int_{-\infty}^{\infty} d\omega \; S_o(\omega) \; \frac{(1-e^{-\beta\omega/2})}{\frac{1}{2}\,\omega} \tag{3.3.22}$$

where

$$S_o(\omega) = \frac{1}{2\pi N} \int_{-\infty}^{\infty} dt \; e^{-i\omega t} <M,M(t)>$$

and

$$\int_{-\infty}^{\infty} d\omega \; S_o(\omega) = Y \quad .$$

The integrand in (3.3.21) has a maximum at $\lambda=0$, from which it follows that

$$\chi_T \leqslant Y \quad .$$

The second inequality follows using the convexity of $\frac{1-e^{-x}}{x}$.

3.4 Fourth order fluctuation

The gap parameter was defined in (2.1.7). To calculate the gap parameter one has to calculate the critical index, γ_2, of

$$F_2 = \frac{1}{Nm^4\beta^4} \frac{\partial^4}{\partial H_x^4} \log Z \Big|_{H_x=0} , \tag{3.4.1}$$

The gap parameter Δ is then

$$\Delta = \tfrac{1}{2} (\gamma_2 - \gamma) . \tag{3.4.2}$$

We note that upon differentiation (3.4.1) becomes

$$Nm^4\beta^4F_2 = \frac{\frac{\partial^4}{\partial H_x^4} \mathrm{Tr}\, e^{\beta(JP+M_xH_x)}\Big|_{H_x=0}}{\mathrm{Tr}\, e^{KP}} - 3 \left[\frac{\frac{\partial^2}{\partial H_x^2} \mathrm{Tr}\, e^{\beta(JP+M_xH_x)}\Big|_{H_x=0}}{\mathrm{Tr}\, e^{KP}}\right]^2 \tag{3.4.3}$$

To obtain (3.4.3) we made use of the fact that above T_c and at H=0 odd derivatives of Z vanish.

When the magnetization and Hamiltonian commute, (3.4.3) reduces to

$$\beta^4 \{\langle M_x^4\rangle - 2 \langle M_x^2\rangle^2\} . \tag{3.4.4}$$

The second term in (3.4.3) is proportional to $(\chi_{\parallel}^{o})^2$. In Section 3.3B we saw that $\chi_{\parallel}^{o}$ behaves like $<M_x^2>$ as $T \to T_c$. The first term in (3.4.3) is

$$\frac{\beta^4 m^4}{Z} \sum_n \frac{K^{n-4}}{(n-4)!} \mathrm{Tr} \sum_{ij\ell k} P^j M_x P^k M_x P^\ell M_x P^i M_x \quad . \qquad (3.4.5)$$

The difference between (3.4.5) and $<M_x^4>$ is in terms of commutators of M and $\mathcal{H}$. By physical reasoning this difference is expected not to diverge, or diverge less than the same quantity with the commutator brackets removed.

As mentioned in Section 3.3B commutators have the effect of removing two spins from each trace, thereby reducing the divergence.

A more rigorous treatment means going to the fourth order in the field in the expression for the density matrix

$$(\frac{-1}{ih})^4 \int_{-\infty}^{t} \int_{-\infty}^{t_1} \int_{-\infty}^{t_2} \int_{-\infty}^{t_3} e^{\frac{it\mathcal{H}}{h}} [M_x(t_1),[M_x(t_2),[M_x(t_3),[M_x(t_4),\rho]]]]$$

$$\times\, e^{\frac{-it\mathcal{H}}{h}} dt_1 dt_2 dt_3 dt_4 \;, \qquad (3.4.6)$$

which is rather complicated.

We treat therefore

$$Y_2 \simeq \frac{16}{m^4} \frac{1}{N} \{ \frac{3}{2} < M_x^2 >^2 - \frac{1}{2} < M_x^4 > \} \quad . \qquad (3.4.7)$$

The definition (3.4.7) has the advantage of yielding a positive series starting with unity.

The term $<M_x^4>$ is a sum over four indices

$$<M_x^4> = \frac{m^4}{16} \sum_{i,j,k,\ell} <\sigma_i^x \sigma_j^x \sigma_k^x \sigma_\ell^x> \quad .$$

We consider all possible cases for the summand and list them below:

(i) $<\sigma_a^{x4}>$

(ii) $<\sigma_a^{x2} \sigma_b^{x2}>$, $a \neq b$

(iii) $<\sigma_a^{x3} \sigma_b^{x}>$, $a \neq b$

(iv) $<\sigma_a^{x2} \sigma_b^{x} \sigma_c^{x}>$, $a \neq b \neq c$

(v) $<\sigma_a^{x} \sigma_b^{x} \sigma_c^{x} \sigma_d^{x}>$, $a \neq b \neq c \neq d$

Summing (i) - (v) separately, we obtain

$$<M_x^4> = \frac{m^4}{16} \{ N + 3N(N-1) + 8N \sum_{j \neq 0} <\sigma_o^x \sigma_j^x>$$

$$+ 12N(N-2) \sum_{j \neq 0} <\sigma_o^x \sigma_j^x> + \sum_{i \neq j \neq k \neq \ell} <\sigma_i^x \sigma_j^x \sigma_k^x \sigma_\ell^x> \} \qquad (3.4.8)$$

$$\langle M_x^2\rangle = \frac{m^2N}{4}\,(1 + 2 \sum_{j\neq 0} \langle \sigma_o^x\sigma_j^x\rangle)$$

$$3\langle M_x^2\rangle^2 = \frac{m^4N^2}{16}\,(3 + 12 \sum_{j\neq 0} \langle\sigma_o^x\sigma_j^x\rangle + \tag{3.4.9}$$

$$+ 12 \sum_{\substack{j\neq 0\\ k\neq 0}} \langle \sigma_o^x\sigma_j^x\rangle \langle\sigma_o^x\sigma_k^x\rangle)$$

We see that the parts of the second and fourth terms in (3.4.7) which were proportional to N^2 are cancelled by the first two in (3.4.9). The third term of (3.4.9) subtracted from $\sum_{i\neq j\neq k\neq \ell} \langle\sigma_i^x\sigma_j^x\sigma_k^x\sigma_\ell^x\rangle$ leaves the part which is linear in N.

When $[M,\mathcal{H}] = 0$ there is no need to check on linearity in N, as F_2 is a derivative of the free energy which we know to be linear in N.

We can define a generalized exponential e_g^{A+B} in which factors B will always be taken to the front

$$e_g^{A+B} = e^A . e^B \quad .$$

Using this definition of order we see that

$$Y_2 = \frac{16}{Nm^4\beta^4}\;\frac{\partial^4}{\partial H_x^4}\log_g\;\; \mathrm{Tr}\; e_g^{-\beta(\mathcal{H}-M_xH_x)}\Big|_{H_x=0}$$

Kubo (1962) discussed these generalized exponentials and the calculation of generalized cumulants and moments with them. The relation between cumulants and moments remains unchanged as long as we apply the generalized order consistently. Therefore

$$\log_g \ \mathrm{Tr}\ e_g^{-\beta(\mathcal{H}-M_x H_x)}$$

is equal to the cumulant expansion series which is linear in N.

We see from (3.4.8) and (3.4.9) that

$$Y_2 = \frac{16m^4}{N} \{ 1 + 8 \sum_{j\neq 0} < \sigma_o^x \sigma_j^x > - Q \} \qquad (3.4.11)$$

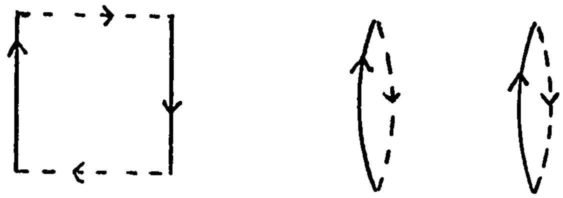
where

$$Q = -\tfrac{1}{2} \sum_{j\neq j\neq k\neq \ell} \frac{K^n}{n!} \ \mathrm{Tr}^* \ P^n \sigma_i^x \sigma_j^x \sigma_k^x \sigma_\ell^x \quad .$$

The second term in (3.4.11) is four times the flucutation series apart from the initial unity. We calculate the third term. We generate the graphs by opening two bonds in the partition function graphs, under the restriction that the four vertices be distinct.

We note that each graph $P^n a_a^\dagger a_b a_c^\dagger a_d$ appears 24 times in the sum as each index i, j, k, ℓ can take any value a, b, c, or d. On the other hand we are counting each term twice in the graphical expansion because the dotted arrow associated with $a_a^\dagger a_b a_c^\dagger a_d$ can be either

$a \to b$, $c \to d$ or $a \to d$, $c \to b$, for example



Therefore

$$Q = -6 \sum_{n} \frac{K^n}{n!} \sum_{g'_{n+2}} \frac{h(g'_{n+2})V(g'_{n+2})(g_n, L)}{2^s} . \quad (3.4.12)$$

The vertical weight is calculated with the dotted arrows fixed at the last two levels (since the four vertices are distinct their order is immaterial).

For elimination of equivalent graphs and calculation of horizontal weights the matrix elements M(a,b), M(c,d) are preceded by a minus sign. N(a,b), N(b,a), N(c,d) and N(d,c) are zero if the vertices a-b and c-d respectively are not connected by other arrows.

CHAPTER IV

THE SERIES FOR THE STATIC QUANTITIES AND THEIR ANALYSIS

4.1 Series analysis

The functions we deal with are assumed to have near T_c an asymptotic behaviour of the form:

$$f(x) \sim A(x_c - x)^{-(g+1)} \quad . \tag{4.1.1}$$

We have a finite number of terms in a series expansion of f(x) in powers of x. Two basic methods have been developed to obtain estimates of x_c and g from this truncated expansion

$$f(x) = \sum_{n=0}^{N} a_n x^n + R_N \quad . \tag{4.1.2}$$

(a) The ratio method

This method was first used by Domb and Sykes (1957). Had (4.1.1) been an exact equality, using the binomial expansion we would see that the ratios r_n defined by

$$r_n = a_n/a_{n-1} \tag{4.1.3}$$

would be equal to

$$r_n = \frac{1}{x_c}\left(1 + \frac{g}{n}\right) \quad . \tag{4.1.4}$$

If the series (4.1.2) converges, its radius of convergence in the complex x plane is the distance from the origin to the first singularity. The limit of $|r_n^{-1}|$, if it exists, is the radius of convergence. For series with all positive terms the first singularity must lie on the positive real axis and can be expected to be the physical singularity we are seeking; therefore we expect the ratios to approach x_c^{-1} as $n \to \infty$. Since we expect (4.1.1) to hold near x_c the relation (4.1.4) will obtain in the limit $n \to \infty$. A plot of r_n against $1/n$ will therefore approach a straight line with intercept $1/x_c$ at $\frac{1}{n}=0$ and a limiting slope of g.

Various modifications and refinements of the ratio method have been introduced. Neville tables have been used by Baker, Eve, Gilbert and Rushbrooke (1968) which are successive linear extrapolations. The quantities l_n, q_n etc. are constructed $l_n = n\, r_n - (n-1)\, r_{n-1}$, $q_n = \frac{1}{2}\left[n\, l_n - (n-2)\, l_{n-1}\right]$, $c_n = \frac{1}{3}\left[n\, q_n - (n-3)\, q_{n-1}\right]$, etc., and as long as they are monotonic they provide improved estimates of x_c^{-1}. Once the critical point is evaluated, better estimates for the exponent can be obtained by the relation (Domb and Sykes (1957))

$$n\left[x_c(a_n/a_{n-1}) - 1\right] \to g \qquad \text{as } n \to \infty \quad .$$

If this sequence is monotonic a Neville table can be constructed for it too. Given an estimate g' of g one can obtain a better estimate for x_c from the sequence

$$r_n(n/(n + g')). \tag{4.1.5}$$

Alternate ratios are often used to smooth out oscillations for loose packed lattices. Fisher (1962) suggested the sequences

$$r_n' = \tfrac{1}{2}\{(n+\varepsilon)\ r_n - (n+\varepsilon-2)\ r_{n-2}\} \tag{4.1.6}$$

for a choice of small ε.

In general the series will have non physical singularities too; the ratio sequence will converge more rapidly when they are far from the circle of convergence.

For series of alternating sign the dominant singularity will be on the negative real axis and for this and for the general non positive series the ratio method will not yield the physical singularity. On the other hand a pair of singularities close to the real axis could show as a consistent limit while the series is well behaved on the real axis and has no physical singularity, but for three dimensional cases we expect a physical singularity so this problem occurs only in the two dimensional case. Transformations of variable, usually bilinear, have been used to bring the physical singularity in to be the closest to the origin (Wortis (1969), Guttman, Thompson (1969)), with noticeable success.

(b) Pade approximants

The (N,M) Pade approximant to a power series F(x) is the ratio of two polynomials of degree N and M, whose N+M+1 coefficients are determined uniquely by the requirement that the coefficients of the power expansion of the ratio be equal to those of F(x) up to the N+M order.

$$[N,M] = \frac{P(x)}{Q(x)} = \frac{p_o+p_1x + ..p_Nx^N}{1+q_1x +.. q_Mx^M} . \tag{4.1.7}$$

First introduced to critical phenomena by Baker (1961) it has proved an invaluable tool for the analysis of series and especially for non positive series where the ratio method does not apply.

In a series of papers Baker has shown that for certain classes of functions the [M,M] and [M-1,M] approximants form upper and lower bounds to F(x) for real positive x and that subsequences of the diagonal approximants converge to F(z) everywhere in the complex plane as $M \to \infty$.

The zeroes of the denominator are calculated and the singularity of F(x) shows up consistently, usually as the smallest positive zero. Obviously the approximation is better if the function's singularity is a simple pole; therefore it is customary to calculate Pade approximants to

(i) $\frac{\partial}{\partial z} \log F(z)$,

or if an estimate of γ is known to

(ii) $[F(z)]^{1/\gamma}$, and

(iii) $[\frac{\partial}{\partial z} F(z)]^{1/\gamma+1}$.

We have assumed

$$F(z) = (z_c - z)^{-\gamma} G(z) \tag{4.1.8}$$

with G(z) a non singular function at z_c. It follows immediately that

$$\text{(i)} \quad \frac{z}{dz} \log F(z) = - \frac{\gamma}{z-z_c} + \frac{d}{dz} \log G(z) \quad . \tag{4.1.9}$$

So if G(z) has no zeroes near z_c that pole should appear with good convergence in the Pade tables.

$$\text{(ii)} \quad (F(z))^{1/\gamma+\varepsilon} = (z_c - z)^{-1-\varepsilon} (G(z))^{1/\gamma+\varepsilon} \quad . \tag{4.1.10}$$

Here the convergence is better as the zeroes of G(z) will not interfere. (iii) with an approximate γ is:

$$(\frac{\partial F(z)}{\partial z})^{1/\gamma+1+\varepsilon} = (-\gamma G(z))^{1/\gamma+1+\varepsilon} (z_c - z)^{-1-\varepsilon} +$$

$$+ (\frac{\partial G}{\partial z})^{1/\gamma+1+\varepsilon} (z_c - z)^{-\gamma/\gamma+1} \quad . \tag{4.1.11}$$

Here the convergence will be slower than in (4.1.10) because of the second term but still better than (4.1.9). When the estimates for γ are not close to the real value one expects a shift in the estimate for z_c from Pade approximants to (4.1.10) and (4.1.11) since

$$(z_c - z)^{-1+\varepsilon} g(z) = (z_c)^{-1+\varepsilon} g(z)\left[1 + (\varepsilon-1)\frac{z}{z_c} + 0\left(\frac{z}{z_c}\right)^2\right]. \tag{4.1.12}$$

So to a first approximation the pole of this junction is at

$$y_c \approx \frac{z_c}{1-\varepsilon} \approx z_c(1 + \varepsilon)$$

varying the value of ε and plotting y_c against ε. We have a straight line, for ε small enough (in practice up to rather large values), whose intercept with the correct value of z_c will give a very good estimate of the exponent.

Another way of estimating the exponents is to calculate the Pade approximant at z_c to

$$(z-z_c)\frac{d}{dz}\ln F(z) = \gamma + 0(z-z_c) \quad . \tag{4.1.13}$$

A method which is less sensitive to the choice of z_c was introduced by Baker, Eve, Gilbert and Rushbrooke (1968); the Pade approximant at z_c to

$$\frac{d}{dz} \ln \frac{dF(z)}{dz} \bigg/ \frac{d}{dz} \ln F(z) \qquad (4.1.14)$$

gives an estimate for $\frac{\gamma+1}{\gamma}$. Since (4.1.14) is $\frac{\gamma+1}{\gamma}$ at all z not far from z_c, this is insensitive to the choice of z_c. A plot of the Pade approximants to (4.1.14) gives a straight line in a γ against z_c plot. Its intercept with the straight line obtained from (4.1.10) yields a simultaneous estimate of γ and z_c.

4.2 The static series and their analysis

Using the graphical expansions outlined in Chapter III, we have obtained the initial parallel susceptibility and fourth order fluctuation high temperature series for the face-centered cubic and triangular lattices. This choice of lattices was made because the close packed lattices are known to yield better behaved high temperature series.

For the Heisenberg model it is also desirable to study the staggered susceptibility on loose packed lattices in order to locate the Néel point, T_N. However there is no reason to do these calculations on the loose packed lattices since for the XY model the staggered parallel susceptibility is equal to the parallel ferromagnetic susceptibility.

The series obtained are:

for the face centered cubic lattice,

$$\bar{\chi}^{o}_{\parallel} = 1 + 6K + 32K^2 + 161.5K^3 + 792.3K^4 + 3823.924K^5 + \\ + 18262.124K^6 + 86567.462K^7 + 402842.0556K^8 + \ldots$$

$$Y_2 = 1 + 24K + 339K^2 + 3656K^3 + 33176.25K^4 + 268835K^5 + \\ + 2010189.817K^6 + 13768318.21K^7 + \ldots$$

for the triangular lattice,

$$\bar{\chi}^{o}_{\parallel} = 1 + 3K + 7K^2 + 13.75K^3 + 25.25K^4 + 41.0125K^5 + \\ + 67.6702K^6 + 109.50186K^7 + 170.5454K^o + \ldots$$

$$Y_2 = 1 + 12K + 79.5K^2 + 379K^3 + 1432.875K^4 + 4621.5K^5 + 13336.25K^6 + 35115.962K^7 + \ldots$$

(a) Comparison of susceptibility and fluctuation

In view of the asymptotic equivalence of the fluctuation and reduced susceptibility series we wish to compare the ratios of the coefficients.

TABLE 4.1

Ratio of fluctuation over susceptibility coefficients

n	triangular lattice	f.c.c. lattice
1	1	1
2	1.071428571	1.03125
3	1.05454545	1.01541799
4	.965346534	1.00435441
5	.971959768	1.00149088
6	.985478098	1.00111803
7	1.011481242	1.00089795
8	1.026660712	1.01355544

In the case of the f.c.c. lattice the ratios are approaching unity ever more closely as n increases (except for the last term). The last term breaks the trend both here and in the ratio plot and we suspect a numerical error in the susceptibility series might be the cause.

In the triangular lattice case the ratios of coefficients of susceptibility over fluctuation are more erratic. From the result of Falk and Bruch $\chi \leqslant Y$ at all temperatures therefore the ratios should be greater or equal to unity as n increases and this seems to be the trend.

(b) Analysis of the f.c.c. susceptibility series

Figure 4.1 is the ratio plot for the f.c.c. susceptibility series. We see that the ratio plot is linear (except for the last term) and we can estimate

$$K_c^{-1} = 0.2206 \pm .001 \qquad \gamma = 1.33 \pm 0.03 .$$

The above results agree well with the ratio analysis of the fluctuation (Betts, Elliott and Lee (1970)) who find $K_c^{-1} = 0.2206 \pm .0010$ and $\gamma = 1.335 \pm 0.02$.

We apply the modified ratio method (Section 4.1) to the f.c.c. susceptibility series.

TABLE 4.2

Ratios of f.c.c. susceptibility with $K_c'=0.24$, $\gamma'=1.33$

n	r_n	$n(K_c' r_n - 1) + 1$	$n\, a_n/(n+\gamma'-1)a_{n-1}$
1	6	1.32600	4.51128
2	5.33333	1.35733	4.57798
3	5.046875	1.36058	4.54673
4	4.905882	1.33680	4.56023
5	4.826358	1.33313	4.52754
6	4.775754	1.33265	4.52678
7	4.740273	1.33320	4.52686

Fig. 4.2 exhibits:

(1) The physical pole of $(\chi_{\parallel}^{o}(K))^{1/\gamma}$ as a function of γ.

(2) The estimate of γ from $(K-K_c') \frac{\partial}{\partial K} \log \chi_{\parallel}^{o}(K)\Big|_{K=K_c'}$ against K_c'.

This is given by the vertical bars. The bars shrink as approach K_c.

(3) The arrow at the left hand side shows the spread in γ calculated from Pade approximants to:

$$\frac{\partial}{\partial K} \log \frac{\partial}{\partial K} \chi_{\parallel}^{o}(K) / \frac{\partial}{\partial K} \log \chi_{\parallel}^{o}(K) .$$

The approximants to $(\frac{\partial\chi}{\partial K})^{1/\gamma+1}$ gave a straight line when plotting the pole against γ. The line had the same slope as (1) only with larger spread. We also calculated Pade approximants to $\frac{\partial}{\partial K}\log\chi(K)$ listed in Table 4.3, and to $(\frac{\partial^2}{\partial K^2}\chi/\chi)^{\frac{1}{2}}$ listed in Table 4.8. The results are all consistent.

TABLE 4.3

Estimates of K_c for the f.c.c. lattice from Pade approximants to $\frac{\partial}{\partial K}\log\chi_{\parallel}(K)$.

N	M = 2	M = 3	M = 4	M = 5	M = 6	M = 7
0	.2255	.2233	.2213	.2207	.2206	.2230± .005i
1	.2236	.2095	.2203	.2206	.2207	
2	.2283	.2105	.2208	.2203		
3	.2201	.2208	.2205			
4	.2201	.2201				
5	.2206					

TABLE 4.4

Estimates of K_c for the f.c.c. lattice
from Pade approximants to $(\chi_{\parallel}(K))^{4/5}$

N	M = 2	M = 3	M = 4	M = 5	M = 6	M = 7
1	.20017	.21911	.21887	.21910	.21973	.21882
2	.21895	.21886	.21898	.21820	.21909	
3	.21886	.21892	.2147± 0.005i	.21897		
4	.21911	.21722	.21892			
5	.21955	.21911				
0	.21865					

TABLE 4.5

Estimates of K_c for the f.c.c. lattice
from Pade approximants to $(\chi_{\parallel}(K))^{3/4}$

N	M = 2	M = 3	M = 4	M = 5	M = 6	M = 7	M = 8
0		.2206	.2212	.2212	.2211	.2210	.2271
1	.2196	.2216	.2212	.2212	.2208	.2211	
2	.2215	.2212	.2210	.2210	.2212		
3	.2212	.2210	.2210	.2210			
4	.2212	.2210	.2210				
5	.2207	.2212					
6	.2211						

TABLE 4.6

Estimates of K_c for the f.c.c. lattice from Pade approximants to $(\chi_{\parallel}(K))^{10/13}$

N	M = 2	M = 3	M = 4	M = 5	M = 6	M = 7
1				.22022	.22039	.22020
2	.22045	.22019	.22021	.22023	.22022	
3	.22021	.22021	.22018	.22021		
4	.22021	.22021	.22021			
5	.22033	.22021				
6	.22017					

TABLE 4.7

Estimates of γ for the f.c.c. lattice from Pade approximants to $(K-K_c)\frac{\partial}{\partial K}\log\chi_{\parallel}(K)\Big|_{K=K_c}$

Pade	K_c=.2200	K_c=.2202	K_c=.2204	K_c=.2206	K_c=.2208	K_c=.221	K_c=.222
(1,3)	1.293			1.31391		1.327	1.356
(2,2)	1.294	1.3014	1.30845	1.31535	1.32204	1.329	1.358
(2,3)	1.291	1.2995	1.30772	1.31579	1.32372	1.331	1.368
(3,2)	1.291	1.2994	1.30770	1.31579	1.32363	1.331	1.365
(1,4)	1.291	1.2994	1.30764	1.31521	1.32213	1.328	1.349
(2,4)	1.294	1.3001	1.30721	1.31507	1.32371	1.333	1.393
(4,2)	1.291	1.2998	1.30666	1.31497	1.32371	1.333	1.386
(3,3)	1.300	1.3037	1.30879	1.31547	1.32371	1.334	1.408
(1,5)	1.232	11.2706	1.29872	1.31495	1.31862	1.310	1.119
(3,4)	1.291	1.2995	1.30772	1.31580	1.32372	1.331	1.368
(4,3)	1.291	1.2994	1.30771	1.31579	1.32363	1.331	1.365
(2,5)	1.291	1.2995	1.30765	1.31521	1.32213	1.328	1.350
(5,2)	1.291	1.2993	1.30731	1.31474	1.32163	1.328	1.351
(1,6)	1.295	1.3014	1.30828	1.31525	1.32230	1.329	

TABLE 4.8

Estimates of K_c for the f.c.c. lattice from Pade approximants to $[\frac{\partial^2}{\partial K^2} \chi_{\parallel}(K)/\chi_{\parallel}(K)]^{\frac{1}{2}}$.

N	M = 2	M = 3	M = 4	M = 5	M = 6
0		.2217	.2206	.2206	.2145±.06i
1		.2197	.2206	.2206	
2	.2193	.2207	.2197		
3	.2206	.2193			
4	.2206				

(c) Analysis of the fourth order fluctuation series for the f.c.c. lattice

The ratio plot is given by the solid line in Fig. 4.3. The modified ratios using the known value of K_c are tabulated below and plotted in Fig. 4.3 (the dotted line).

TABLE 4.9

Ratios of $Y_2(K)$ for f.c.c. lattice, $K_c'=.221$

n	r_n	$(K_c' r_n - 1)\ n + 1$
2	14.125	5.243
3	10.785	5.150
4	9.074	5.022
5	8.103	4.954
6	7.477	4.915

We estimate then $\gamma_2 = 4.64 \pm 0.10$ if we ignore the last K^7 term.

The Pade approximants to the fourth order fluctuation are not well behaved. A few of the approximants are tabulated below. There was no point in plotting the equivalent of Fig. 4.1 as the spread in estimates from different Pades was large, and the K_c against γ plot from the estimates to $[Y_2(K)]^{1/\gamma}$ almost vertical.

Tables 4.11 and 4.12 are Pade approximants to $\frac{\partial}{\partial K^x} \log Y_2(K^x)$ and $(K^x - K_c^x)\frac{\partial}{\partial K^x} \log Y_2(K^x)$ with $K = \frac{0.5K^x}{1-0.5K^x}$ which seemed somewhat better behaved. All the above were considered with the estimate from the modified ratio method in table 4.9.

TABLE 4.10

Estimates of K_c for f.c.c. lattice from Pade approximants to $[Y_2(K)]^{1/4.65}$

N	M = 1	M = 2	M = 3	M = 4	M = 5	M = 6
1	.2125	*	*	.2376	.2113	.1919
2	.2269	*	*	.2249	.2317	
3	.2423	.2302	.2231	.2387		
4	.1908	.2127	.2281			
5	.2318	.1853				
6	*					

* The physical pole did not appear at all or was off the real axis.

TABLE 4.11

Estimates of K_c for the f.c.c. lattice from Pade approximants to $\frac{\partial}{\partial K^x} \log Y_2(K^x)$ where $K = \frac{\frac{1}{2}K^x}{1-\frac{1}{2}K^x}$

N	M = 2	M = 3	M = 4
2	.4011	.3634	.3702
3	.3159	.3697	
4	*		

TABLE 4.12

Estimates of γ_2 for the f.c.c. lattice from Pade approximants to $\left[(K^x - K^x_c) \frac{\partial}{\partial K^x} \log Y_2(K^x)\right]\Big|_{K^x=.356}$ where $K = \frac{\frac{1}{2}K^x}{1-\frac{1}{2}K^x}$

N	M = 1	M = 2	M = 3	M = 4	M = 5
1	4.5188	6.5715	4.0173	4.6461	4.6300
2	5.2479	4.3449	4.2448	4.6307	
3	3.9788	4.2378	4.3037		
4	4.7663	4.7461			
5	4.7428				

TABLE 4.13

Estimates of K_c for the f.c.c. lattice from Pade approximants to $\frac{\partial}{\partial K} \log Y_2(K)$

N	M = 2	M = 3	M = 4	M = 5
1	*	.2754	.1938	.2272
2	.2694	.2440	.2474	
3	.164	.2473		
4	*			

TABLE 4.14

Estimates of γ_2 for the f.c.c. lattice from Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log Y_2(K) \Big|_{K_c=.221}$

N	M = 2	M = 3	M = 4	M = 5
1	6.367	4.151	5.477	18.436
2	5.473	4.502	4.240	
3	4.437	2.969		
4	4.075			

Fig. 4.1

The ratio plot of the initial parallel susceptibility for the f.c.c. lattice

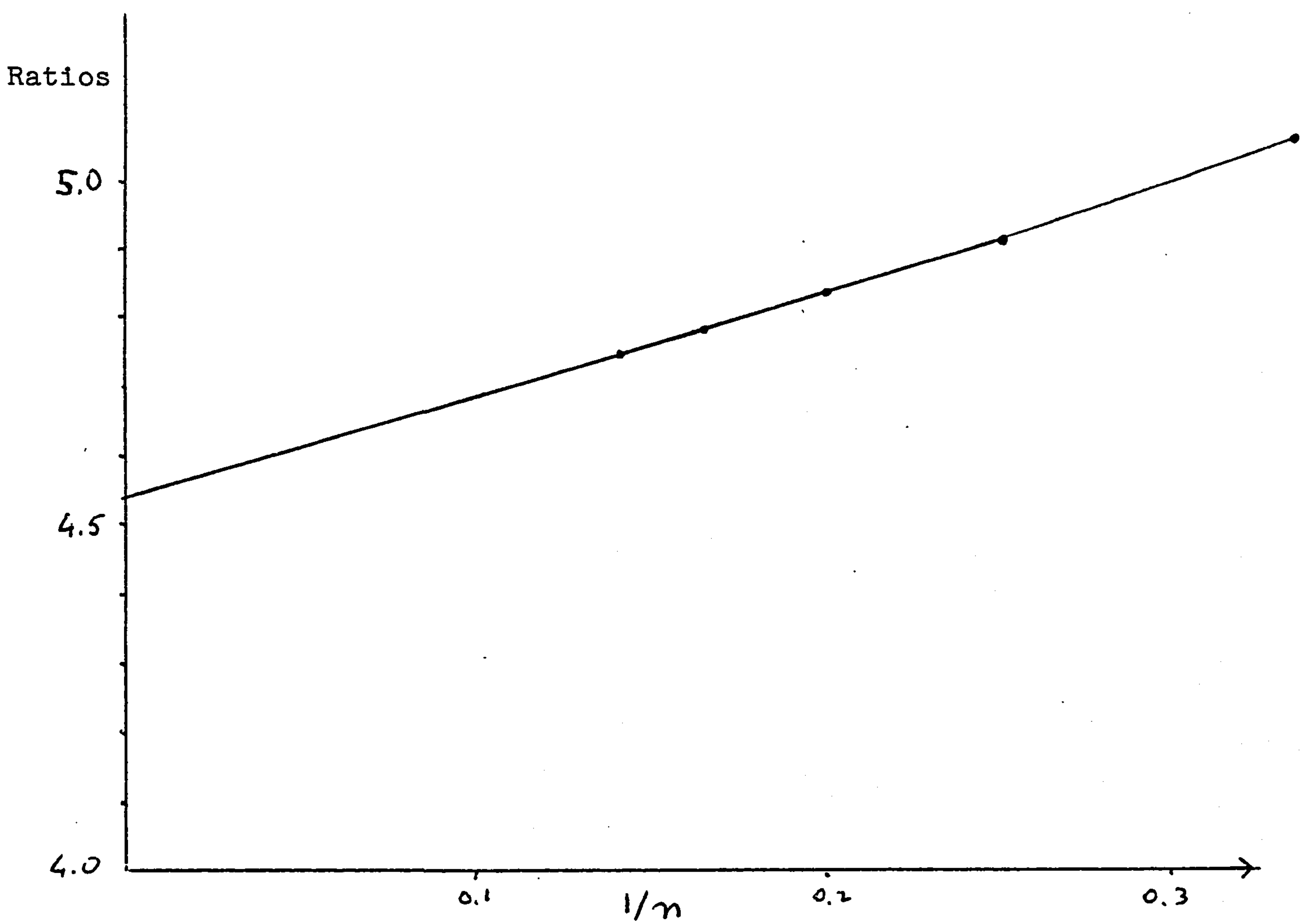

Ratios
5.0
4.5
4.0
0.1
0.2
0.3
1/n

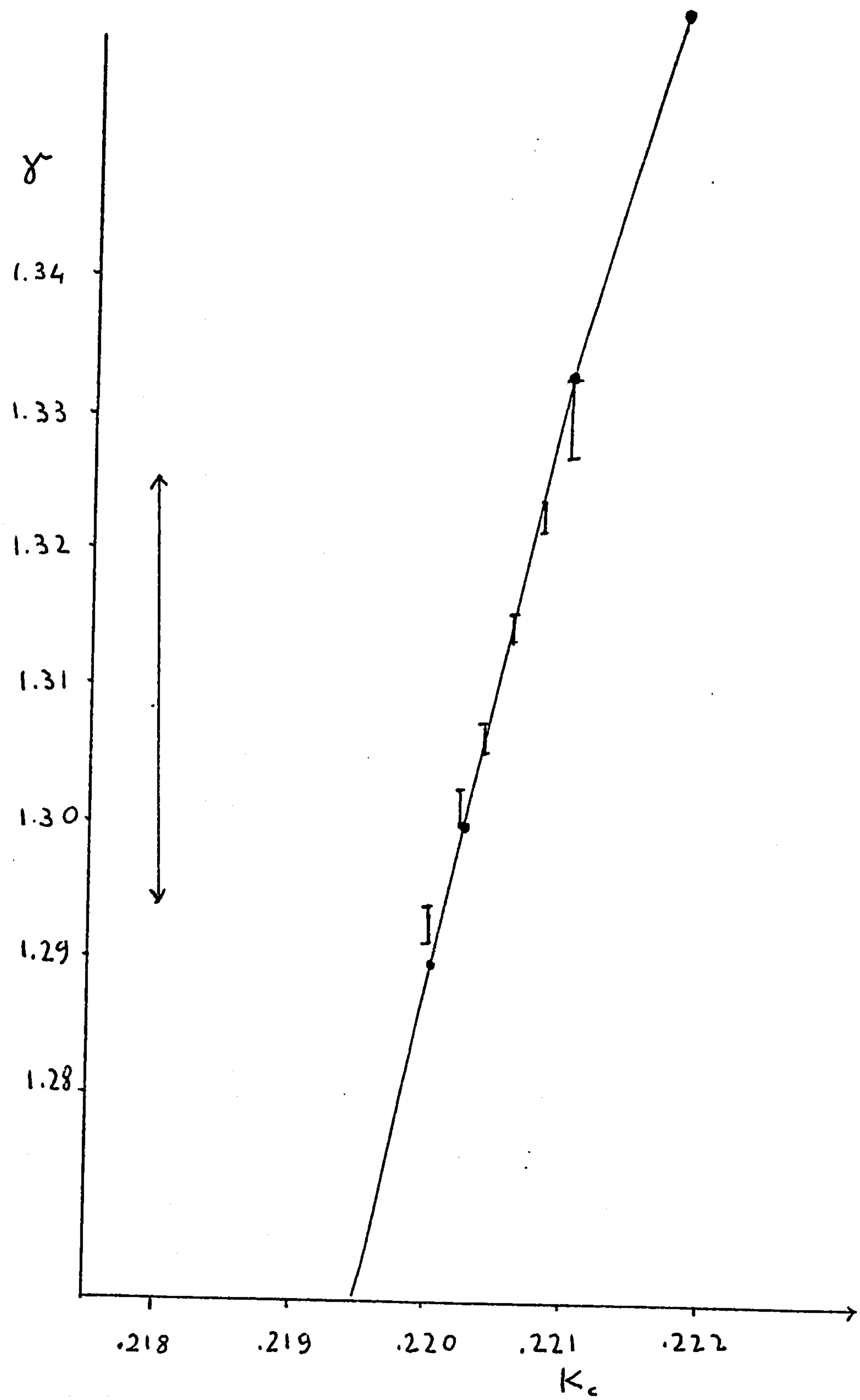
Fig. 4.2

Estimate of K_c and γ for the f.c.c. lattice.

The solid line is the estimate of K_c from approximants to $[\chi(K)]^{1/\gamma}$.

The vertical bars are estimate of γ from approximants to $(K-K_c)\,\frac{\partial}{\partial K}\log\chi\Big|_{K=K_c}$.

The arrow on the left is estimate of γ from $\frac{\partial}{\partial K}\log\chi/\frac{\partial}{\partial K}\log\chi$ at various values of K.



γ
1.34
1.33
1.32
1.31
1.30
1.29
1.28
.218
.219
.220
.221
.222
K_c

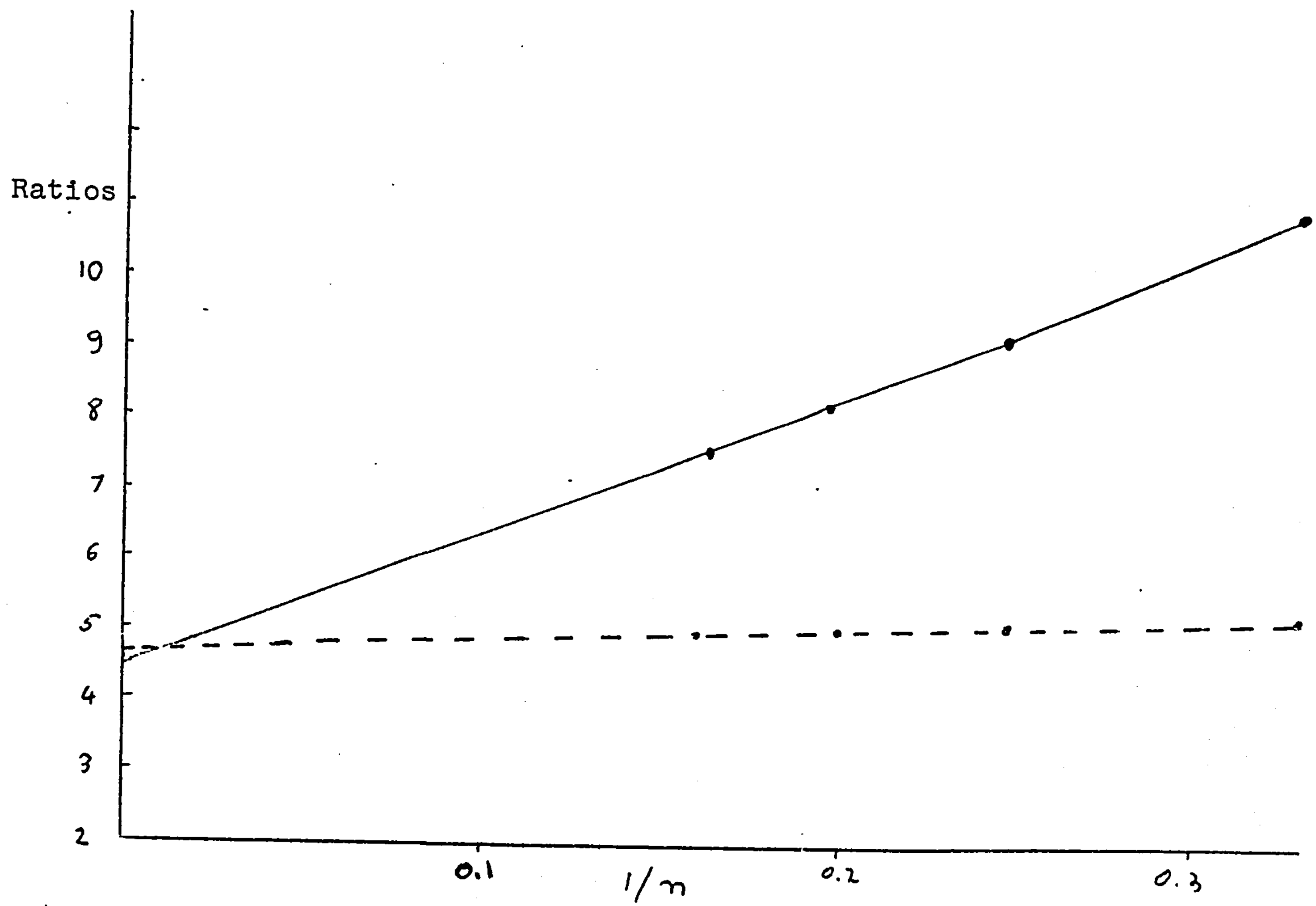
Fig. 4.3

The ratio plot for the fourth order fluctuation of the f.c.c. lattice.

The solid line is the ratio plot of the series.

The dotted line is the plot of the estimates of γ

$\gamma_n = (K_c\ r_n - 1)\ n - 1.$


Ratios
10
9
8
7
6
5
4
3
2
0.1
1/n
0.2
0.3

(d) <u>The triangular lattice</u>

The evidence for a phase transition in the XY model on the triangular lattice is not conclusive. We present our results below; a discussion is presented in the next section of conclusions.

In Fig. 4.4 the plot of the physical singularity from approximants to $(\chi^o)^{1/\gamma}$ against γ is given. On the same Fig. 4.4 the estimate of γ from the approximants to $\frac{\partial}{\partial K} \log \frac{\partial}{\partial K} \chi / \frac{\partial}{\partial K} \log \chi$ is shown.

From Fig. 4.4 we could say that if there is a phase transition it occurs at $K_c = .65 \pm .07$.

Fig. 4.5 is the ratio plot.

TABLE 4.15

Ratios of triangular susceptibility series $K_c' = \frac{2}{3}$

n	r_n	$n(K_c' r_n - 1) + 1$
1	3	2
2	2.33333	2.1111
3	1.96429	1.9286
4	1.83636	1.8970
5	1.62426	1.4142
6	1.64929	1.0000
7	1.61817	1.5515

TABLE 4.16

Ratios of $\frac{\partial}{\partial K} \chi_{\parallel}(K)$ for the triangular lattice, $K_c' = \frac{2}{3}$

n	r_n	$M\,(K_c' r_n - 1) + 1$
1	4.66667	3.1111
2	2.94642	2.9286
3	2.44847	2.8969
4	2.03032	2.4142
5	1.98000	2.600
6	1.88786	2.551

The Pade approximants to $\frac{\partial}{\partial K} \log \chi(K)$ are not converged at all.

TABLE 4.17

Estimates of K_c for the triangular lattice from Pade approximants to $\frac{\partial}{\partial K} \ln \chi_{\parallel}(K)$

N	M = 1	M = 2	M = 3	M = 4	M = 5	M = 6	M = 7
0		*	.5924	*	.4814	*	.5717
1	.9524	.7502	*	*	.5969	*	
2	.5833	.8552	*	*	.6552		
3	*	*	.8871	.7888			
4	*	.3557	.5988				
5	.9998	*					

TABLE 4.18

Estimates of γ for the triangular lattice from Pade approximants to $\left[(K-K_c)\frac{\partial}{\partial K}\ln\chi(K)\right]\Big|_{K_c=2/3}$

N	M = 2	M = 3	M = 4	M = 5
1	1.8219	1.6724	1.3187	1.6427
2	2.1888	6.2717	1.4412	
3	3.6626	2.0076		
4	1.2286			

The analysis of the fourth order fluctuation is not too conclusive. The series itself seems to diverge at $K_c^{-1} = 1.2 \pm 0.2$ which could be interpreted both as $K_c = 1$ which is just the mathematical radius of convergence for a positive series or as a physical signularity at the lower limit.

TABLE 4.19

Ratios of the fourth order fluctuation on the triangular lattice, $K_c' = 2/3$

n	r_n	$n(K_c' r_n - 1) + 1$
1	12	6
2	6.625	7.8333
3	4.76730	7.53460
4	3.78067	7.08179
5	3.22533	6.75110
6	2.88570	6.54280

The ratio plots are given in Fig. 4.6.

TABLE 4.20

Estimates of γ_2 for the triangular lattice from Pade approximants to $(K-K_c)\,\frac{\partial}{\partial K}\log Y_2(K)\Big|_{K_c=.6667}$

N	M = 2	M = 3	M = 4
2	8.1894	5.0272	5.0512
3	4.1519	5.0500	
4	5.7267		

The value of $K_c = 0.6667$ was obtained by a better analysis of the fluctuation series (Betts - private communication).

Fig. 4.4

Ratio plot for the parallel initial susceptibility on the triangular lattice

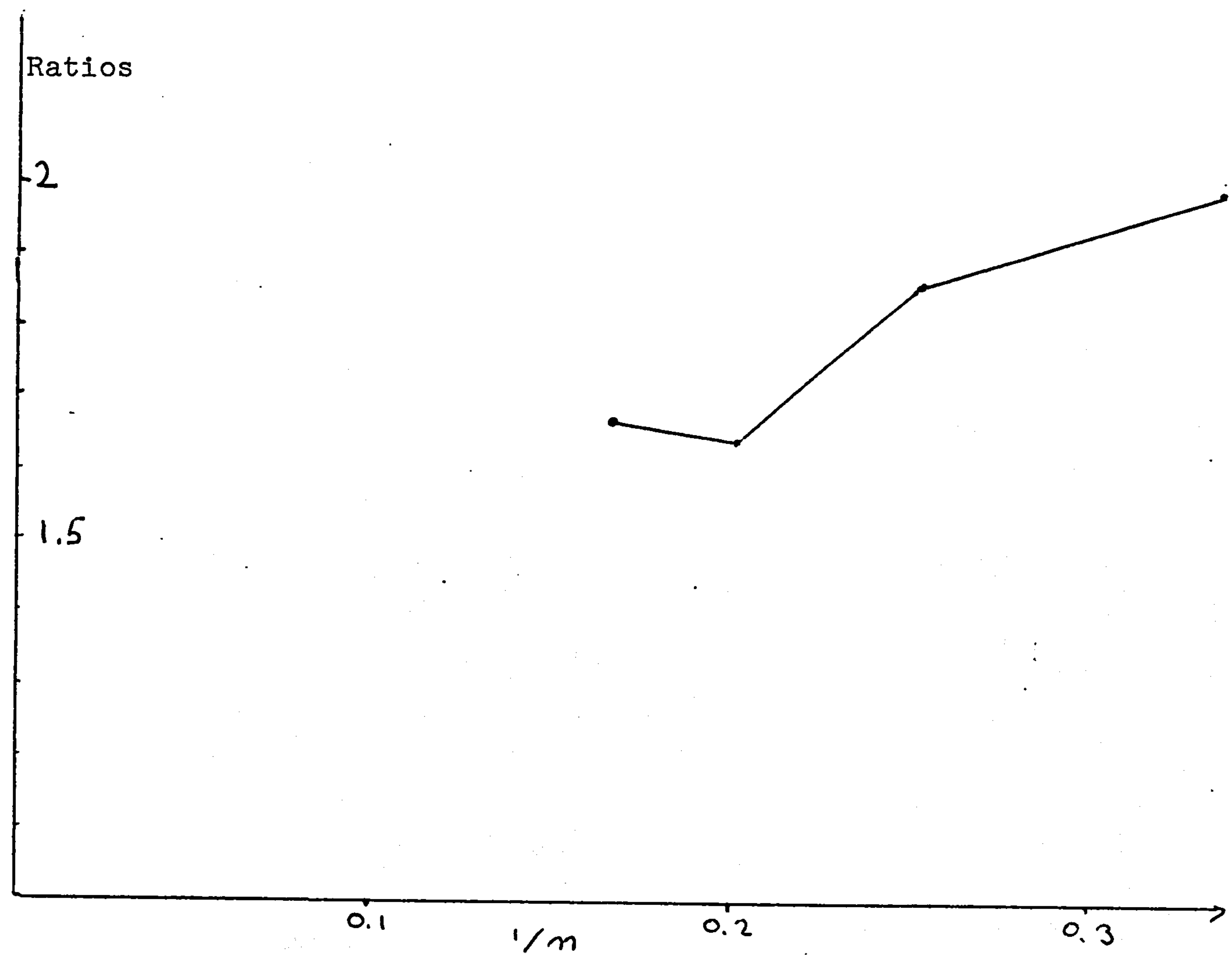

Ratios
2
1.5
0.1
1/n
0.2
0.3

Fig. 4.5

Plot of against K_c for the triangular lattice.

The horizontal bars show the spread of Pade approximants to $[\chi(K)]^{1/\gamma}$. The vertical bar is the spread in as estimated from $\frac{\partial}{\partial K}\log\frac{\partial}{\partial K}\chi_{\shortparallel}(\frac{\partial}{\partial K}\log\chi)$

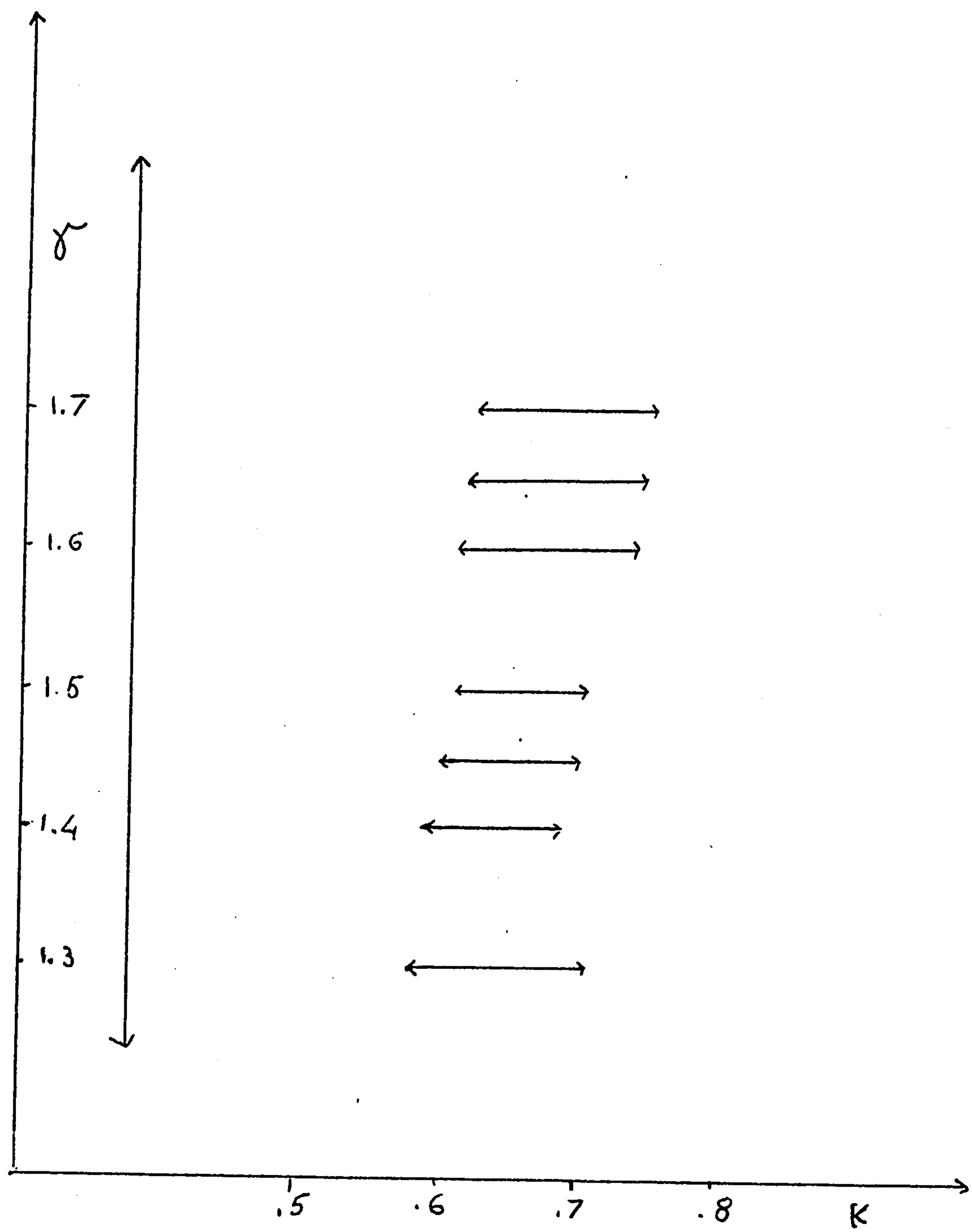
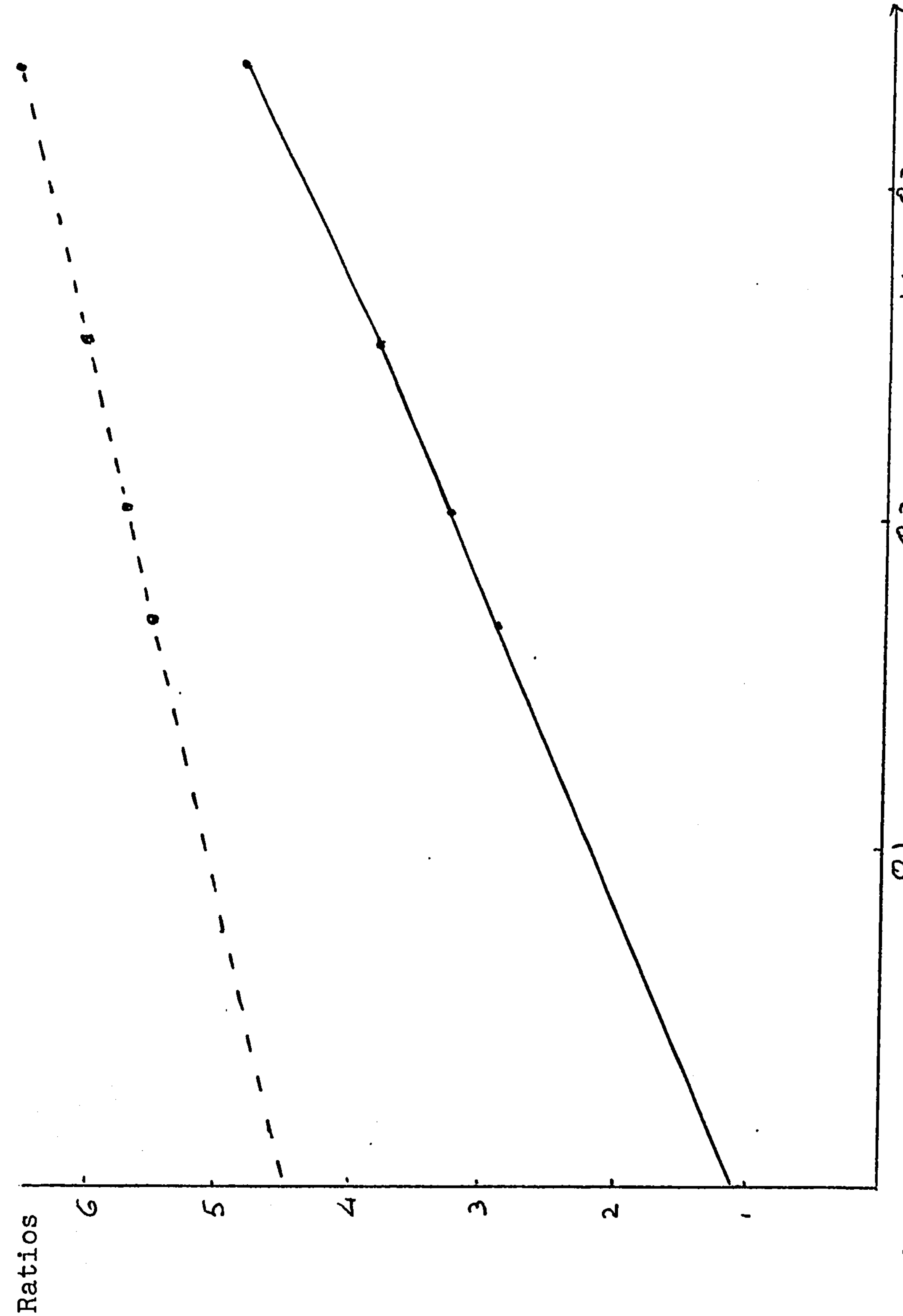

γ
1.7
1.6
1.5
1.4
1.3
.5
.6
.7
.8
K

Fig. 4.6

Ratio plot of the fourth order fluctuation series on the triangular lattice.

The solid line is the regular a_n/a_{n-1} plot.
The dotted line is the plot of $(\gamma-1)_n = (K_c r_n - 1)n$ against $1/n$.


Ratios
6
5
4
3
2
0.1
0.2
0.3

4.3 Conclusion

(a) Three dimensions

We obtain from the susceptibility series on the f.c.c. lattice that

$$K_c = 0.2206 \pm 0.001 \quad \gamma = 1.315 \pm 0.04 \ ,$$

which agrees with the results obtained from the fluctuation series by Betts, Elliott and Lee (1970)

$$K_c = 0.2210 \pm 0.0005 \quad \gamma = 1.35 \pm 0.03 \ .$$

The analysis of the fourth order fluctuation yields (Ditzian and Betts (1970))

$$\gamma_2 = 4.64 \pm 0.1 \ .$$

Possible simple fractions consistent with our estimates are :

$$\gamma = \frac{4}{3} \qquad \gamma_2 = \frac{14}{3} \ .$$

Therefore the gap parameter Δ is :

$$\Delta = \frac{5}{3}$$

Using scaling relations (Section 2.4) we obtain all other indices listed in Table 4.21.

TABLE 4.21

Index	Scaling relation	Prediction	Experiments for He
γ		4/3	
Δ		5/3	
α	$2 + \gamma - 2\Delta$	0	0.000 ± 0.003
β	$\Delta - \gamma$	1/3	0.333 ± 0.010
δ	$\Delta/(\Delta - \gamma)$	5	
ν	$(2\Delta - \gamma)/3$	2/3	0.67 ± 0.04
η	$(4\Delta-5\gamma)/(2\Delta-\gamma)$	0	

The experimental results are taken from the following experiments:

The specific heat exponent α has been measured by Ahlers (1967), who measured C_p to great accuracy taking into account gravitational field effects and vaporization. The temperature dependence of the superfluid density in He^4 near T_λ has been measured by Clow and Reppy (1966). The quantity measured is the angular momentum caused by a persistent current. The result is a value for β the exponent of the order parameter.

The value of ν has been measured by Henkel, Smith and Reppy (1969). The experiment consisted in measuring the angular momentum caused by a persistent current in a film of known thickness D. The angular momentum is linear in D and becomes zero at D_o. The value of D_o-D solid is the healing length ξ_s under the assumption that near the critical point only one coherence length exists

$$\xi_s \propto (T - T_c)^{-\nu} \quad .$$

We see an excellent agreement of the XY model with experiments on He^4.

Domb (19) and Domb and Hunter (1965) advanced on Taylor series approach which predicted that the exponent δ be an odd integer. Our result of $\delta = 5$ agrees and also supports the conjecture that $\delta = 5$ for all three dimensional models.

(b) Two dimensions

The Ising model in two dimensions has not only a phase transition but the only analytically demonstrated phase transition. The other models in two dimensions are in a much more dubious state.

Mermin and Wagner (1966) proved that spontaneous magnetization cannot occur in one and two dimensions for the isotropic Heisenberg model. They show,using the Bogoliubov inequality (1962), that in two dimensions

$$|M(H,T)| < B\, T^{-\frac{1}{2}} |\ln|H||^{\frac{1}{2}}$$

where B is a constant.

This proof, as we mentioned in 3.3B does not apply to the XY model.

Stanley and Kaplan (1966, 1967) have shown that zero magnetization at all $T > 0$ does not imply to phase transition. The correlations can be of a qualitative longer range below some T_c and the susceptibility may diverge even if $M = 0$.

Stanley and Kaplan (1966, 1967), Moore (1969) show for the classical Heisenberg model and plane model clear evidence of phase transition. Stanley (1969) has evidence of phase transition in two dimensions for the quantum Heisenberg model.

The suggested behaviour, Dys n (unpublished), Stanley (1967, 1969), if

$$\langle S_o\, S_R \rangle \propto R^{-\lambda T}$$

such that $M = 0$ yet $\chi = \infty$.

Our evidence is not really conclusive. It seems to indicate a divergence in the susceptibility at $K_c \sim 0.67 \pm 0.1$ with an exponent $\gamma = 1.5 \pm 0.2$ which agree with more accurate results of the fluctuation

(Betts - private communication) which seems to diverge at $K_c = .67 \pm .01$ with exponent $\gamma = 1.5 \pm 0.02$.

The fourth order fluctuation series by itself does not help in deciding whether this is a phase transition or not as it s critical point is not well defined and it could be that the series converges up to $K = 1$. If there is a phase transition at $K_c = 0.667$ then from the modified ratio method $\gamma_2 = 5.4 \pm 0.5$. Possible ratios within the error are

$$\gamma = \frac{12}{8} \qquad \gamma_2 = \frac{42}{8}$$

then $\Delta = \frac{15}{8}$, $\delta = 5$, $\nu = \frac{9}{8}$

$\beta = \frac{3}{8}$, $\eta = \frac{2}{3}$, $\alpha = -\frac{2}{8}$.

CHAPTER V

DYNAMICAL CRITICAL PHENOMENA

5.1 Introduction

The critical region is usually characterized by long range and long time fluctuations. Reaching equilibrium therefore takes a long time and it is natural to extend critical phenomena theories to cover dynamic properties.

In order to measure dynamical properties of the system one has to use probes such as neutron scattering or frequency dependent magnetic fields. While neutron scattering experiments depend on both transfer of energy $\hbar\omega$ and transfer of momentum $\hbar \underset{\sim}{k}$, frequency dependent fields have infinite wavelength , ($\underset{\sim}{k}=0$). For this reason frequency dependent measurement yields only results that do not probe into the spatial dependence of the correlations. Since our calculation did not include neutron scattering we will not discuss it.

In the Ising model correlations of the z components of the spins can only have space dependence as each σ_i^z commutes with the Hamiltonian and therefore is constant in time. Fisher and Burford (1967)) calculated the zz correlations, which give the elastic scattering of neutrons from an Ising model.

Allan and Betts (1968) using the Kubo linear response method calculated exactly the frequency dependent susceptibility $\chi^{xx}(\omega)$ and inelastic neutron scattering from a spin ½ Ising model in 2 dimensions.

Essam and Garelick (1968) obtained the exact solution for all spins and in presence of parallel fields, their solution was based on solving the Green's function hierarchy of operations of motions without need for approximations other than linear response.

Allan and Betts (1968) noticed that the limit of $\chi^{xx}(\omega)$ as ω goes to zero was equal to $\chi_T^{xx}(0)$ in the case of the honeycomb lattice but not the square lattice. The Kubo "adiabatic", or quasistatic susceptibility is not equal to the isothermal susceptibility on the square lattice because the system is not ergodic in the absence of a field in the x direction.

As shown by Essm and Garelick (1968) $M = -\sum_r P_r E_r'(H)$ where $E_r'(H)$ is the first derivative of the r'th energy level with respect to the field and $P_r(T)$, the probability of finding a number of the ensemble in state $|r\rangle$

$$\chi_T^{xx} = \left(\frac{\partial M^x}{\partial H^x}\right)_T = -\Sigma P_r E_r''(H^x) - \Sigma \left(\frac{\partial P_r}{\partial H}\right)_T E_r'(H^x)$$

$$= \chi(\omega=0) - \Sigma \left(\frac{\partial P_r}{\partial H}\right)_T E_r'(H^x) \qquad (5.1.1)$$

and $E_r'(H^x = 0)$ is not zero when there is degeneracy, that is different spin configurations with same energy.

Allan and Betts (1968) pointed out that spins which have an equal number of neighbours pointing up as down, are essentially free. This causes the degeneracy mentioned above. We want to note here that for the XY model in any lattice even 1 dimensional there is no such degeneracy when we deal with the magnetization in the x direction, which is parallel to the interaction. As discussed in the next section the magnetization in the z direction is non-ergodic at least in the 1-dimensional case.

For the XY model we had to use series expansion methods for the time, or frequency, variable as well as for the temperature while the Ising model results mentioned above had closed formulae for the time variable. Series expansions were only needed for the static spin correlations of the spin at the origin with k of its nearest neighbours, $k \leqslant q$.

Another subject we want to mention is the critical slowing down for dynamical susceptibility. Suzuki (1969 a,b) calculated the dynamical susceptibility for the kinetic Ising model in two dimensions(and for the XY chain which we discuss in the next section). We quote here some of his results as this was the only calculation of a dynamic susceptibility for a physically plausible model before our work, and we use his definitions and terminology.

The kinetic Ising model has transition probabilities defined by

$$\omega_j(\sigma_o) = \frac{1}{2\tau}\,(1 - \sigma_j \;\mathrm{tgh}\; \beta \sum_k J_{jk}\,\sigma_k) \;. \qquad (5.1.2)$$

τ indicates the relaxation time of a free spin interacting with a heat bath. This system has a Louville operator

$$\mathcal{L} = \sum_k \omega_k(\sigma_k)(1 - P_k)$$

where P_k flips the k'th spin. The dynamical susceptibility can be expanded in a moment series:

$$\chi(\omega) = N\mu m^2 \left\{\frac{\mu_1}{i\omega\tau} + \frac{\mu_2}{(i\omega\tau)^2} + \ldots\right\} \qquad (5.1.3)$$

where

$$\mu_n = \frac{\tau^n}{Nm^2} < M \;\mathcal{L}^n\; M > \;. \qquad (5.1.4)$$

All moments μ_n are positive and remain finite at the critical point. Suzuki proved

$$\frac{Nm^2\beta\mu_2}{(\omega\tau)^2 + \frac{\mu_4}{\mu_2}} \leqslant \text{Re}\ \chi(\omega) \leqslant \frac{Nm^2\beta\mu_2}{(\omega\tau)^2} \qquad (5.1.5)$$

and therefore postulates that the susceptibility behaves like

$$\chi(\omega) \sim \frac{1}{i\omega + \varepsilon^{\gamma}\ f(\frac{i\omega}{\varepsilon^{\gamma}}, \varepsilon)} \qquad (5.1.6)$$

and $f(0,\varepsilon)$ can be singular at $\varepsilon=0$. Expanding in powers of ω

$$\chi(\omega) = N\beta\ \Sigma(-i\omega\tau\ )^n\ a_n(\varepsilon) \qquad (5.1.7)$$

and calculation gave

$$a_n(\varepsilon) \sim \varepsilon^{-\alpha_n}$$

$$\alpha_n \geqslant \gamma + n\ \Delta_s \qquad (5.1.8)$$

where

$$\Delta_s = \alpha_1 - \gamma \qquad (5.1.9)$$

and $\Delta_s \geqslant \gamma$ was proved by Abe and Hatano (1969). The index of critical slowing down Δ_s is defined from

$$\tau_M = \int_0^{\infty} \frac{\langle M(t)M\rangle}{\langle M^2\rangle}\, dt \sim \varepsilon^{-\Delta_s} \qquad (5.1.10)$$

and is found to be the same as in (5.1.9). Suzuki defines the index of critical slowing down of the self correlation (see 5.4)

$$\int_0^\infty \langle \sigma_1(t)\sigma_1 \rangle \; dt \sim \varepsilon^{-\Delta_A} \quad . \tag{5.1.11}$$

Classical theories predict $\Delta_s = \gamma$. Suzuki defines $R_M(\varepsilon)$ by

$$\tau_M = \chi(0) \; R_M^{-1}(\varepsilon) \tag{5.1.12}$$

and states a proposed law of similarity as follows. The relaxation time singularity consists of the direct or thermodynamic critical slowing down due to the susceptibility and the indirect, due to $R(\varepsilon)$, called induced critical slow down (or speed up as the case may be). Relaxation times can be defined for various quantities not only the magnetization. The similarity law states that the indirect critical slow down is the same for some critical variables. Variables for which it holds are called similar variables.

For the kinetic Ising model in 2 dimensions Suzuki expects that the magnetization and the energy are similar variables.

$$\tau_E = \langle \delta E \frac{1}{\mathcal{L}} \delta E \rangle / \langle (\delta E)^2 \rangle \sim \varepsilon^{-\Delta_E} \tag{5.1.13}$$

$$\tau_{EM} = \langle \delta E \frac{1}{\mathcal{L}} M \rangle / \langle M \delta E \rangle \sim |\varepsilon|^{-\Delta_{ME}} \tag{5.1.14}$$

$$\tau_M = \langle M \frac{1}{\mathcal{L}} M \rangle / \langle M^2 \rangle - \varepsilon^{-\Delta_M} \tag{5.1.15}$$

and we know $\langle (\delta E)^2 \rangle \sim \varepsilon^{-\alpha}$ and $\langle M\delta E \rangle \sim |\varepsilon|^{\beta-1}$. Only Δ_M is calculated directly but Suzuki using the relation

$$\langle (\lambda M + \delta E) \frac{1}{\mathcal{L}} (\lambda M + \delta E) \rangle \geq 0 \tag{5.1.16}$$

proves that

$$2\Delta_{ME} - (\Delta_M + \Delta_E) \leq \alpha + 2\beta + \gamma - 2 \tag{5.1.17}$$

for real λ. Similarity and (5.1.17) yield $\alpha + 2\beta + \gamma \geq 2$ which is valid assuming scaling. Suzuki obtains that $\Delta_M = 2.00 \pm 0.05$. Similarity claims $\Delta_E - \alpha = \Delta_M - \gamma$ and since $\alpha = 0$ $\gamma = \frac{7}{4}$ this yields $\Delta_E = \frac{1}{4}$. This is consistent with computer simulations.

We calculated a series for $\chi^{xx}(\omega)$ by methods explained in sections (5.4) and (5.5) and estimated the critical index of slowing down Δ_s obtaining that in this case it is actually a speeding up, $\Delta_s < \gamma$.

5.2 Scaling of static and dynamic correlations

We shall describe in the following the Halperin-Hohenberg homogeneity arguments which are more general than the Kadanoff construction (Section 2.4). The correlation is defined by

$$\Gamma(r,\varepsilon) = \langle (S_i - \langle S \rangle)(S_j - \langle S \rangle) \rangle \qquad (5.2.1)$$

where $\varepsilon = \dfrac{T-T_c}{T_c}$ $\quad r = |r_i - r_j|$.

The static scaling hypothesis for the correlations is

$$\Gamma(r,\varepsilon) = \begin{cases} r^x \, g^+(r/\xi) & \varepsilon > 0 \\ r^{x'} g^-(r/\xi) & \varepsilon < 0 \end{cases} \qquad (5.2.2)$$

where ξ is the correlation length. Furthermore $x' = x$, $g^+ = g^-$ as there is no discontinuity at $\varepsilon = 0$ for finite r. The Fourier transform $\Gamma(k,\varepsilon)$ is defined by

$$\Gamma(\underline{r},\varepsilon) = \int \frac{d^3k}{(2\pi)^3} \, e^{i(\underline{k}\cdot\underline{r})} \, \Gamma(\underline{k},\varepsilon) \quad , \qquad (5.2.3)$$

then

$$\Gamma(\underline{k},\varepsilon) = \begin{cases} k^y \, g^+(k\xi,\ \varepsilon) & \varepsilon > 0 \\ k^y \, g^-(k\xi,\ \varepsilon) & \varepsilon < 0 \end{cases} \qquad (5.2.4)$$

and $g^+(\infty, 0) = g^-(\infty, 0)$. $y = d+x$ where d is the dimensionality. The indices η and ν were defined in (2.1.8) and (2.1.9) respectively. The Fourier transform of (2.1.9) is

$$\Gamma(\underline{k}, \varepsilon=0) \propto k^{y-z} \tag{5.2.5}$$

$$\Gamma(\underline{k}=0, \varepsilon) \propto \varepsilon^{-\gamma} \propto \xi^{\gamma/\nu} \tag{5.2.6}$$

as $\xi \sim \varepsilon^{-1/\nu}$. From (5.2.4) we see

$$\Gamma(\underline{k}, \xi) \propto \xi^{-y} [1 + \ldots] \quad \text{for } k\xi << 1 \tag{5.2.7}$$

if $\Gamma(\underline{k}=0, \varepsilon)$ is finite for $\frac{1}{\xi} \neq 0$. Similarly if $\Gamma(k, \varepsilon=0)$ is finite for $k \neq 0$

$$\Gamma(\underline{k}, \xi) \propto k^{y} [1 + \ldots] \quad k\xi >> 1 . \tag{5.2.8}$$

Comparing (5.2.5), (5.2.6) with (5.2.7) and (5.2.8), the scaling law

$$y = - 2 + \eta = -\gamma/\nu \tag{5.2.9}$$

results. Adding assumptions on the structure of $\Gamma(\underline{k},\xi,H)$, all scaling laws (2.4.24) predicted by the Kadanoff construction are obtained. Returning to $\Gamma(\underline{r},\xi)$, since

$$x = y - d$$

$$\Gamma(\underline{r},\ \xi) = r^{\eta-2-d}\, g(r/\xi) \tag{5.2.10}$$

The dynamical scaling assumption is a generalization of (5.2.4) to the frequency dependent correlation. $\Gamma_\xi(\underline{k},\ \omega)$ is defined by

$$\Gamma_\xi(\underline{r},t) = \int \frac{d^3\underline{k}}{(2\pi)^3} \int \frac{d\omega}{2\pi}\, e^{i(\underline{k}\cdot\underline{r}-\omega t)}\ \Gamma_\xi(\underline{k},\omega) \tag{5.2.11}$$

where

$$\Gamma_\xi(r,t) = \langle\{S(r,t) - \langle S(r,t)\rangle\ ,\ S(0,0) - \langle S(0,0)\rangle\}\rangle\ . \tag{5.2.12}$$

The curly brackets are anticommutator. ξ, the correlation length, gives the dependence on the temperature. The scaling assumption is

$$\Gamma_\xi(\underline{k},\omega) = \frac{2\pi\ \Gamma_\xi(\underline{k})\ f_{k\xi}\left(\frac{\omega}{k^z\Omega(k\xi)}\right)}{k^z\ \Omega(k\xi)} \tag{5.2.13}$$

where

$$\Gamma_\xi(\underline{k}) = \int_{-\infty}^{\infty} \frac{d\omega}{2\pi}\ \Gamma_\xi(\underline{k},\omega) \tag{5.2.14}$$

and (5.2.14) implies then

$$\int_{-\infty}^{\infty} f_{k\xi}\ (x)\ dx = 1\ . \tag{5.2.15}$$

Ω is determined from the constraint

$$\int_{-1}^{1} f_{k\xi}(x)\, dx = \frac{1}{2} \quad . \tag{5.2.16}$$

The function $k^z\, \Omega(k\xi)$ is called the characteristic frequency $\omega_\xi^M(\underline{k})$. The time dependent correlation is scaled as

$$\Gamma_\xi(\underline{k},t) \propto \frac{\Gamma_\xi(\underline{k})\ \hat{f}(t.k^z\ \Omega(k\xi))}{k^z\ \Omega(k\xi)} \quad . \tag{5.2.17}$$

For the isotropic Heisenberg model the Landau-Lifshitz (1935) formula gives

$$\omega_\xi^M(\underline{k}) = \lambda k^2$$

where

$$\lambda = \frac{\rho_s}{|< M >|} \quad ,$$

and ρ_s is a stiffness constant proportional to ξ^{-1}. From this Halperin and Hohenberg deduce to first order

$$z = 3 - \beta/\nu \quad .$$

z cannot be determined from thermodynamic considerations in the anisotropic case.

We calculated $<\sigma_1(t)\ \sigma_1>$, the self correlation. The NMR line width Δ_{NMR} is given by (Heller (1966)):

$$\Delta_{NMR} \propto \int_0^\infty < \sigma_1(t)\ \sigma_1 > dt \qquad (5.2.18)$$

$$\propto \int_0^\infty \Gamma_\xi(r=0,\ t)\ dt$$

$$\propto \int_0^\infty \ d^3k\ \Gamma_\xi(\underline{k},\omega=0)$$

$$\propto \int_0^\infty \frac{k^2 dk\ \Gamma_\xi(\underline{k})\ f_{k\xi}(0)}{k^z\ \Omega(k\xi)}$$

$$\propto \int_0^\infty dk\ k^{2-z+\eta-2}\ \frac{g(k\xi)\ f_{k\xi}(0)}{\Omega(k\xi)}$$

$$\propto \xi^{z-\eta-1} \int_0^\infty dx\ F(x) \quad .$$

Since $\xi \sim \varepsilon^{-\nu}$

$$\Delta_{NMR} \propto \varepsilon^{-\nu(z-\eta-1)} \quad . \qquad (5.2.19)$$

The assumption that (5.1.13) holds for the order parameter is restricted scaling. Extended scaling is when (5.2.13) holds for other operators also.

Assuming that the frequency scales like $\omega/\varepsilon^{\Delta_s}$ yields, using (5.2.13), that

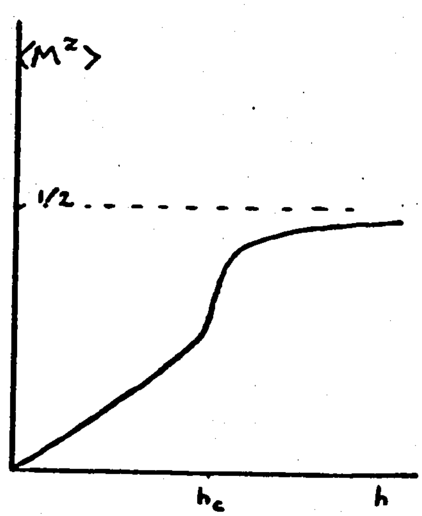
$$z = \nu^{-1}\ \Delta_s \quad . \qquad (5.2.20)$$

5.3 Dynamical results for the one dimensional XY model

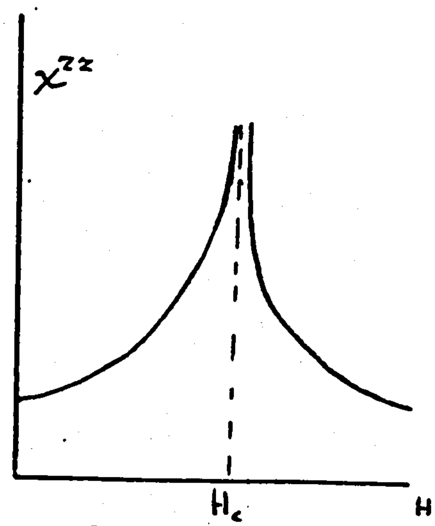
Many authors have studied the time dependent correlations in the one dimensional XY model. (a) Niemejer (1967, 1968), (b) Katsura, Horiguchi and Suzuki (1969), (c) Suzuki (1969), and (d) Barouch, McCoy and Dresden (1970).

(a) and (d) were concerned with the exact solution of the anisotropic XY model which can be obtained for arbitrary fields in the z direction. Of course specific cases and asymptotic limits had to be taken to see what those solutions mean. (b) obtained linear response for the isotropic XY model by the two time Green's function method. (c) discussed the results for the anisotropic XY model terms of critical slowing down.

In (a) the static result obtained was that the one dimensional XY model has a divergence at T=0, $h=h_c$,



$\langle M^z(h, T=0)\rangle$



$\chi^{zz}(h, T=0)$

This makes the order in which limits are taken to obtain asymptotic behaviour crucial . The susceptibility behaves like

$$\chi_{T=0}(h) \approx \log(|h-1|) \quad , \tag{5.3.1}$$

where

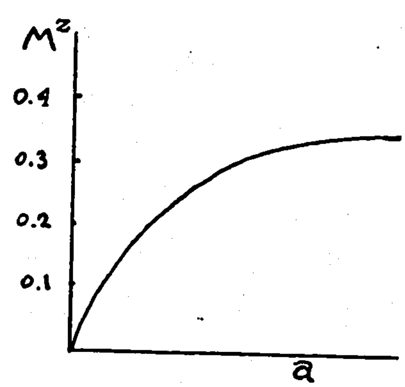
$$h = \frac{\mu(H-H_c)}{J\gamma}$$

γ being the anisotropy parameter. The points of interest to us were in (d) and (c).

In (d) the authors found that the asymptotic behaviour of M(t) is the same for large times for all H, only the coefficients depending on the details. There is no approach to equilibrium no matter how slowly the field varies. The easiest example they provide is

$$H(t) = \begin{cases} a & t \leq 0 \\ 0 & t > 0 \end{cases} \quad .$$

The plot of M_z ($t=\infty$, $T=0$) as a function of a looks like



with M_z definitely saturating at a value less than ½, where ½ is the saturation value of the initial magnetization.

Suzuki obtains that the dynamical susceptibility behaves like

$$\mathrm{Re}\,\chi(\omega,\, h_c,\, T=0) \sim -\log|\omega| \qquad (5.3.2)$$

and despite lack of ergodicity

$$\lim_{t\to\infty} (M,\, M(t)) = \langle M\rangle^2$$

so he can define the relaxation time and obtains

$$\tau_M^2 = -\int_0^\infty \frac{(\delta M,\, \delta M(t))\,t}{(M,M)}\, dt \sim h^{-2\Delta_M} \qquad (5.3.3)$$

where $\Delta_M = 1$.

For the partial energy defined by

$$E = 4 \sum_i S_i^x\, S_{i+1}^x \qquad (5.3.4)$$

he obtains $\Delta_E = 1$ and since $\gamma_E = 0$ similarity holds for this partial energy and the susceptibility.

We note that here $\Delta_M > \gamma$, but here because of the singular character of the model the temperature was kept fixed at T=0 and the magnetic field is the variable, which is quite different from our procedure. Also these results were obtained by Suzuki for the anisotropic XY model as $\mathrm{Re}\,\chi(k=0,\, \omega) = 0$, according to his calculations, when the anisotropy vanishes.

5.4 The Kubo linear response theory

The Kubo formalism (Kubo 1957) is a general approach to the problem of time dependent disturbances. The results are perturbation series in the disturbance. We shall, as most users of the formalism do, keep only the term linear in the disturbance.

The system is assumed to be in equilibrium without disturbances at $t = -\infty$. It's properties are then described by a density matrix ρ_o. For a canonical ensemble

$$\rho_o = \frac{e^{-\beta\mathcal{H}_o}}{\mathrm{Tr}\; e^{-\beta\mathcal{H}_o}} \quad . \tag{5.4.1}$$

A disturbance is introduced; the external force F(t) is conjugate to the observable A. The perturbed Hamiltonian is now

$$\mathcal{H} = \mathcal{H}_o + \mathcal{H}' = \mathcal{H}_o - \vec{A}.\vec{F}(t) \quad . \tag{5.4.2}$$

The time evolution of the system is given by the equation of motion of the density matrix

$$\frac{d}{dt}\,\rho(t) = \frac{1}{i\hbar}\,[\mathcal{H},\, \rho(t)] \quad . \tag{5.4.3}$$

The solution of (5.4.3) after linearization is:

$$\rho(t) = \rho_o + \frac{1}{i\hbar}\int_{-\infty}^{t} e^{-\frac{i(t-t')\mathcal{H}_o}{h}}\,[\mathcal{H},\rho_o]\, e^{\frac{i(t-t')\mathcal{H}_o}{h}}\, dt \; . \tag{5.4.4}$$

The response of an observable B to the disturbance is

$$\Delta B = \mathrm{Tr}\ (\rho(t) - \rho_o)\ B\ .$$

ΔB is the macroscopic difference of the average of B at time t from its equilibrium average. It follows that:

$$\Delta B = \frac{1}{i\hbar}\ \mathrm{Tr} \int_{-\infty}^{t} [\rho_o,\ A] B(t-t') F(t') dt' \qquad (5.4.5)$$

where

$$B(t) = e^{\frac{it}{\hbar}\mathcal{H}_o}\ B\ e^{-\frac{it}{\hbar}\mathcal{H}_o} \qquad .$$

The linear response function ϕ_{BA}, which is the response of the observable B to a disturbance conjugate to A is defined by

$$\Delta B(t) = \int_{-\infty}^{t} \phi_{BA}(t-t') F(t')\ dt' \quad . \qquad (5.4.6)$$

It follows then, that

$$\phi_{BA}(t) = \frac{1}{i\hbar}\ \mathrm{Tr}\ \rho_o\ [A,\ B(t)] \quad . \qquad (5.4.7)$$

Many disturbances of interest can be expanded in Fourier series. We therefore seek the response to a harmonic force. It is convenient to take F as

$$F(t) = \mathrm{Re}\ F_o\ e^{i\omega t + \varepsilon t} \qquad (5.4.8)$$

where ε is a small positive factor which ensures that $F(-\infty)=0$ as an initial unperturbed condition. This is a slow quasistatic switching on of the force.

The frequency dependent susceptibility is defined by

$$\Delta B(t) = \mathrm{Re}\ \chi_{BA}(\omega)\ F_o\ e^{i\omega t} \ . \qquad (5.4.9)$$

The result of combining (5.4.9) and (5.4.6) is:

$$\chi_{BA}(\omega) = \lim_{\delta\to 0+} \int_0^\infty \phi_{BA}(t)\ e^{-i\omega t-\delta t}\ dt \ . \qquad (5.4.10)$$

The response function is real and the susceptibility satisfies the following symmetry relations

(1) $\mathrm{Re}\ \chi_{BA}(\omega) = \mathrm{Re}\ \chi_{BA}(-\omega)$

(2) $\mathrm{Im}\ \chi_{BA}(\omega) = -\mathrm{Im}\ \chi_{BA}(-\omega)$

(3) $\chi_{BA}(\omega, -F) = \varepsilon_A\ \varepsilon_B\ \chi_{AB}(\omega, F)$,

where $\varepsilon_A, \varepsilon_B$ are +1 or -1 as A and B are respectively even or odd with respect to time reversal. Relation (3) is known as the Onsager relation (1931).

For short times the response function can be expanded in an asymptotic power series. Using (3.3.17)

$$\phi_{BA}(t) = \frac{1}{i\hbar}\mathrm{Tr}\,\rho_o \left[A, \left\{B + \frac{it}{\hbar}[\mathcal{H},B] + \left(\frac{it}{\hbar}\right)^2 \left[\mathcal{H},[\mathcal{H},B]\right] + \dots \right\}\right] \qquad (5.4.11)$$

$$= \Sigma f_n t^n$$

This series is either odd or even in t and in our magnetic case ϕ_{MM} is odd. Substituting (5.4.11) in (5.4.9) and using

$$\int_0^\infty x^m e^{-\varepsilon x} e^{-i\omega x} dx = \pi i^m \delta^m(\omega - i\varepsilon) + \frac{m!}{(i\omega+\varepsilon)^{m+1}} . \quad (5.4.12)$$

we obtain, for ϕ_{BA} odd in t,

$$\text{Re } \chi_{BA}(\omega) = \Sigma \frac{m!(-1)^{\frac{m+1}{2}}}{\omega^{m+1}} f_m$$

$$(5.4.13)$$

$$\text{Im } \chi_{BA}(\omega) = \pi(i)^m \delta^m(\omega) f_m .$$

The initial values of the response function (since $f_m = \frac{1}{m!} \phi^{(m)}(0)$) determine the coefficients of the power series in $\frac{1}{\omega}$ for the susceptibility and the moments for the dissipative part. The quantity we are calculating here is $\chi^{xx}(\omega)$, that is the force we apply is $H^x e^{i\omega t}$ and both operators A and B are M^x. The response function is:

$$\phi_{xx}(t) = \frac{i}{\hbar} \text{Tr } \rho_o [M_x, M_x(t)] \quad (5.4.14)$$

and the susceptibility follows from (5.4.11) and (5.4.13). Obviously in this case $\phi_{xx}(t) = -\phi_{xx}(-t)$. It can be noted, that

$$\phi_{xx}(t) = \phi_{yy}(t)$$

and

$$\phi_{xy}(t) = \phi_{yx}(t) = \phi_{xz}(t) = \phi_{yz}(t)$$

$$= \phi_{zx}(t) = \phi_{zy}(t) = 0 \ .$$

But for neutron scattering where one needs the $\chi(\underline{q},\omega)$ the zz part does not vanish.

We want to obtain the zero frequency susceptibility. The identity

$$[A, e^{-\beta\mathcal{H}_o}] = \frac{\hbar}{i} e^{-\beta\mathcal{H}} \int_0^\beta \dot{A}(-i\hbar\lambda)\, d\lambda \qquad (5.4.15)$$

was proved by Kubo (1957) and independently by Feynman (1948). Using (5.4.15) and integrating by parts we obtain the following expression in the zero frequency limit

$$\chi_{BA}(0) = \int_0^\beta \mathrm{Tr}\, \rho_o\, A(-i\hbar\lambda)B\, d\lambda - \beta\, \mathrm{Tr}\, \rho_o\, A^o B^o \ . \qquad (5.4.16)$$

$\chi_{BA}(0)$ is the quasistatic (also called adiabatic) susceptibility and

$$A^o = \lim_{T\to\infty} \frac{1}{T} \int_0^T A(t)\, dt \ .$$

The isothermal susceptibility on the other hand is

$$\chi^T_{BA}(0) = \frac{\mathrm{Tr}\, \rho\, B - \mathrm{Tr}\, \rho_o\, B}{F} \qquad (5.4.17)$$

which can be shown (Kubo 1957) to be equal to

$$\chi^{T}_{BA}(0) = \int_0^\beta \mathrm{Tr}\, \rho_o\, A(-i\hbar\lambda)B\, d\lambda - B\langle A\rangle\langle B\rangle \tag{5.4.18}$$

in the linear approximation.

The second term in (5.4.16) was obtained from

$$\lim_{t\to\infty} \int_0^\beta \mathrm{Tr}\, \rho_o\, A(-i\hbar\lambda)B(t)d\lambda$$

by noting that if this limit exists it is equal to

$$\lim_{t\to\infty} \frac{1}{t} \int_0^t dt \int_0^\beta \mathrm{Tr}\, \rho_o\, A(-i\hbar\lambda)\, B(t)\, d\lambda =$$

$$= \int_0^\beta \mathrm{Tr}\, \rho_o\, A(-i\hbar\lambda)\, B_o\, d\lambda\ .$$

This limiting process picks up the zero frequency component of B, B_o, which is diagonal with respect to $\mathcal{H}_o$. Now

$$\mathrm{Tr}\, \rho_o\, Q\, B_o = \sum_{i,j,k} \rho_o^{ij}\, Q^{jk}\, B_o^{ki} =$$

$$= \sum_i \rho_o^{ii}\, Q^{ii}\, B_o^{ii} = \mathrm{Tr}\, \rho_o\, Q_o\, B_o$$

and the diagonal part of $A(-i\hbar\lambda)$ is just A^o since $(e^{-\lambda\mathcal{H}} A\, e^{\lambda\mathcal{H}})_{ii} = A_{ii}$.

For the isothermal and adiabatic susceptibility to be equal it is sufficient that

$$\lim_{t\to\infty} \langle AB(t)\rangle = \langle A\rangle\langle B\rangle\ . \tag{5.4.19}$$

A system which satisfies (5.4.19) is called ergodic. For a discussion of the ergodicity of our system, see Section (5.1).

5.5 The high temperature series expansion for the frequency dependent susceptibility

As we saw in the previous section, the susceptibility can be expanded in an asymptotic series in powers of ω^{-1}. The coefficients of this expansion are determined by the time derivatives of the response function at zero time.

Since

$$\langle M_x(t)\rangle = \int_0^t \phi_{xx}(t-t')\, H_x(t')\, dt' \qquad (5.5.1)$$

we expect ϕ_{xx} to be linear in N, the number of lattice sites. Therefore in the terminology of Sec. 3.2

$$\phi_{xx} = \{\text{linear part in N of } -\tfrac{i}{\hbar}\langle[M_x, M_x(t)]\rangle\}$$

$$= -\frac{i}{\hbar}\, \mathrm{Tr}\, e^{KP}\, [M_x,\, M_x(t)] \quad . \qquad (5.5.2)$$

Defining $\omega_o = J/\hbar$ we have

$$\phi_{xx}(t) = -\frac{i}{\hbar}\, \mathrm{Tr}^*\, e^{KP}\, [M_x,\, e^{-iP\omega_o t}\, M_x\, e^{iP\omega_o t}] \quad . \qquad (5.5.3)$$

We expand all exponentials in (5.5.3) in power series of P and have a double series in K and t

$$\phi_{xx} = -\frac{im^2}{4\hbar}\, \mathrm{Tr}^* \sum_{m,n,q=0}^{\infty} \frac{K^n}{n!}\, \frac{(i\omega_o t)^{m+q}}{m!\; q!} \times$$

$$\times \sum_{i,j} (P^n \sigma_i^x (-P)^m \sigma_j^x P^q - P^n (-P)^m \sigma_i^x P^q \sigma_j^x) \quad , \qquad (5.5.4)$$

where m' is the magnetic moment of the atoms.

We rearrange the sum, use the cyclic property of the trace and interchange m and q in the first term of (5.5.4) to obtain:

$$\phi_{xx} = -\frac{im'^2}{4\hbar} \text{Tr*} \sum_{n,s} \frac{K^n}{n!} \frac{(i\omega_o t)^s}{s!} \times$$

$$\times \sum_{m=0}^{s} \binom{s}{m} \sum_{i,j} P^{n+m} \sigma_i^x P^{s-m} \sigma_j^x \left((-1)^{s-m} - (-1)^m\right). \qquad (5.5.5)$$

For even s $[(-1)^{s-m} - (-1)^m]$ vanishes. Therefore,

$$\phi_{xx} = \frac{im'^2}{2\hbar} \text{Tr*} \sum_{n} \frac{K^n}{n!} \sum_{s} \text{odd} \frac{(i\omega_o t)^s}{s!} \times$$

$$\times \sum_{m=0}^{s} \binom{s}{m} (-1)^m \sum_{i,j} P^{n+m} \sigma_i^x P^{s-m} \sigma_j^x \quad . \qquad (5.5.6)$$

Substituting $\sigma_i^x = a_i^\dagger + a_i$

$$\phi_{xx}(t) = \frac{im'^2}{2\hbar} \sum_{n=0}^{\infty} \frac{K^n}{n!} \sum_{s} \text{odd} \frac{(i\omega_o t)^s}{s!} \times$$

$$\times \sum_{m=0}^{s} \binom{s}{m} (-1)^m \text{Tr*} \left[\sum_{i,j} (P^{n+m} a_i^\dagger P^{s-m} a_j + P^{n+m} a_i P^{s-m} a_j^\dagger)\right].$$

$$(5.5.7)$$

We have in (5.5.7) an expression similar to the one we had for the static susceptibility (3.3.10) with an added complication. Now a different factor multiplies different vertical orderings of the arrows.

Instead of one vertical weight we now calculate $\ell+1$ weights, where ℓ is the number of solid arrows in the graph. As before the tip of the dotted $i\to j$ arrow is fixed - at the zero level. The tail is fixed in sequence at each of the levels k and the number of allowed orderings of the other arrows is $v(k-2)$. For a fixed n and s

$$\sum_{m=0}^{s} \binom{s}{m} (-1)^m \, Tr^* \, p^{n+m} \, a_i^\dagger \, p^{s-m} \, a_j =$$

$$= \sum_{g'_{s+n+1}} \sum_{m=0}^{s} \binom{s}{m} (-1)^m \frac{(g_{s+n},L)\, h(g')\, v(s-m)}{2^v} \qquad (5.5.8)$$

where v is the number of vertices.

As in the susceptibility the graphs were either "bubbles" for i=j, or fluctuation type graphs with a dotted arrow i-j unrestricted in length. It can be noted though that when $v(k)=v$ for all k, we have in (5.5.9)

$$\sum_{m=0}^{s} \binom{s}{m} (-1)^m v = 0$$

so graphs where the i-j arrow has a vertex of order 2 do not contribute, which reduces greatly the number of fluctuation type graphs. There is no need to calculate all v(k), since using the cyclic property of the trace we can obtain that

$$v(k) = v(\ell - k) \quad . \tag{5.5.9}$$

The equivalent of Theorem I is a bit more complicated here.

Theorem Ia

Let g be a disconnected graph of ℓ solid arrows and one dotted arrow. There are two subgraphs, g_1 and g_2. g_1 has ℓ_1 solid arrows and a dotted one and g_2 has ℓ_2 solid arrows. Then:

$$v(k) = v_2 \sum_{i=0}^{k-1} v_1(i) \binom{k-1}{i} \binom{\ell-k+1}{\ell_1-i} \tag{5.5.10}$$

where $v_1(i)$ is the vertical weight of g_1 with the dotted tail at the ith level. v(k) is the vertical weight for the whole graph g with tail of the dotted arrow at the kth level. v_2 is the vertical weight of g_2 as a partition function graph.

Proof

We keep the dotted tail fixed at the kth level. Among the k-1 levels between the tip and tail of the dotted arrows i will be filled by arrows from g_1. The number i can run from zero to k-1 and

$$v(k) = v_2 \sum_{i=0}^{k-1} v_1(i+1)\ X_i$$

where X_i is the number of ways ℓ arrows, $\ell_1 \varepsilon g_1$ and $\ell_2 \varepsilon g_2$, can be assigned to ℓ levels in such a way as to have i arrows belonging to g_1 assigned to the first k-1 levels.

The result (5.5.10) follows when we note

$$X_i = \frac{(k-1)!}{i!(k-1-i)} \frac{(\ell-k+1)}{(\ell_1-i)!\ (\ell_2-k+1-i)!} .$$

The first factor is choosing i levels out of k-1 to fill with g_1. The second factor is the number of ways of assigning ℓ-k+1 levels so that ℓ_1-i are occupied by arrows of g_1 and the rest by arrows of g_2,

The equivalent of Theorem II holds too.

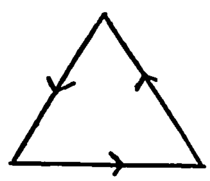
<u>Theorem IIa</u>

Let a connected graph g of ℓ solid arrows and a dotted arrow be composed of two subgraphs, g_1 of ℓ_1 solid arrows and the dotted arrow and g_2 of ℓ_2 solid arrows such that g_1 and g_2 have m common vertices of order 2 in g and no other common vertices. Then the vertical weights v(k) of g are given by the same expression (5.5.10) as in Theorem Ia.

Proof

Exactly as the proof of Theorem II followed that of Theorem I. We have no restrictions on vertices of order 2, so they can be cut to give two separated graphs.

A numerical example to clarify the meaning of the theorem: The graph g is composed of g_1 and g_2



$\ell = 6$, $\ell_1 = \ell_2 = 3$. v_2 , the vertical weight of g_2 alone, is $3! = 6$. $v_1(i)$ are the vertical weights for g_1 where i-1 levels separate head and tail of the dotted arrow. Obviously $v_1(1) = v_1(4) = 1$, $v_1(2) = v_1(3) = 0$. Let us calculate v(3), the vertical weight of g when 2 levels separate head and tail of dotted arrow.

Substituting in (5.5.10)

$$v(3) = 6.1.\binom{2}{0}\binom{4}{3} = 24 .$$

With some labour the same result can be obtained directly.

Theorem IIIa

Let a connected graph g of ℓ solid arrows and a dotted arrow be composed of two subgraphs g_1 and g_2 of

ℓ_1 and ℓ_2 solid arrows respectively and a third subgraph consisting of the single dotted arrow. The subgraphs g_1 and g_2 have in common m vertices of order 2 in g and no other common vertices. Then the vertical weights are given by:

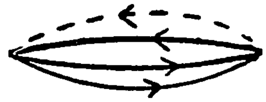
$$v(k) = \sum_{i=0}^{k} v_1(i+1)v_2(k-i)\binom{k-1}{i}\binom{\ell-k+1}{\ell_1-i} \quad . \qquad (5.5.11)$$

The dotted arrow belongs to both g_1 and g_2 for the purpose of calculating the $v_1(i+1)$, $v_2(k-i)$. The proof follows exactly the proof of Ia. After assigning i levels from the first k-1 levels to g_1, we assign the (k-1-i) levels left to g_2. The dotted arrow belongs to both, so the vertical weights of both are dependent on i.

In the actual calculation we did not go far enough to need the theorems, their only use was for checking the computer programs.

Using the fact that vertices of order 2 introduce no added restriction the dotted arrow was broken by adding a vertex of order 2 and the two new arrows were put at the head of the vector describing the graph.

In Appendix I the graph



is described by the vector 13 32 21 12 21 .
Thus the first arrow could be kept fixed at the zeroth level and the second at the k'th with no difficulty.

5.6 The frequency dependent susceptibility series, analysis and conclusions

The series we obtained for the frequency dependent susceptibility on the f.c.c. lattice is:

$$\chi(\omega)=\frac{-m'^2}{2\hbar}\sum_{s\ \text{odd}}\left[s!\left(\frac{\omega_0}{\omega}\right)^{s+1}\chi_{s+1}(K)\right]$$

$$\chi_2(K)=3K+9K^2+14.75K^3+22.0K^4+61.375K^5+237.8041667K^6+ 880.980209K^7+O(K^8)$$

$$\chi_4(K)=20K+6K^2-149.5K^3-575.291667K^4-1433.55K^5+O(K^6)$$

$$\chi_6(K)=91.5K+83.825K^2-296.1208K^3+O(K^4)$$

$$\chi_8(K)=391.516667K+O(K^2)$$

As part of the calculation we had to calculate $<[\sigma_1(t),\sigma_1]>$, the bubble graphs. As can be seen from (5.5.5) the odd powers of t for $<[\sigma_1(t),\sigma_1]>$ are just twice those of $<\sigma_1(t)\sigma_1>$, so we have the coefficients of the first, third, fifth and seventh powers of t.

We also calculate the coefficients of the second and fourth powers of t in order to see how the dependency on K changes with the powers of t, and estimate $\int_0^\infty<\sigma_1(t)\sigma_1>dt$ (see (5.2.18)). The results are

$$<\sigma_1(t)\sigma_1> = 1 + \sum_{i=1}^{\infty} a_i(K)(-i\omega_0 t)^i$$

$$a_1=3K+6K^2+10.75K^3+22.5K^4+64.175K^5+218.691667K^6+$$

$$+780.8421131K^7+ O(K^8)$$

$$a_2=6+12K+49.5K^2+142.0K^3+374.25K^4 1054.65K^5+3317.85625K^6+O(K^7)$$

$$a_3=28K+97K^2+298K^3+853.166667K^4+2453.48333K^5+O(K^6)$$

$$a_4=336+1164K+6702K^2+24392K^3+O(K^4)$$

$$a_5=156.3K+707.7K^2+2756.3125K^3+O(K^4)$$

$$a_7=664.37857K+O(K^2)$$

We assumed that $\langle\sigma_1(t)\sigma_1\rangle$ is independent of N and therefore

$$\langle\sigma_1(t)\sigma_1\rangle = \frac{\mathrm{Tr}\ e^{-\beta\mathcal{H}}\sigma_1(t)\sigma_1}{\mathrm{Tr}\ e^{-\beta\mathcal{H}}} = \frac{A(K,t) + NB(K,t) + \ldots}{1 + a(K)\ N + \ldots}$$

$$= A(K,t) \quad .$$

A. Analysis of second and fourth moments of the susceptibility

We did the regular Pade approximant analysis and ratio analysis as seen in the following tables.

TABLE 5.1

Pade approximants to $\frac{\partial}{\partial K} \log \chi_2(K)$

N	M = 1	M = 2	M = 3	M = 4
1	.1754	.1138	.2174	.2332
2	.1145	.1479	.2380	
3	.2292	.2547		
4	.2497			

TABLE 5.2

Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log \chi_2(K) \Big|_{K=.221}$

N	M = 0	M = 1	M = 2	M = 3	M = 4
1	.0407	.0511	.0911	.0925	.0870
2	.0513	.0377	.0926	.0914	
3	.0987	.0957	.0874		
4	.0954	.1006			
5	.0845				

TABLE 5.3

Ratios of $\chi_2(K)$

n	$r_n(\chi_2)$
1	
2	3
3	1.6389
4	1.4915
5	2.7898
6	3.8746
7	3.7046

TABLE 5.4

Pade approximants to $\frac{\partial}{\partial K}$ log $[(\chi_4(K)]^{-1}$.

N	M = 1	M = 2
1	.1891	.2221
2	.2169	

TABLE 5.5

Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log \chi_4(K)^{-1}\Big|_{K=.221}$

N	M = 0	M = 1	M = 2
1	.735	.881	.877
2	.859	.877	
3	.875		

TABLE 5.6

Pade approximants to $(\chi_4(K)^{-1})^{1/0.8}$

N	M = 1	M = 2	M = 3	M = 4
0	*	.3481	.2443	.2235
1	*	.1814	.2111	
2	.3199	.2236		
3	.2014			

TABLE 5.7

Pade approximants $(\chi_4(K)^{-1})^{1/0.9}$

N	M = 1	M = 2	M = 3	M = 4
0		.3678	.2561	.2323
1	*	.1871	.2167	
2	.3154	.2282		
3	.2093			

B. Analysis of the coefficients of the first, second and third powers of t in $\langle \sigma_1(t)\sigma_1 \rangle$

TABLE 5.8

Pade approximants to $\frac{\partial}{\partial K} \log a_1(K)$

N	M = 1	M = 2	M = 3	M = 4	M = 5
0	.632	.414	.312	.276	.260
1	.352	.176	.232	.240	
2	.218	.225	.242		
3	.225	.211			
4	.239				

TABLE 5.9

Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log a_1(K) \Big|_{K=0.221}$

N	M = 0	M = 1	M = 2	M = 3	M = 4	M = 5
0	.4420	.2679	.2007	.1672	.1471	.1333
1	.1547	.0827	.1007	.0955	.0852	
2	.0971	.0983	.0968	.1075		
3	.0983	.0976	.0988			
4	.0966	.0989				
5	.0893					

TABLE 5.10

Pade approximants to $\frac{\partial}{\partial K} \log a_2(K)$

N	M = 1	M = 2	M = 3	M = 4	M = 5
0			.2131	.2237 ±.1246i	.2401
1	.4237	*	.3333	.3061	
2	.7367	.5149	.2922		
3	.2970	.1277			
4	.1518				

TABLE 5.11

Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log a_2(K)\Big|_{K=0.221}$

N	M = 2	M = 3	M = 4	M = 5
0	.3102	.3226	.2475	.2322
1	.3218	.3116	.2268	
2	.1629	.0888		
3	.1154			

TABLE 5.12

Pade approximants to $(a_2(K))^{1/0.31}$

N	M = 1	M = 2	M = 3	M = 4	M = 5
1	.1575	.1548	.1894 ±.0735i	.1979 ±.0724i	.2054
2	.1984	.2736 ±.0495i	.2612 ±.0601i	.2803	
3	.2216	.2604 ±.0604i	.2695 ±.0545i		
4	.2389	.2929 ±.0346i			
5	.2507				

TABLE 5.13

Pade approximants to $(a_2(K))^{1/.25}$

N	M = 1	M = 2	M = 3	M = 4	M = 5
1	.140	*	.170± .068i		.192
2	.176	.224± .062i		.254	
3	.198	.224± .062i	.224± .062i		
4	.216	.250± .052i			
5	.230				

TABLE 5.14

Pade approximants to $(a_2(K))^{1/.23}$

N	M = 1	M = 2	M = 3	M = 4	M = 5
1	.134	*	.163± .065i	*	.186
2	.167	.208± .062i	.212± .061i	.238	
3	.190	.212± .061i	.207± .063i		
4	.207	.237± .053i			
5	.222				

TABLE 5.15

Pade approximants to $\frac{\partial}{\partial K} \log a_3(K)$

N	M = 1	M = 2	M = 3
0	.373	.421	.340
1	.415	.385	
2	.326		

TABLE 5.16

Pade approximants to $(K-K_c) \frac{\partial}{\partial K} \log a_3(K) \Big|_{K=0.221}$

N	M = 0	M = 1	M = 2	M = 3
0	.766	.544	.414	.341
1	.454	.207	.139	
2	.242	.118		
3	.164			

TABLE 5.17

Pade approximants to $(a_3(K))^{1/0.35}$

N	M = 1	M = 2	M = 3	M = 4
0	.101	.138± .094i	.221	.221
1	.159	.197± .088i	.221	
2	.198	.244± .075i		
3	.225			

TABLE 5.18

Pade approximants to $(a_3(K))^{1/.38}$

N	M = 1	M = 2	M = 3	M = 4
0	.110	.155± .100i	.267	.232
1	.170	.213± .001i	.230	
2	.209	.262± .074i		
3	.235			

TABLE 5.19

Ratios of $a_1(K)$, $a_2(K)$ and $a_3(K)$

n	r_{a_1}	r_{a_2}	r_{a_3}
1		2	
2	2	4.125	3.4643
3	1.7917	2.8687	3.0722
4	2.0930	2.6356	2.8630
5	2.8522	2.8180	2.8757
6	3.4077	3.1459	
7	3.5705		

TABLE 5.20

Pade approximants to $[(K-K_c)^{0.1} a_1(K) K^{-1}]_{K=.221}$

N	M = 0	M = 1	M = 2	M = 3	M = 4	M = 5	M = 6
0		3.920	3.743	3.724	3.726	3.724	3.715
1	3.462	3.757	3.721	3.726	3.725	3.728	
2	3.683	3.730	3.727	3.725	3.727		
3	3.722	3.727	3.710	3.728			
4	3.727	3.726	3.729				
5	3.725	3.727					
6	3.720						

TABLE 5.21

Pade approximants to $[(K-K_c)^{0.24} a_2(K)]_{K=.221}$

N	M = 0	M = 1	M = 2	M = 3	M = 4	M = 5	M = 6
0		5.223	6.596	6.495	5.984	6.022	6.134
1	5.020	*	6.500	6.619	6.019	5.964	
2	5.879	6.275	6.006	6.132	6.102		
3	6.150	6.114	6.110	6.109			
4	6.109	6.109	6.109				
5	6.109	*					
6	6.109						

TABLE 5.22

Pade approximants to $[(K-K_c)^{0.35} a_3(K) K^{-1}]_{K=0.221}$

N	M = 0	M = 1	M = 2	M = 3	M = 4
0		28.25	26.67	24.83	23.77
1	23.37	26.78	34.69	22.03	
2	25.65	25.60	22.31		
3	25.60	25.65			
4	24.70				

The results for the self correlation indicate that

$$<\sigma_1(t)\sigma_1> = 1 + \sum_{n=1}^{\infty} A_{2n} \, (K - K_c)^{-\gamma_{2n}^A} (-i\omega_o t)^{2n}$$

$$+ \sum_{n=0}^{\infty} A_{2n+1} \, K(K - K_c)^{-\gamma_{2n+1}^A} \, (i\omega_o t)^{2n+1} \qquad (5.6.1)$$

with

$$\gamma_1^A = 0.099 \pm 0.005 \qquad A_1 = 0.82 \pm 0.1$$

$$\gamma_2^A = 0.24 \pm 0.03 \qquad A_2 = 6.1 \pm 0.5$$

$$\gamma_3^A = 0.35 \pm 0.03 \qquad A_3 = 5.3 \pm 2 \quad ,$$

where the A_n were obtained by taking Pade approximants of the function $\left[(K-K_c)^{\gamma_n^A} a_n(K)\right]$ evaluated at $K=K_c$ for n even and of $[(K-K_c)^{\gamma_n^A} a_n(K)K^{-1}]$ evaluated at $K=K_c$ for n odd.

The differences are $\Delta_A = \gamma_n^A - \gamma_{n-1}^A \simeq 0.10 \pm 0.05$

$$<\sigma_1(t)\sigma_1> \simeq 1 + \Sigma A_n (T-T_c)^{-n\Delta_A} (-i\omega_o t)^n$$

$$\simeq f\left(\frac{t}{\varepsilon^{\Delta_A}}\right) \quad . \qquad (5.6.2)$$

Near T_c, if we can assume that $\int_0^\infty f(x)dx$ converges, we find that the autocorrelation will vanish like ε^{Δ_A}.

$$<\sigma_1(t)\sigma_1> \approx \int_0^\infty f\left(\frac{t}{\varepsilon^{\Delta_A}}\right)dt = \varepsilon^{\Delta_A} \int f(x)dx \simeq \varepsilon^{\Delta_A} \quad . \qquad (5.6.3)$$

We saw that $\Delta_{NMR} \propto \int_0^\infty <\sigma_1(t)\sigma_1>dt \simeq \varepsilon^{\Delta_A}$ (5.6.4)

and in (5.2.18) we obtained that $\Delta_{NMR} \simeq \varepsilon^{\nu(\eta+1-z)}$, in our case $\eta = 0$, $\nu = \frac{2}{3}$, therefore $z = 0.85 \pm 0.10$. As seen in (5.2.20), $z = \frac{\Delta_s}{\nu}$; therefore $\Delta_s = 0.57 \pm 0.10$, where Δ_s is the critical slowing down index.

The result for Δ_A is corroborated by the calculation of Δ_s from the frequency dependent susceptibility and then substituting in (5.2.18) to obtain Δ_A.

As we know

$$\chi(\omega = 0,\ \varepsilon) \sim \varepsilon^{-\gamma} .$$

The behaviour in ω we shall assume to be

$$\chi(\omega,\ \varepsilon = 0) \sim \omega^{-\gamma/\Delta_s} , \qquad (5.6.5)$$

where this defines Δ_s.

A possible function with this behaviour and only even moments is

$$\chi(\omega) \sim \left[-\omega^2 + \varepsilon^{2\Delta_s} f(\omega,\varepsilon)\right]^{-\gamma/2\Delta_s} \qquad (5.6.6)$$

and $f(\omega,\varepsilon)$ regular at $\omega=0$, $\varepsilon=0$.

The index of critical slowing down defined by Suzuki (1969) as mentioned in (5.1.10) is

$$\tau_2 = \lim_{\omega \to 0} \left[\frac{\chi(\omega) - \chi(0)}{\omega^2\ \chi(0)}\right]^{\frac{1}{2}}$$

$$= \lim_{\omega \to 0} \left[\frac{\left(1 - f^{-1} \frac{\omega^2}{\varepsilon^{2\Delta_s}}\right)^{-\gamma/2\Delta_s} - 1}{\omega^2}\right]^{\frac{1}{2}} = \varepsilon^{-\Delta_s} \qquad (5.6.7)$$

Our assumption is that $\chi(\omega)$ scales like $f\left(\frac{\omega}{\varepsilon^{\Delta_s}}\right)$, therefore the moments

$$\chi_2 \sim \varepsilon^{-\gamma_2} = \varepsilon^{-(\gamma-2\Delta_s)}$$
$$\chi_4 \sim \varepsilon^{-\gamma_4} \simeq \varepsilon^{-(\gamma-4\Delta_s)} \quad .$$

From our results

$$\gamma_2 = +.096 \pm .005 \rightarrow \Delta_s = .62 \pm .10$$

$$\gamma_4 = -.88 \pm .05 \rightarrow \Delta_s = .55 \pm .10 \quad .$$

This agrees with our former estimate.

Clearly our estimates of Δ_s however large the error margins yield

$$\Delta_s < \gamma$$

since

$$\Delta_s = 0.58 \pm 0.10 \ .$$

This agrees with Tomita (1968) for the isotropic Heisenberg model where kinetic speeding up occurs, while the kinetic Ising model had $\Delta_s > \gamma$, a kinetic slowing down.

APPENDIX A

Graphs and Weights

In the following tables the graphs needed for the calculation of the static initial susceptibility, dynamical susceptibility and fourth order fluctuation are listed.

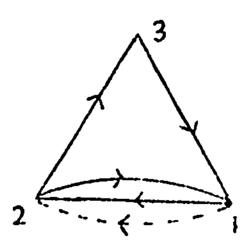
Table A.5 lists the fluctuation-like graphs used for the static susceptibility. The bubble graphs are not listed as they are identical to those of the dynamical susceptibility listed in Table A.7 apart from the vertical weight. The static weight is the sum of all dynamical weights. Table A.9 has the partition function graphs.

Table A.6 lists the fluctuation-like graphs generated for the dynamical susceptibility.

Table A.8 lists the fourth order fluctuation graphs.

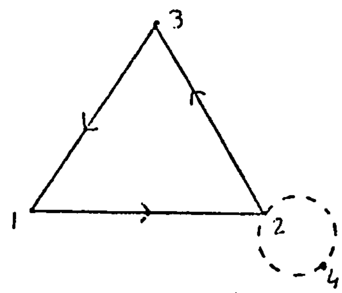
The entries are in two lines for each graph. In the first line in order the entries are: the number of vertices, the number of solid arrows (except for Table A.8 which lists the number of all arrows, solid plus two dotted), lattice constant, horizontal weight, and vertical weight or weights. The lattice constants are the f.c.c. ones.

In the second line the graph itself is listed, for example



1 2 2 3 3 1 1 2 2 1 .

Dotted arrows come first in the listing. In Tables A.6, A.7 the spurious vertex is kept in the listing of the graph, for example



2 4 4 2 2 3 3 1 1 2 .

Since $v(k) = v(\ell-k)$ we did not list all vertical weights, only 4 for $\ell \leqslant 7$ and 5 for $\ell = 8$.

Below is the subdivision of graphs according to the number of solid arrow ℓ.

TABLE A.1

Fluctuation-like static susceptibility graphs

ℓ	No. of graphs
1	1
2	1
3	4
4	9
5	30
6	80
7	268
8	854
Total	1247

TABLE A.2

Fluctuation-like dynamic susceptibility graphs

ℓ	No. of graphs
3	1
4	2
5	10
6	26
7	103
8	348
Total	490

TABLE A.3

Bubble graphs

ℓ	No. of graphs
2	1
3	1
4	5
5	8
6	32
7	69
8	245
Total	361

TABLE A.4

Fourth order fluctuation graphs

ℓ	No. of graphs
2	2
3	3
4	20
5	61
6	292
7	1117
Total	1495

TABLE A.5

```
2  1   0.600000000000D 01    2    2
 1 2 2 1
3  2   0.660000000000D 02    2    6
 1 2 2 3 3 1
2  3   0.600000000000D 01    2    2
 1 2 2 1 1 2 2 1
3  3   0.660000000000D 02    4    8
 1 2 2 1 1 3 3 1
4  3   0.702000000000D 03    2   24
 1 2 2 3 3 4 4 1
4  3  -0.690000000000D 02    4   24
 1 2 2 1 3 4 4 3
3  4   0.800000000000D 01    6   14
 1 2 2 1 1 2 2 3 3 1
3  4   0.800000000000D 01    6    8
 2 1 1 2 2 3 3 1 1 2
3  4   0.660000000000D 02    4   10
 2 3 3 1 1 2 2 1 1 2
4  4   0.240000000000D 03    4   40
 1 2 2 1 1 3 3 4 4 1
4  4   0.702000000000D 03    4   40
 1 3 3 4 4 1 1 2 2 1
4  4   0.220000000000D 03    6   40
 3 4 4 1 1 2 2 1 1 3
5  4   0.735000000000D 04    2  120
 1 2 2 3 3 4 4 5 5 1
5  4  -0.264000000000D 03    4  120
 1 2 2 1 3 4 4 5 5 2
5  4  -0.222000000000D 04    2  120
 3 4 4 5 5 3 1 2 2 1
2  5   0.600000000000D 01    2    2
 1 2 2 1 1 2 2 1 1 2 2 1
3  5   0.800000000000D 01    6   10
 1 2 2 3 3 1 1 2 2 3 3 1
3  5   0.800000000000D 01    6   34
 1 2 2 1 1 3 3 2 2 3 3 1
3  5   0.660000000000D 02    4   16
 1 2 2 1 1 2 2 1 1 3 3 1
3  5   0.660000000000D 02    4   12
 1 3 3 1 1 2 2 1 1 2 2 1
4  5   0.330000000000D 02    8   84
 1 2 2 1 1 2 2 3 3 4 4 1
4  5   0.330000000000D 02    8   48
 2 1 1 2 2 3 3 4 4 1 1 2
4  5   0.702000000000D 03    4   60
 2 3 3 4 4 1 1 2 2 1 1 2
4  5   0.702000000000D 03    2   60
 3 4 4 1 1 2 2 1 1 2 2 3
4  5   0.702000000000D 03    4   84
 1 2 2 1 1 3 3 4 4 3 3 1
```

```
4  5   0.7020000000000D 03    2    80
 1  3  3  4  4  3  3  1  1  2  2  1
4  5   0.2200000000000D 03    6    72
 1  2  2  1  1  3  3  1  1  4  4  1
4  5   0.3600000000000D 02    2    80
 1  2  2  3  3  1  1  2  2  4  4  1
4  5   0.2400000000000D 03    4    48
 2  3  3  1  1  2  2  4  4  1  1  2
4  5   0.3600000000000D 02    4    80
 1  2  2  1  1  3  3  2  2  4  4  1
4  5   0.2400000000000D 03    4    84
 1  3  3  2  2  4  4  1  1  2  2  1
4  5  -0.6900000000000D 02    4    60
 1  2  2  1  3  4  4  3  3  4  4  3
4  5  -0.6900000000000D 02    4    60
 3  4  4  3  3  4  4  3  1  2  2  1
5  5   0.1248000000000D 04    4   240
 1  2  2  1  1  3  3  4  4  5  5  1
5  5   0.7350000000000D 04    4   240
 1  3  3  4  4  5  5  1  1  2  2  1
5  5   0.6780000000000D 04    4   240
 3  4  4  5  5  1  1  2  2  1  1  3
5  5   0.2496000000000D 04    4   240
 1  2  2  3  3  1  1  4  4  5  5  1
5  5   0.1080000000000D 04    4   240
 2  3  3  1  1  4  4  5  5  1  1  2
5  5  -0.2220000000000D 04    2   240
 1  2  2  1  3  4  4  3  3  5  5  3
5  5  -0.2220000000000D 04    4   240
 3  4  4  3  3  5  5  3  1  2  2  1
6  5   0.7626600000000D 05    2   720
 1  2  2  3  3  4  4  5  5  6  6  1
6  5   0.1292000000000D 04    6   720
 1  2  2  1  3  4  4  3  5  6  6  5
6  5  -0.1416000000000D 04    4   720
 1  2  2  1  3  4  4  5  5  6  6  3
6  5  -0.3097800000000D 05    2   720
 3  4  4  5  5  6  6  3  1  2  2  1
6  5  -0.4152000000000D 04    4   720
 1  2  2  3  3  1  4  5  5  6  6  4
3  6   0.8000000000000D 01   12    24
 2  1  1  3  3  1  1  2  2  3  3  1  1  2
3  6   0.6600000000000D 02    2    28
 2  3  3  1  1  2  2  1  1  3  3  1  1  2
3  6   0.8000000000000D 01    6    22
 1  2  2  1  1  2  2  1  1  2  2  3  3  1
3  6   0.8000000000000D 01    6    16
 2  1  1  2  2  1  1  2  2  3  3  1  1  2
3  6   0.6600000000000D 02    4    14
 2  3  3  1  1  2  2  1  1  2  2  1  1  2
```

```
3  6   0.800000000000D 01   12     44
 1 2 2 1 1 3 3 1 1 2 2 3 3 1
4  6   0.240000000000D 03    2    206
 1 2 2 1 1 2 2 3 3 4 4 3 3 1
4  6   0.240000000000D 03    2    114
 2 1 1 2 2 3 3 4 4 3 3 1 1 2
4  6   0.702000000000D 03    4    140
 2 3 3 4 4 3 3 1 1 2 2 1 1 2
4  6   0.240000000000D 03    4    154
 3 4 4 3 3 1 1 2 2 1 1 2 2 3
4  6   0.240000000000D 03    4    176
 1 2 2 1 1 3 3 1 1 2 2 4 4 1
4  6   0.240000000000D 03    4     96
 2 1 1 3 3 1 1 2 2 4 4 1 1 2
4  6   0.240000000000D 03    4    112
 1 3 3 1 1 2 2 4 4 1 1 2 2 1
4  6   0.240000000000D 03    4    112
 3 1 1 2 2 4 4 1 1 2 2 1 1 3
4  6   0.220000000000D 03   12    112
 2 4 4 1 1 2 2 1 1 3 3 1 1 2
4  6   0.702000000000D 03    4    112
 4 1 1 2 2 1 1 3 3 1 1 2 2 4
4  6   0.240000000000D 03    4    112
 1 2 2 1 1 2 2 1 1 3 3 4 4 1
4  6   0.702000000000D 03    4     84
 1 3 3 4 4 1 1 2 2 1 1 2 2 1
4  6   0.220000000000D 03    6     84
 3 4 4 1 1 2 2 1 1 2 2 1 1 3
4  6   0.360000000000D 02    8    114
 1 2 2 3 3 1 1 2 2 3 3 4 4 1
4  6   0.330000000000D 02    8     68
 3 1 1 2 2 3 3 4 4 1 1 2 2 3
4  6   0.240000000000D 03    4     70
 3 4 4 1 1 2 2 3 3 1 1 2 2 3
4  6   0.360000000000D 02    8    206
 1 2 2 1 1 3 3 2 2 3 3 4 4 1
4  6   0.360000000000D 02    8    212
 2 1 1 3 3 2 2 3 3 4 4 1 1 2
4  6   0.330000000000D 02    8    204
 1 3 3 2 2 3 3 4 4 1 1 2 2 1
4  6   0.240000000000D 03    4    238
 3 4 4 1 1 2 2 1 1 3 3 2 2 3
5  6   0.108000000000D 04    8    504
 1 2 2 1 1 3 3 1 1 4 4 5 5 1
5  6   0.678000000000D 04    2    504
 1 4 4 5 5 1 1 2 2 1 1 3 3 1
5  6   0.495000000000D 03   12    504
 4 5 5 1 1 2 2 1 1 3 3 1 1 4
5  6   0.168000000000D 03   10    588
 1 2 2 1 1 2 2 3 3 4 4 5 5 1
```

```
 5  6   0.168000000000D 03    10    336
  2 1 1 2 2 3 3 4 4 5 5 1 1 2
 5  6   0.735000000000D 04     4    420
  2 3 3 4 4 5 5 1 1 2 2 1 1 2
 5  6   0.735000000000D 04     4    420
  3 4 4 5 5 1 1 2 2 1 1 2 2 3
 5  6   0.232800000000D 04     4    560
  1 2 2 1 1 3 3 4 4 3 3 5 5 1
 5  6   0.232800000000D 04     4    560
  2 1 1 3 3 4 4 3 2 5 5 1 1 2
 5  6   0.735000000000D 04     2    560
  1 3 3 4 4 3 3 5 5 1 1 2 2 1
 5  6   0.678000000000D 04     4    560
  3 5 5 1 1 2 2 1 1 2 3 4 4 3
 5  6   0.249600000000D 04     4    588
  1 2 2 1 1 3 3 4 4 5 5 3 3 1
 5  6   0.249600000000D 04     4    560
  1 3 3 4 4 5 5 3 3 1 1 2 2 1
 5  6   0.735000000000D 04     4    588
  3 4 4 5 5 3 3 1 1 2 2 1 1 3
 5  6   0.678000000000D 04     2    588
  4 5 5 3 3 1 1 2 2 1 1 3 3 4
 5  6   0.384000000000D 03     2    560
  1 2 2 1 1 3 3 2 2 4 4 5 5 1
 5  6   0.384000000000D 03     2    560
  2 1 1 3 3 2 2 4 4 5 5 1 1 2
 5  6   0.124800000000D 04     4    588
  1 3 3 2 2 4 4 5 5 1 1 2 2 1
 5  6   0.249600000000D 04     4    588
  2 4 4 5 5 1 1 2 2 1 1 3 3 2
 5  6   0.232800000000D 04     2    588
  4 5 5 1 1 2 2 1 1 3 3 2 2 4
 5  6   0.384000000000D 03     2    560
  1 2 2 3 3 1 1 2 2 4 4 5 5 1
 5  6   0.124800000000D 04     4    336
  2 3 3 1 1 2 2 4 4 5 5 1 1 2
 5  6   0.249600000000D 04     4    336
  2 4 4 5 5 1 1 2 2 3 3 1 1 2
 5  6   0.232800000000D 04     2    336
  4 5 5 1 1 2 2 3 3 1 1 2 2 4
 5  6   0.360000000000D 02     6    560
  1 2 2 3 3 1 1 4 4 2 2 5 5 1
 5  6   0.648000000000D 03     4    560
  2 3 3 1 1 4 4 2 2 5 5 1 1 2
 5  6   0.648000000000D 03     2    560
  1 4 4 2 2 5 5 1 1 2 2 3 3 1
 5  6  -0.222000000000D 04     2    420
  1 2 2 3 3 1 4 5 5 4 4 5 5 4
 5  6  -0.264000000000D 03     4    420
  4 5 5 4 4 5 5 4 1 2 2 3 3 1
```

```
 5  6  -0.264000000000D 03     12      420
  1 2 2 1 3 4 4 3 3 4 4 5 5 3
 5  6  -0.264000000000D 03      6      588
  3 4 4 3 3 4 4 5 5 3 1 2 2 1
 5  6  -0.264000000000D 03      6      336
  4 3 3 4 4 5 5 3 1 2 2 1 3 4
 5  6  -0.222000000000D 04      4      420
  4 5 5 3 1 2 2 1 3 4 4 3 3 4
 6  6   0.216480000000D 05      4     1680
  4 5 5 6 6 1 1 2 2 3 3 1 1 4
 6  6   0.763200000000D 04      4     1680
  1 2 2 1 1 3 3 4 4 5 5 6 6 1
 6  6   0.762660000000D 05      4     1680
  1 3 3 4 4 5 5 6 6 1 1 2 2 1
 6  6   0.699240000000D 05      4     1680
  3 4 4 5 5 6 6 1 1 2 2 1 1 3
 6  6   0.685080000000D 05      2     1680
  4 5 5 6 6 1 1 2 2 1 1 3 3 4
 6  6   0.127440000000D 05      4     1680
  1 2 2 3 3 1 1 4 4 5 5 6 6 1
 6  6   0.522200000000D 04      4     1680
  2 3 3 1 1 4 4 5 5 6 6 1 1 2
 6  6   0.258720000000D 05      4     1680
  1 4 4 5 5 6 6 1 1 2 2 3 3 1
 6  6  -0.309780000000D 05      4     1680
  3 5 5 6 6 3 1 2 2 1 3 4 4 3
 6  6  -0.966000000000D 04      6     1680
  5 6 6 3 1 2 2 1 3 4 4 3 3 5
 6  6  -0.175800000000D 05      4     1680
  1 2 2 3 3 1 4 5 5 4 4 6 6 4
 6  6  -0.415200000000D 04      8     1680
  4 5 5 4 4 6 6 4 1 2 2 3 3 1
 6  6  -0.104160000000D 05      4     1680
  1 2 2 1 3 4 4 3 3 5 5 6 6 3
 6  6  -0.104160000000D 05      4     1680
  3 4 4 3 3 5 5 6 6 3 1 2 2 1
 7  6   0.786858000000D 06      2     5040
  1 2 2 3 3 4 4 5 5 6 6 7 7 1
 7  6   0.736140000000D 05      2     5040
  5 6 6 7 7 5 1 2 2 1 3 4 4 3
 7  6  -0.885600000000D 04      4     5040
  1 2 2 1 3 4 4 5 5 6 6 7 7 3
 7  6  -0.400944000000D 06      2     5040
  3 4 4 5 5 6 6 7 7 3 1 2 2 1
 7  6  -0.212480000000D 05      4     5040
  1 2 2 3 3 1 4 5 5 6 6 7 7 4
 7  6  -0.571440000000D 05      4     5040
  4 5 5 6 6 7 7 4 1 2 2 3 3 1
 7  6   0.864000000000D 04      8     5040
  1 2 2 1 3 4 4 3 5 6 6 7 7 5
```

```
 2  7   0.6000000000000D 01      2        2
  1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1
 3  7   0.8000000000000D 01     12       28
  2 3 3 1 1 2 2 3 3 1 1 2 2 1 1 2
 3  7   0.8000000000000D 01      6      116
  1 2 2 1 1 2 2 1 1 3 3 2 2 3 3 1
 3  7   0.8000000000000D 01     12       76
  1 3 3 2 2 3 3 1 1 2 2 1 1 2 2 1
 3  7.  0.6600000000000D 02      4       24
  1 2 2 1 1 2 2 1 1 2 2 1 1 3 3 1
 3  7   0.6600000000000D 02      4       16
  1 3 3 1 1 2 2 1 1 2 2 1 1 2 2 1
 3  7   0.6600000000000D 02      4       36
  1 2 2 1 1 2 2 1 1 3 3 1 1 3 3 1
 3  7   0.8000000000000D 01      6       32
  1 2 2 1 1 2 2 3 3 1 1 2 2 3 3 1
 3  7   0.8000000000000D 01      6       12
  2 1 1 2 2 3 3 1 1 2 2 3 3 1 1 2
 4  7   0.7020000000000D 03      2      256
  1 2 2 1 1 3 3 1 1 2 2 4 4 2 2 1
 4  7   0.7020000000000D 03      4      224
  1 3 3 4 4 3 3 1 1 2 2 1 1 2 2 1
 4  7   0.7020000000000D 03      4      176
  1 3 3 1 1 2 2 4 4 2 2 1 1 2 2 1
 4  7   0.2200000000000D 03      6      240
  1 2 2 1 1 2 2 1 1 3 3 1 1 4 4 1
 4  7   0.2200000000000D 03     12      160
  1 3 3 1 1 4 4 1 1 2 2 1 1 2 2 1
 4  7   0.7020000000000D 03      4      256
  3 4 4 3 3 1 1 2 2 1 1 2 2 1 1 3
 4  7   0.7020000000000D 03      4      320
  1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 1
 4  7   0.7020000000000D 03      2      112
  3 4 4 1 1 2 2 1 1 2 2 1 1 2 2 3
 4  7   0.2000000000000D 01     24      616
  1 2 2 1 1 3 3 2 2 4 4 3 3 4 4 1
 4  7   0.3600000000000D 02      4      616
  1 3 3 2 2 4 4 3 3 4 4 1 1 2 2 1
 4  7   0.3600000000000D 02      4      256
  1 2 2 1 1 2 2 1 1 3 3 2 2 4 4 1
 4  7   0.2400000000000D 03      4      176
  1 3 3 2 2 4 4 1 1 2 2 1 1 2 2 1
 4  7   0.3600000000000D 02      8      536
  1 2 2 1 1 3 3 1 1 2 2 3 3 4 4 1
 4  7   0.3600000000000D 02      8      283
  2 1 1 3 3 1 1 2 2 3 3 4 4 1 1 2
 4  7   0.3600000000000D 02      8      312
  1 3 3 1 1 2 2 3 3 4 4 1 1 2 2 1
 4  7   0.3600000000000D 02      8      320
  3 1 1 2 2 3 3 4 4 1 1 2 2 1 1 3
```

```
4  7   0.240000000000D 03      4      320
 2  3  3  4  4  1  1  2  2  1  1  3  3  1  1  2
4  7   0.240000000000D 03      4      352
 3  4  4  1  1  2  2  1  1  3  3  1  1  2  2  3
4  7   0.240000000000D 03      4      352.
 4  1  1  2  2  1  1  3  3  1  1  2  2  3  3  4
4  7   0.360000000000D 02      8      288
 1  2  2  1  1  2  2  3  3  1  1  4  4  3  3  1
4  7   0.360000000000D 02      8      152
 2  1  1  2  2  3  3  1  1  4  4  3  3  1  1  2
4  7   0.240000000000D 03      4      176
 2  3  3  1  1  4  4  3  3  1  1  2  2  1  1  2
4  7   0.360000000000D 02      8      312
 3  1  1  4  4  3  3  1  1  2  2  1  1  2  2  3
4  7   0.240000000000D 03      4      192
 1  4  4  3  3  1  1  2  2  1  1  2  2  3  3  1
4  7   0.240000000000D 03      4      192
 4  3  3  1  1  2  2  1  1  2  2  3  3  1  1  4
4  7   0.360000000000D 02      2      256
 1  2  2  1  1  2  2  3  3  1  1  2  2  4  4  1
4  7   0.360000000000D 02      2       96
 2  1  1  2  2  3  3  1  1  2  2  4  4  1  1  2
4  7   0.240000000000D 03      4      128
 2  3  3  1  1  2  2  4  4  1  1  2  2  1  1  2
4  7   0.240000000000D 03      4       96
 1  2  2  1  1  3  3  4  4  1  1  3  3  4  4  1
4  7   0.240000000000D 03      4      160
 1  3  3  4  4  1  1  3  3  4  4  1  1  2  2  1
4  7   0.240000000000D 03      2      152
 3  4  4  1  1  3  3  4  4  1  1  2  2  1  1  3
4  7   0.240000000000D 03      4      544
 1  2  2  1  1  3  3  1  1  4  4  2  2  4  4  1
4  7   0.240000000000D 03      2      608
 1  3  3  1  1  4  4  2  2  4  4  1  1  2  2  1
4  7   0.240000000000D 03      2      536
 4  2  2  4  4  1  1  2  2  1  1  3  3  1  1  4
4  7   0.330000000000D 02     16      320
 1  2  2  1  1  3  3  1  1  2  2  4  4  3  3  1
4  7   0.330000000000D 02     16      176
 2  1  1  3  3  1  1  2  2  4  4  3  3  1  1  2
4  7   0.702000000000D 03      4      224
 2  4  4  3  3  1  1  2  2  1  1  3  3  1  1  2
4  7   0.330000000000D 02      8      176
 1  2  2  1  1  2  2  1  1  2  2  3  3  4  4  1
4  7   0.330000000000D 02      8      128
 2  1  1  2  2  1  1  2  2  3  3  4  4  1  1  2
4  7   0.702000000000D 03      4      112
 2  3  3  4  4  1  1  2  2  1  1  2  2  1  1  2
4  7   0.200000000000D 01     24      336
 1  2  2  1  1  3  3  4  4  2  2  3  3  4  4  1
```

```
 4  7    0.36000000000000D 02       8      352
  1  3  3  4  4  2  2  3  3  4  4  1  1  2  2  1
 4  7    0.20000000000000D 01      12      624
  3  4  4  2  2  3  3  4  4  1  1  2  2  1  1  3
 4  7    0.33000000000000D 02       8      112
  1  2  2  3  3  4  4  1  1  2  2  3  3  4  4  1
 4  7    0.33000000000000D 02       8      624
  1  2  2  1  1  3  3  4  4  2  2  4  4  3  3  1
 4  7    0.33000000000000D 02       8      432
  1  2  2  1  1  2  2  3  3  4  4  3  3  4  4  1
 4  7    0.33000000000000D 02       8      232
  2  1  1  2  2  3  3  4  4  3  3  4  4  1  1  2
 4  7    0.70200000000000D 03       2      280
  2  3  3  4  4  3  3  4  4  1  1  2  2  1  1  2
 4  7   -0.69000000000000D 02       4      112
  3  4  4  3  3  4  4  3  3  4  4  3  1  2  2  1
 4  7   -0.69000000000000D 02       4      112
  1  2  2  1  3  4  4  3  3  4  4  3  3  4  4  3
 4  7   -0.69000000000000D 02       4      280
  1  2  2  1  1  2  2  1  3  4  4  3  3  4  4  3
 5  7    0.16800000000000D 03      10      544
  3  1  1  2  2  3  3  4  4  5  5  1  1  2  2  3
 5  7    0.38400000000000D 03       4      912
  1  2  2  3  3  1  1  2  2  3  3  4  4  5  5  1
 5  7    0.24960000000000D 04       4      560
  3  4  4  5  5  1  1  2  2  3  3  1  1  2  2  3
 5  7    0.64800000000000D 03       4      912
  2  4  4  3  3  5  5  1  1  2  2  3  3  1  1  2
 5  7    0.23280000000000D 04       2      560
  4  5  5  1  1  2  2  3  3  1  1  2  2  3  3  4
 5  7    0.36000000000000D 02      12      896
  1  2  2  3  3  4  4  1  1  2  2  3  3  5  5  1
 5  7    0.12480000000000D 04       4      544
  3  4  4  1  1  2  2  3  3  5  5  1  1  2  2  3
 5  7    0.49500000000000D 03       8     1152
  1  2  2  1  1  3  3  1  1  4  4  1  1  5  5  1
 5  7    0.38400000000000D 03       4      896
  2  3  3  1  1  2  2  4  4  3  3  5  5  1  1  2
 5  7    0.12480000000000D 04       4      768
  2  1  1  3  3  1  1  2  2  4  4  5  5  1  1  2
 5  7    0.67800000000000D 04       4     1408
  1  2  2  1  1  3  3  1  1  4  4  5  5  4  4  1
 5  7    0.67800000000000D 04       4      896
  2  4  4  5  5  1  1  2  2  1  1  3  3  1  1  2
 5  7    0.67300000000000D 04       4      896
  4  5  5  1  1  2  2  1  1  3  3  1  1  2  2  4
 5  7    0.73500000000000D 04       4      896
  5  1  1  2  2  1  1  3  3  1  1  2  2  4  4  5
 5  7    0.69600000000000D 03       4      912
  1  2  2  1  1  3  3  4  4  5  5  3  3  4  4  1
```

```
5  7   0.249600000000D 04    4   896
 1 3 3 4 4 5 5 3 3 4 4 1 1 2 2 1
5  7   0.696000000000D 03    2  1504
 3 4 4 5 5 3 3 4 4 1 1 2 2 1 1 3
5  7   0.232800000000D 04    4   912
 4 5 5 3 3 4 4 1 1 2 2 1 1 3 3 4
5  7   0.360000000000D 02   24  1568
 1 2 2 1 1 3 3 4 4 2 2 5 5 3 3 1
5  7   0.124800000000D 04    4  1632
 3 4 4 2 2 5 5 3 3 1 1 2 2 1 1 3
5  7   0.124800000000D 04    4  1568
 1 2 2 1 1 2 2 3 3 4 4 3 3 5 5 1
5  7   0.124800000000D 04    4   896
 2 1 1 2 2 3 3 4 4 3 3 5 5 1 1 2
5  7   0.735000000000D 04    4  1120
 2 3 3 4 4 3 3 5 5 1 1 2 2 1 1 2
5  7   0.124800000000D 04    4  1120
 3 4 4 3 3 5 5 1 1 2 2 1 1 2 2 3
5  7   0.124800000000D 04    4  1120
 4 3 3 5 5 1 1 2 2 1 1 2 2 3 3 4
5  7   0.735000000000D 04    4  1120
 3 5 5 1 1 2 2 1 1 2 2 3 3 4 4 3
5  7   0.678000000000D 04    4  1120
 5 1 1 2 2 1 1 2 2 3 3 4 4 3 3 5
5  7   0.124800000000D 04    4  1408
 1 2 2 1 1 3 3 1 1 2 2 4 4 5 5 1
5  7   0.249600000000D 04    4   896
 5 1 1 2 2 1 1 2 2 3 3 1 1 4 4 5
5  7   0.108000000000D 04    8   896
 4 5 5 1 1 2 2 1 1 2 2 3 3 1 1 4
5  7   0.678000000000D 04    2  1344
 1 4 4 5 5 4 4 1 1 2 2 1 1 3 3 1
5  7   0.678000000000D 04    2  1408
 4 5 5 4 4 1 1 2 2 1 1 3 3 1 1 4
5  7   0.735000000000D 04    4  1632
 1 2 2 1 1 3 3 4 4 5 5 4 4 3 3 1
5  7   0.735000000000D 04    4  1568
 1 3 3 4 4 5 5 4 4 3 3 1 1 2 2 1
5  7   0.124800000000D 04    4   896
 1 2 2 1 1 2 2 1 1 3 3 4 4 5 5 1
5  7   0.735000000000D 04    4   672
 1 3 3 4 4 5 5 1 1 2 2 1 1 2 2 1
5  7   0.678000000000D 04    4   672
 3 4 4 5 5 1 1 2 2 1 1 2 2 1 1 3
5  7   0.192000000000D 03    4  1536
 1 2 2 1 1 3 3 4 4 2 2 3 3 5 5 1
5  7   0.384000000000D 03    4  1568
 1 3 3 4 4 2 2 3 3 5 5 1 1 2 2 1
5  7   0.696000000000D 03    4  1696
 3 4 4 2 2 3 3 5 5 1 1 2 2 1 1 3
```

```
5  7   0.6480000000000D 03     4    1696
 4  2  2  3  3  5  5  1  1  2  2  1  1  3  3  4
5  7   0.1920000000000D 03     2    1504
 1  2  2  1  1  3  3  2  2  4  4  3  3  5  5  1
5  7   0.1920000000000D 03     2    1536
 2  1  1  3  3  2  2  4  4  3  3  5  5  1  1  2
5  7   0.3840000000000D 03     4    1568
 1  3  3  2  2  4  4  3  3  5  5  1  1  2  2  1
5  7   0.6480000000000D 03     4    1648
 2  4  4  3  3  5  5  1  1  2  2  1  1  3  3  2
5  7   0.6960000000000D 03     4    1648
 4  3  3  5  5  1  1  2  2  1  1  3  3  2  2  4
5  7   0.1920000000000D 03     2    1504
 1  2  2  3  3  1  1  2  2  4  4  3  3  5  5  1
5  7   0.6960000000000D 03     2    1504
 2  1  1  3  3  2  2  4  4  5  5  4  4  1  1  2
5  7   0.2328000000000D 04     4    1648
 1  3  3  2  2  4  4  5  5  4  4  1  1  2  2  1
5  7   0.2496000000000D 04     4    1568
 2  4  4  5  5  4  4  1  1  2  2  1  1  3  3  2
5  7   0.6960000000000D 03     4    1648
 4  5  5  4  4  1  1  2  2  1  1  3  3  2  2  4
5  7   0.3840000000000D 03     4    1648
 1  2  2  1  1  3  3  2  2  3  3  4  4  5  5  1
5  7   0.3840000000000D 03     4    1696
 2  1  1  3  3  2  2  3  3  4  4  5  5  1  1  2
5  7   0.1680000000000D 03    10    1632
 1  3  3  2  2  3  3  4  4  5  5  1  1  2  2  1
5  7   0.2496000000000D 04     4    1904
 3  4  4  5  5  1  1  2  2  1  1  3  3  2  2  3
5  7   0.2328000000000D 04     2    1904
 4  5  5  1  1  2  2  1  1  3  3  2  2  3  3  4
5  7   0.2040000000000D 03     8    1648
 1  2  2  1  1  2  2  3  3  4  4  5  5  3  3  1
5  7   0.2040000000000D 03     8     912
 2  1  1  2  2  3  3  4  4  5  5  3  3  1  1  2
5  7   0.2496000000000D 04     4    1120
 2  3  3  4  4  5  5  3  3  1  1  2  2  1  1  2
5  7   0.2496000000000D 04     4    1232
 3  4  4  5  5  3  3  1  1  2  2  1  1  2  2  3
5  7   0.1080000000000D 04     4    1232
 4  5  5  3  3  1  1  2  2  1  1  2  2  3  3  4
5  7   0.6480000000000D 03     2     768
 1  2  2  1  1  3  3  4  4  1  1  3  3  5  5  1
5  7   0.6480000000000D 03     2     768
 2  1  1  3  3  4  4  1  1  3  3  5  5  1  1  2
5  7   0.6480000000000D 03     2    1344
 1  3  3  4  4  1  1  3  3  5  5  1  1  2  2  1
5  7   0.1080000000000D 04     8     768
 3  4  4  1  1  3  3  5  5  1  1  2  2  1  1  3
```

```
5  7   0.232800000000D 04    4    768
 4 1 1 3 3 5 5 1 1 2 2 1 1 3 3 4
5  7   0.204000000000D 03   16   1408
 1 2 2 1 1 2 2 3 3 1 1 4 4 5 5 1
5  7   0.204000000000D 03   16    768
 2 1 1 2 2 3 3 1 1 4 4 5 5 1 1 2
5  7   0.108000000000D 04    8    896
 2 3 3 1 1 4 4 5 5 1 1 2 2 1 1 2
5  7   0.249600000000D 04    4    896
 3 1 1 4 4 5 5 1 1 2 2 1 1 2 2 3
5  7   0.249600000000D 04    4    896
 1 4 4 5 5 1 1 2 2 1 1 2 2 3 3 1
5  7   0.696000000000D 03    2   1536
 1 2 2 1 1 3 3 2 2 4 4 5 5 4 4 1
5  7   0.648000000000D 03    4   1344
 1 2 2 1 1 3 3 1 1 4 4 2 2 5 5 1
5  7   0.648000000000D 03    4   1408
 1 3 3 1 1 4 4 2 2 5 5 1 1 2 2 1
5  7   0.232800000000D 04    4   1408
 1 4 4 2 2 5 5 1 1 2 2 1 1 3 3 1
5  7   0.108000000000D 04    8   1408
 4 2 2 5 5 1 1 2 2 1 1 3 3 1 1 4
5  7   0.124800000000D 04    4    896
 1 3 3 1 1 2 2 4 4 5 5 1 1 2 2 1
5  7   0.124800000000D 04    4    896
 3 1 1 2 2 4 4 5 5 1 1 2 2 1 1 3
5  7   0.696000000000D 03    4    912
 4 3 3 5 5 1 1 2 2 3 3 1 1 2 2 4
5  7  -0.264000000000D 03    6   1904
 3 4 4 3 3 5 5 4 4 5 5 3 1 2 2 1
5  7  -0.264000000000D 03    2   2016
 1 2 2 1 3 4 4 3 3 5 5 4 4 5 5 3
5  7  -0.264000000000D 03    4    336
 1 2 2 1 3 4 4 5 5 3 3 4 4 5 5 3
5  7  -0.222000000000D 04    4    672
 3 5 5 3 1 2 2 1 3 4 4 3 3 4 4 3
5  7  -0.264000000000D 03    6    560
 3 4 4 5 5 3 3 4 4 5 5 3 1 2 2 1
5  7  -0.222000000000D 04    2   1120
 1 2 2 1 1 2 2 1 3 4 4 3 3 5 5 3
5  7  -0.222000000000D 04    4   1120
 3 4 4 3 3 5 5 3 1 2 2 1 1 2 2 1
5  7  -0.222000000000D 04    4    672
 1 2 2 1 3 4 4 3 3 4 4 3 3 5 5 3
5  7  -0.222000000000D 04    4    896
 3 4 4 3 3 4 4 3 3 5 5 3 1 2 2 1
6  7   0.258720000000D 05    4   4704
 2 4 4 5 5 6 6 1 1 2 2 1 1 3 3 2
6  7   0.219600000000D 04    8   4480
 1 4 4 5 5 6 6 4 4 1 1 2 2 3 3 1
```

```
6  7    0.114000000000D 05    4    4480
 2 1 1 3 3 4 4 3 3 5 5 6 6 1 1 2
6  7    0.762660000000D 05    2    4480
 1 3 3 4 4 3 3 5 5 6 6 1 1 2 2 1
6  7    0.685080000000D 05    4    4480
 3 5 5 6 6 1 1 2 2 1 1 3 3 4 4 3
6  7    0.216480000000D 05    4    4032
 1 3 3 4 4 1 1 5 5 6 6 1 1 2 2 1
6  7    0.635030000000D 05    4    4704
 4 5 5 6 6 3 3 1 1 2 2 1 1 3 3 4
6  7    0.266000000000D 03    2    4480
 1 2 2 3 3 4 4 1 1 2 2 5 5 6 6 1
6  7    0.477600000000D 05    2    4704
 4 5 5 6 6 1 1 2 2 1 1 3 3 2 2 4
6  7    0.163200000000D 04    8    4032
 1 2 2 1 1 3 3 4 4 1 1 5 5 6 6 1
6  7    0.114000000000D 05    4    4480
 1 2 2 1 1 3 3 4 4 3 3 5 5 6 6 1
6  7    0.238000000000D 04   12   14032
 3 4 4 1 1 5 5 6 6 1 1 2 2 1 1 3
6  7    0.600000000000D 03    4    4480
 1 2 2 3 3 1 1 4 4 2 2 5 5 6 6 1
6  7    0.652800000000D 04    2    4480
 2 3 3 1 1 4 4 2 2 5 5 6 6 1 1 2
6  7    0.652800000000D 04    2    4480
 1 4 4 2 2 5 5 6 6 1 1 2 2 3 3 1
6  7    0.660000000000D 04    4    4480
 2 5 5 6 6 1 1 2 2 3 3 1 1 4 4 2
6  7    0.234400000000D 04    4    4480
 5 6 6 1 1 2 2 3 3 1 1 4 4 2 2 5
6  7    0.970000000000D 03   12    4704
 1 2 2 1 1 2 2 3 3 4 4 5 5 6 6 1
6  7    0.970000000000D 03   12    2688
 2 1 1 2 2 3 3 4 4 5 5 6 6 1 1 2
6  7    0.762660000000D 05    4    3360
 2 3 3 4 4 5 5 6 6 1 1 2 2 1 1 2
6  7    0.762660000000D 05    4    3360
 3 4 4 5 5 6 6 1 1 2 2 1 1 2 2 3
6  7    0.762660000000D 05    2    3360
 4 5 5 6 6 1 1 2 2 1 1 2 2 3 3 4
6  7    0.777600000000D 04    4    4480
 1 2 2 1 1 3 3 4 4 5 5 3 3 6 6 1
6  7    0.777600000000D 04    4    4480
 2 1 1 3 3 4 4 5 5 3 3 6 6 1 1 2
6  7    0.258720000000D 05    4    4480
 1 3 3 4 4 5 5 3 3 6 6 1 1 2 2 1
6  7    0.477600000000D 05    2    4480
 3 4 4 5 5 3 3 6 6 1 1 2 2 1 1 3
6  7    0.203040000000D 05    4    4480
 4 5 5 3 3 6 6 1 1 2 2 1 1 3 3 4
```

```
6  7   0.477600000000D 05      2     4480
 5 3 3 6 6 1 1 2 2 1 1 3 3 4 4 5
6  7   0.117840000000D 05      8     4480
 3 6 6 1 1 2 2 1 1 3 3 4 4 5 5 3
6  7   0.216480000000D 05      4     4480
 6 1 1 2 2 1 1 3 3 4 4 5 5 3 3 6
6  7   0.240000000000D 04      2     4480
 1 2 2 3 3 1 1 2 2 4 4 5 5 6 6 1
6  7   0.763200000000D 04      4     2688
 2 3 3 1 1 2 2 4 4 5 5 6 6 1 1 2
6  7   0.253720000000D 05      4     2688
 2 4 4 5 5 6 6 1 1 2 2 3 3 1 1 2
6  7   0.477600000000D 05      2     2688
 4 5 5 6 6 1 1 2 2 3 3 1 1 2 2 4
6  7   0.258720000000D 05      4     4704
 1 2 2 3 3 1 1 4 4 5 5 6 6 4 4 1
6  7   0.117840000000D 05      4     4704
 2 3 3 1 1 4 4 5 5 6 6 4 4 1 1 2
6  7   0.966000000000D 03      4     4480
 1 2 2 1 1 3 3 4 4 2 2 5 5 6 6 1
6  7   0.127440000000D 05      4     4704
 1 3 3 4 4 2 2 5 5 6 6 1 1 2 2 1
6  7   0.114000000000D 05      2     4704
 3 4 4 2 2 5 5 6 6 1 1 2 2 1 1 3
6  7   0.240000000000D 04      2     4480
 1 2 2 1 1 3 3 2 2 4 4 5 5 6 6 1
6  7   0.240000000000D 04      2     4480
 2 1 1 3 3 2 2 4 4 5 5 6 6 1 1 2
6  7   0.763200000000D 04      4     4704
 1 3 3 2 2 4 4 5 5 6 6 1 1 2 2 1
6  7   0.762660000000D 05      4     4704
 3 4 4 5 5 6 6 3 3 1 1 2 2 1 1 3
6  7   0.127440000000D 05      4     4480
 1 3 3 4 4 5 5 6 6 3 3 1 1 2 2 1
6  7   0.127440000000D 05      4     4704
 1 2 2 1 1 3 3 4 4 5 5 6 6 3 3 1
6  7   0.699240000000D 05      4     4480
 1 3 3 4 4 5 5 4 4 6 6 1 1 2 2 1
6  7   0.580800000000D 04      8     4480
 1 2 2 1 1 3 3 4 4 5 5 4 4 6 6 1
6  7   0.196200000000D 05      6     4032
 4 5 5 6 6 1 1 2 2 1 1 3 3 1 1 4
6  7   0.699240000000D 05      2     4032
 1 4 4 5 5 6 6 1 1 2 2 1 1 3 3 1
6  7   0.529200000000D 04      3     4032
 1 2 2 1 1 3 3 1 1 4 4 5 5 6 6 1
6  7   0.600000000000D 03      6     4480
 1 2 2 3 3 4 4 1 1 5 5 3 3 6 6 1
6  7   0.284400000000D 04      2     4480
 4 5 5 2 2 6 6 1 1 2 2 3 3 1 1 4
```

```
6  7    0.660000000000D 04      2     4480
 1 4 4 5 5 2 2 6 6 1 1 2 2 3 3 1
6  7    0.652800000000D 04      2     4480
 2 3 3 1 1 4 4 5 5 2 2 6 6 1 1 2
6  7    0.600000000000D 03      2     4480
 1 2 2 3 3 1 1 4 4 5 5 2 2 6 6 1
6  7    0.114000000000D 05      2     2688
 3 4 4 1 1 2 2 5 5 6 6 1 1 2 2 3
6  7    0.127440000000D 05      4     2688
 2 3 3 4 4 1 1 2 2 5 5 6 6 1 1 2
6  7    0.157860000000D 05      3     4480
 5 6 6 1 1 2 2 1 1 3 3 4 4 3 3 5
6  7    0.129200000000D 04     12     3360
 1 2 2 1 3 4 4 3 5 6 6 5 5 6 6 5
6  7    0.129200000000D 04      6     3360
 5 6 6 5 5 6 6 5 1 2 2 1 3 4 4 3
6  7   -0.153600000000D 04      4     2688
 1 2 2 1 3 4 4 5 5 3 3 4 4 6 6 3
6  7   -0.153600000000D 04      2     4480
 3 4 4 5 5 3 3 4 4 6 6 3 1 2 2 1
6  7   -0.104160000000D 05      4     2688
 4 5 5 3 3 4 4 6 6 3 1 2 2 1 3 4
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6  7   -0.244000000000D 03     24     4704
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6  7   -0.244000000000D 03     24     2688
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6  7   -0.415200000000D 04      8     3360
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6  7   -0.966000000000D 04      2     4032
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6  7   -0.966000000000D 04      6     4032
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6  7   -0.309780000000D 05      2     4704
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6  7   -0.309780000000D 05      4     4704
 3 4 4 3 3 5 5 6 6 5 5 3 1 2 2 1
6  7   -0.309780000000D 05      2     4480
 3 5 5 6 6 5 5 3 1 2 2 1 3 4 4 3
6  7   -0.153600000000D 04      4     4704
 1 2 2 1 3 4 4 3 3 5 5 4 4 6 6 3
6  7   -0.153600000000D 04      4     4480
 3 4 4 3 3 5 5 4 4 6 6 3 1 2 2 1
6  7   -0.104160000000D 05      4     4704
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6  7   -0.141600000000D 04      4     3360
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6  7   -0.309780000000D 05      2     3360
 3 4 4 5 5 6 6 3 1 2 2 1 1 2 2 1
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 6  7  -0.141600000000D 04     8    4704
  3 4 4 3 3 4 4 5 5 6 6 3 1 2 2 1
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 6  7  -0.175800000000D 05     3    4480
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 7  7   0.266928000000D 06     4   13440
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  4 5 5 6 6 7 7 1 1 2 2 3 3 1 1 4
 7  7   0.106536000000D 06     4   13440
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 7  7   0.131040000000D 06     4   13440
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 7  7   0.514680000000D 05     4   13440
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 7  7   0.786858000000D 06     4   13440
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 7  7   0.719748000000D 06     4   13440
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 7  7  -0.576960000000D 05     4   13440
  4 5 5 3 3 6 6 7 7 3 1 2 2 1 3 4
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7  7   0.7361400000000D 05     4   13440
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7  7  -0.1903200000000D 05     8   13440
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7  7  -0.5714400000000D 05     8   13440
 4 6 6 7 7 4 1 2 2 3 3 1 4 5 5 4
7  7  -0.1776300000000D 05    12   13440
 6 7 7 4 1 2 2 3 3 1 4 5 5 4 4 6
7  7  -0.2194300000000D 05     8   13440
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8  7   0.3096074000000D 07     2   40320
 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 1
8  7   0.3143760000000D 06     4   40320
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8  7  -0.2022440000000D 06     4   40320
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8  7  -0.6065400000000D 05     4   40320
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8  7  -0.4952346000000D 07     2   40320
 3 4 4 5 5 6 6 7 7 8 8 3 1 2 2 1
8  7  -0.3003150000000D 05     8   40320
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8  7   0.1830000000000D 05     8   40320
 1 2 2 1 3 4 4 5 5 3 6 7 7 8 8 6
8  7  -0.7327440000000D 06     4   40320
 4 5 5 6 6 7 7 8 8 4 1 2 2 3 3 1
8  7  -0.1357920000000D 06     4   40320
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8  7   0.1183477800000D 07     2   40320
 5 6 6 7 7 8 8 5 1 2 2 1 3 4 4 3
8  7   0.5304000000000D 05     8   40320
 1 2 2 1 3 4 4 3 5 6 6 7 7 8 8 5
```

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 3 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 3
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 2 1 1 2 2 1 1 2 2 1 1 2 2 3 3 1 1 2
3  8   0.800000000000D 01     6      30
 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 3 3 1
3  8   0.800000000000D 01    12      90
 3 1 1 2 2 3 3 1 1 2 2 1 1 2 2 1 1 3
3  8   0.660000000000D 02     4      54
 2 3 3 1 1 2 2 1 1 2 2 1 1 3 3 1 1 2
3  8   0.800000000000D 01    12      72
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3  8   0.800000000000D 01    12      48
 1 3 3 1 1 2 2 3 3 1 1 2 2 1 1 2 2 1
3  8   0.800000000000D 01    12     102
 1 2 2 1 1 2 2 1 1 3 3 1 1 2 2 3 3 1
3  8   0.800000000000D 01     6     110
 3 2 2 3 3 1 1 2 2 1 1 3 3 1 1 2 2 3
3  8   0.800000000000D 01     6     208
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3  8   0.800000000000D 01     6      14
 3 1 1 2 2 3 3 1 1 2 2 3 3 1 1 2 2 3
4  8   0.220000000000D 03     6     144
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4  8   0.702000000000D 03     4     144
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4  8   0.240000000000D 03     4     216
 2 1 1 2 2 1 1 2 2 1 1 3 3 4 4 1 1 2
4  8   0.702000000000D 03     4     216
 4 1 1 2 2 1 1 2 2 1 1 3 3 1 1 2 2 4
4  8   0.240000000000D 03     4     216
 3 1 1 2 2 4 4 1 1 2 2 1 1 2 2 1 1 3
4  8   0.220000000000D 03    12     216
 2 4 4 1 1 2 2 1 1 2 2 1 1 3 3 1 1 2
4  8   0.240000000000D 03     4     288
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4  8   0.240000000000D 03     4     216
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4  8   0.240000000000D 03     4     408
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4  8   0.702000000000D 03     4     324
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4  8   0.220000000000D 03    12     324
 3 4 4 1 1 2 2 1 1 2 2 1 1 3 3 1 1 3
4  8   0.240000000000D 03     4     272
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 2 1 1 2 2 1 1 3 3 1 1 3 3 4 4 1 1 2
4  8   0.240000000000D 03     4     516
 1 3 3 1 1 3 3 4 4 1 1 2 2 1 1 2 2 1
```

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 4 1 1 2 2 3 3 1 1 2 2 1 1 3 3 1 1 4
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 3 1 1 4 4 1 1 2 2 3 3 1 1 2 2 1 1 3
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4  8   0.24000000000000D 03     4     396
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4  8   0.70200000000000D 03     4     336
 3 1 1 2 2 1 1 2 2 1 1 2 2 3 3 4 4 3
4  8   0.24000000000000D 03     2     404
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4  8   0.24000000000000D 03     2     572
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4  8   0.24000000000000D 03     2     424
 4 3 3 4 4 1 1 2 2 1 1 2 2 1 1 3 3 4
4  8   0.70200000000000D 03     4     504
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4  8   0.24000000000000D 03     2     308
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4  8   0.24000000000000D 03     4     768
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4  8   0.24000000000000D 03     4     612
 4 2 2 3 3 1 1 2 2 1 1 3 3 1 1 2 2 4
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4  8   0.70200000000000D 03     4     552
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4  8   0.24000000000000D 03     4     496
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4  8   0.24000000000000D 03     4     684
 4 1 1 2 2 1 1 2 2 1 1 3 3 2 2 3 3 4
4  8   0.24000000000000D 03     4     684
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4  8   0.36000000000000D 02     8     576
 3 2 2 3 3 4 4 1 1 2 2 1 1 2 2 1 1 3
4  8   0.36000000000000D 02     8     572
 2 3 3 4 4 1 1 2 2 1 1 2 2 1 1 3 3 2
4  8   0.36000000000000D 02     8     920
 2 1 1 2 2 1 1 3 3 2 2 3 3 4 4 1 1 2
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4  8   0.330000000000D 02    16    568
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4  8   0.360000000000D 02     8    892
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4  8   0.240000000000D 03     4   1044
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4  8   0.360000000000D 02     8    992
 3 2 2 4 4 1 1 2 2 1 1 3 3 1 1 2 2 3
4  8   0.360000000000D 02     8    920
 3 1 1 2 2 3 3 2 2 4 4 1 1 2 2 1 1 3
4  8   0.360000000000D 02     4    864
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4  8   0.360000000000D 02     4   1576
 1 2 2 1 1 3 3 1 1 2 2 3 3 2 2 4 4 1
4  8   0.360000000000D 02     8   1096
 4 3 3 4 4 1 1 2 2 1 1 3 3 1 1 2 2 4
4  8   0.330000000000D 02    16   1064
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4  8   0.360000000000D 02     8   1116
 3 4 4 1 1 2 2 1 1 3 3 1 1 2 2 4 4 3
4  8   0.360000000000D 02     8   1072
 3 1 1 2 2 4 4 3 3 4 4 1 1 2 2 1 1 3
4  8   0.240000000000D 03     4   1164
 2 4 4 3 3 4 4 1 1 2 2 1 1 3 3 1 1 2
4  8   0.360000000000D 02     8    992
 2 1 1 3 3 1 1 2 2 4 4 3 3 4 4 1 1 2
4  8   0.360000000000D 02     8   1092
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4  8   0.360000000000D 02     8   1884
 1 2 2 1 1 3 3 1 1 2 2 4 4 3 3 4 4 1
4  8   0.240000000000D 03     4    252
 4 1 1 2 2 1 1 2 2 3 3 1 1 2 2 3 3 4
4  8   0.240000000000D 03     4    252
 3 4 4 1 1 2 2 1 1 2 2 3 3 1 1 2 2 3
4  8   0.330000000000D 02    16    232
 3 1 1 2 2 3 3 4 4 1 1 2 2 1 1 2 2 3
4  8   0.360000000000D 02     8    404
 2 3 3 1 1 2 2 3 3 4 4 1 1 2 2 1 1 2
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 2 1 1 2 2 3 3 1 1 2 2 3 3 4 4 1 1 2
4  8   0.360000000000D 02     8    476
 1 2 2 1 1 2 2 3 3 1 1 2 2 3 3 4 4 1
4  8   0.240000000000D 03     4    288
 4 2 2 3 3 1 1 2 2 1 1 2 2 3 3 1 1 4
4  8   0.360000000000D 02     8    476
 3 1 1 4 4 2 2 3 3 1 1 2 2 1 1 2 2 3
4  8   0.360000000000D 02     4    236
 2 1 1 2 2 3 3 1 1 4 4 2 2 3 3 1 1 2
4  8   0.360000000000D 02     4    456
 1 2 2 1 1 2 2 3 3 1 1 4 4 2 2 3 3 1
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4 1 1 2 2 3 3 4 4 1 1 2 2 1 1 3 3 4
4 8 0.360000000000D 02 8 596
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4 8 0.240000000000D 03 4 336
2 3 3 4 4 1 1 2 2 1 1 3 3 4 4 1 1 2
4 8 0.360000000000D 02 8 296
2 1 1 3 3 4 4 1 1 2 2 3 3 4 4 1 1 2
4 8 0.330000000000D 02 16 332
1 3 3 4 4 1 1 2 2 3 3 4 4 1 1 2 2 1
4 8 0.360000000000D 02 8 560
1 2 2 1 1 3 3 4 4 1 1 2 2 3 3 4 4 1
4 8 0.240000000000D 03 4 108
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4 8 0.360000000000D 02 8 176
3 1 1 2 2 3 3 1 1 2 2 4 4 1 1 2 2 3
4 8 0.360000000000D 02 4 236
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4 8 0.360000000000D 02 4 1900
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4 8 0.200000000000D 01 48 956
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4 8 0.360000000000D 02 4 548
3 4 4 1 1 3 3 2 2 4 4 1 1 2 2 1 1 3
4 8 0.360000000000D 02 8 528
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4 8 0.200000000000D 01 48 512
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5 8 0.648000000000D 03 4 4448
4 2 2 4 4 5 5 1 1 2 2 1 1 3 3 1 1 4
5 8 0.648000000000D 03 4 4896
3 1 1 4 4 2 2 4 4 5 5 1 1 2 2 1 1 3
5 8 0.648000000000D 03 4 4352
2 4 4 5 5 1 1 2 2 1 1 3 3 1 1 4 4 2
5 8 0.648000000000D 03 4 4464
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5 8 0.124800000000D 04 4 4400
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5 8 0.648000000000D 03 4 4896
1 3 3 1 1 4 4 2 2 4 4 5 5 1 1 2 2 1
5 8 0.648000000000D 03 4 4432
1 2 2 1 1 3 3 1 1 4 4 2 2 4 4 5 5 1
5 8 0.232800000000D 04 4 4824
5 4 4 1 1 2 2 1 1 3 3 1 1 4 4 2 2 5
5 8 0.124800000000D 04 2 4432
4 2 2 5 5 4 4 1 1 2 2 1 1 3 3 1 1 4
5 8 0.696000000000D 03 4 4352
4 1 1 2 2 1 1 3 3 1 1 4 4 2 2 5 5 4
```

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  3 1 1 4 4 2 2 5 5 4 4 1 1 2 2 1 1 3
 5   8    0.696000000000D 03       4     4448
  2 1 1 3 3 1 1 4 4 2 2 5 5 4 4 1 1 2
 5   8    0.249600000000D 04       4     1152
  5 1 1 2 2 1 1 2 2 3 3 1 1 2 2 4 4 5
 5   8    0.124800000000D 04       4     1152
  3 1 1 2 2 4 4 5 5 1 1 2 2 1 1 2 2 3
 5   8    0.384000000000D 03       2      864
  2 1 1 2 2 3 3 1 1 2 2 4 4 5 5 1 1 2
 5   8    0.384000000000D 03       2     2304
  1 2 2 1 1 2 2 3 3 1 1 2 2 4 4 5 5 1
 5   8    0.249600000000D 04       4     1728
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 5   8    0.384000000000D 03       4     2808
  3 1 1 4 4 5 5 3 3 1 1 2 2 1 1 2 2 3
 5   8    0.124800000000D 04       4     1584
  2 3 3 1 1 4 4 5 5 3 3 1 1 2 2 1 1 2
 5   8    0.384000000000D 03       4     1368
  2 1 1 2 2 3 3 1 1 4 4 5 5 3 3 1 1 2
 5   8    0.249600000000D 04       4     1728
  1 4 4 5 5 3 3 1 1 2 2 1 1 2 2 3 3 1
 5   8    0.384000000000D 03       4     2592
  1 2 2 1 1 2 2 3 3 1 1 4 4 5 5 3 3 1
 5   8    0.249600000000D 04       4     1584
  5 4 4 1 1 2 2 1 1 3 3 4 4 1 1 2 2 5
 5   8    0.334000000000D 03       4     2688
  4 1 1 2 2 5 5 4 4 1 1 2 2 1 1 3 3 4
 5   8    0.124800000000D 04       4     1584
  3 4 4 1 1 2 2 5 5 4 4 1 1 2 2 1 1 3
 5   8    0.232800000000D 04       4     1584
  2 5 5 4 4 1 1 2 2 1 1 3 3 4 4 1 1 2
 5   8    0.334000000000D 03       4     1328
  2 1 1 3 3 4 4 1 1 2 2 5 5 4 4 1 1 2
 5   8    0.124800000000D 04       4     1584
  1 3 3 4 4 1 1 2 2 5 5 4 4 1 1 2 2 1
 5   8    0.384000000000D 03       4     2432
  1 2 2 1 1 3 3 4 4 1 1 2 2 5 5 4 4 1
 5   8    0.204000000000D 03       8     4824
  5 2 2 5 5 1 1 2 2 1 1 3 3 4 4 1 1 5
 5   8    0.204000000000D 03      16     4896
  5 1 1 2 2 1 1 3 3 4 4 1 1 5 5 2 2 5
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 5   8    0.232800000000D 04       4     1440
  5 1 1 2 2 1 1 3 3 4 4 1 1 3 3 4 4 5
 5   8    0.108000000000D 04       8     1440
  4 5 5 1 1 2 2 1 1 3 3 4 4 1 1 3 3 4
 5   8    0.124800000000D 04       4     1392
  4 1 1 3 3 4 4 5 5 1 1 2 2 1 1 3 3 4
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```
5  8   0.648000000000D 03     4    2336
 3 4 4 1 1 3 3 4 4 5 5 1 1 2 2 1 1 3
5  8  -0.222000000000D 04     4    1008
 5 3 1 2 2 1 3 4 4 3 3 4 4 3 3 4 4 5
5  8  -0.264000000000D 03     6    1152
 4 3 3 4 4 3 3 4 4 5 5 3 1 2 2 1 3 4
5  8  -0.264000000000D 03     6    1584
 3 4 4 3 3 4 4 3 3 4 4 5 5 3 1 2 2 1
5  8  -0.264000000000D 03    12    3168
 5 3 3 4 4 5 5 3 1 2 2 1 3 4 4 3 3 5
5  8  -0.222000000000D 04     2    2016
 4 5 5 3 1 2 2 1 3 4 4 3 3 5 5 3 3 4
5  8  -0.264000000000D 03    12    1728
 4 3 3 5 5 3 3 4 4 5 5 3 1 2 2 1 3 4
5  8  -0.264000000000D 03     4    1008
 5 4 4 5 5 4 4 5 5 4 1 2 2 3 3 1 4 5
5  8  -0.222000000000D 04     4    2520
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5  8  -0.264000000000D 03     6    2016
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5  8  -0.264000000000D 03     6    3528
 3 4 4 3 3 4 4 5 5 3 1 2 2 1 1 2 2 1
5  8  -0.264000000000D 03    12    2520
 2 1 1 2 2 1 3 4 4 3 3 4 4 5 5 3 1 2
5  8  -0.264000000000D 03    12    1008
 2 1 3 4 4 3 3 4 4 3 3 4 4 5 5 3 1 2
5  8  -0.264000000000D 03    12    2016
 2 1 3 4 4 3 3 5 5 3 3 4 4 5 5 3 1 2
5  8  -0.222000000000D 04     2    1008
 3 1 4 5 5 4 4 5 5 4 4 5 5 4 1 2 2 3
5  8   0.495000000000D 03    24    1440
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5  8   0.735000000000D 04     4    1008
 4 5 5 1 1 2 2 1 1 2 2 1 1 2 2 3 3 4
5  8   0.678000000000D 04     2    2304
 4 5 5 3 3 1 1 2 2 1 1 2 2 1 1 3 3 4
5  8   0.678000000000D 04     2    1584
 4 5 5 2 2 1 1 2 2 1 1 3 3 1 1 2 2 4
5  8   0.735000000000D 04     2    2016
 4 5 5 3 3 1 1 2 2 1 1 3 3 1 1 2 2 4
5  8   0.232800000000D 04     2    1584
 4 5 5 1 1 2 2 1 1 2 2 1 1 3 3 2 2 4
5  8   0.232800000000D 04     4    3168
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5  8   0.232800000000D 04     2    1152
 4 5 5 1 1 2 2 1 1 2 2 3 3 1 1 2 2 4
5  8   0.232800000000D 04     4    1728
 4 5 5 3 3 1 1 2 2 1 1 2 2 3 3 1 1 4
5  8   0.108000000000D 04     2    5472
 3 4 4 1 1 5 5 2 2 5 5 1 1 2 2 1 1 3
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 5  8    0.1080000000000D 04      4      864
  4  5  5  1  1  2  2  3  3  1  1  2  2  3  3  1  1  4
 5  8    0.6960000000000D 03      4     4824
  5  1  1  2  2  1  1  3  3  1  1  4  4  2  2  3  3  5
 5  8    0.6480000000000D 03      4     4824
  4  2  2  3  3  5  5  1  1  2  2  1  1  3  3  1  1  4
 5  8    0.1920000000000D 03      4     4448
  3  1  1  4  4  2  2  3  3  5  5  1  1  2  2  1  1  3
 5  8    0.2040000000000D 03      8     4432
  2  3  3  5  5  1  1  2  2  1  1  3  3  1  1  4  4  2
 5  8    0.1920000000000D 03      4     4352
  2  1  1  3  3  1  1  4  4  2  2  3  3  5  5  1  1  2
 5  8    0.6480000000000D 03      4     2304
  5  1  1  2  2  1  1  2  2  3  3  1  1  4  4  2  2  5
 5  8    0.6480000000000D 03      2     2304
  4  2  2  5  5  1  1  2  2  1  1  2  2  3  3  1  1  4
 5  8    0.2400000000000D 02      6     2016
  2  1  1  2  2  3  3  1  1  4  4  2  2  5  5  1  1  2
 5  8    0.2400000000000D 02      6     3808
  1  2  2  1  1  2  2  3  3  1  1  4  4  2  2  5  5  1
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  5  1  1  2  2  1  1  2  2  3  3  1  1  4  4  3  3  5
 5  8    0.6480000000000D 03      4     2808
  4  3  3  5  5  1  1  2  2  1  1  2  2  3  3  1  1  4
 5  8    0.6480000000000D 03      4     2808
  3  5  5  1  1  2  2  1  1  2  2  3  3  1  1  4  4  3
 5  8    0.3600000000000D 02     24     2688
  3  1  1  4  4  3  3  5  5  1  1  2  2  1  1  2  2  3
 5  8    0.6480000000000D 03      4     2688
  2  3  3  1  1  4  4  3  3  5  5  1  1  2  2  1  1  2
 5  8    0.2400000000000D 02     24     2336
  2  1  1  2  2  3  3  1  1  4  4  3  3  5  5  1  1  2
 5  8    0.6480000000000D 03      4     2308
  1  4  4  3  3  5  5  1  1  2  2  1  1  2  2  3  3  1
 5  8    0.2400000000000D 02     24     4352
  1  2  2  1  1  2  2  3  3  1  1  4  4  3  3  5  5  1
 5  8    0.6480000000000D 03      4     2880
  5  1  1  2  2  1  1  3  3  4  4  1  1  2  2  3  3  5
 5  8    0.6480000000000D 03      4     2880
  3  5  5  1  1  2  2  1  1  3  3  4  4  1  1  2  2  3
 5  8    0.6480000000000D 03      2     2688
  2  3  3  5  5  1  1  2  2  1  1  3  3  4  4  1  1  2
 5  8    0.2400000000000D 02     12     2400
  2  1  1  3  3  4  4  1  1  2  2  3  3  5  5  1  1  2
 5  8    0.3600000000000D 02     12     2688
  1  3  3  4  4  1  1  2  2  3  3  5  5  1  1  2  2  1
 5  8    0.2400000000000D 02     12     4448
  1  2  2  1  1  3  3  4  4  1  1  2  2  3  3  5  5  1
 5  8    0.6960000000000D 03      4     2592
  5  1  1  2  2  1  1  3  3  4  4  1  1  3  3  2  2  5
```

```
5  8   0.696000000000D 03    4   2592
 4 1 1 3 3 2 2 5 5 1 1 2 2 1 1 3 3 4
5  8   0.648000000000D 03    4   2592
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5  8   0.204000000000D 03   16   2432
 3 2 2 5 5 1 1 2 2 1 1 3 3 4 4 1 1 3
5  8   0.648000000000D 03    4   2592
 2 5 5 1 1 2 2 1 1 3 3 4 4 1 1 3 3 2
5  8   0.192000000000D 03    4   2400
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5  8   0.192000000000D 03    4   4352
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5  8   0.192000000000D 03    4   2336
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5  8   0.696000000000D 03    4   5544
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5  8   0.480000000000D 02    8   5120
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5  8   0.480000000000D 02    8   5040
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5  8   0.360000000000D 02   12   5112
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5  8   0.334000000000D 03    4   5144
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5  8   0.696000000000D 03    4   3168
 5 1 1 2 2 1 1 3 3 4 4 2 2 3 3 4 4 5
5  8   0.696000000000D 03    4   3168
 4 5 5 1 1 2 2 1 1 3 3 4 4 2 2 3 3 4
5  8   0.384000000000D 03    4   3072
 4 2 2 3 3 4 4 5 5 1 1 2 2 1 1 3 3 4
5  8   0.480000000000D 02    8   5160
 3 4 4 2 2 3 3 4 4 5 5 1 1 2 2 1 1 3
5  8   0.360000000000D 02   24   2872
 2 3 3 4 4 5 5 1 1 2 2 1 1 3 3 4 4 2
5  8   0.480000000000D 02    8   2848
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5  8   0.334000000000D 03    4   2864
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5  8   0.480000000000D 02    8   2824
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5  8   0.678000000000D 04    4   1440
 5 1 1 2 2 1 1 2 2 1 1 3 3 1 1 4 4 5
5  8   0.108000000000D 04    8   1440
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5  8   0.108000000000D 04    8   2160
 2 1 1 2 2 1 1 3 3 1 1 4 4 5 5 1 1 2
5  8   0.678000000000D 04    2   2160
 5 1 1 2 2 1 1 3 3 1 1 4 4 1 1 2 2 5
5  8   0.108000000000D 04    8   2160
 4 1 1 2 2 5 5 1 1 2 2 1 1 3 3 1 1 4
```

```
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  2  1  1  3  3  1  1  4  4  1  1  2  2  5  5  1  1  2
 5   8    0.108000000000D 04       8     2160
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  5  1  1  2  2  1  1  2  2  1  1  2  2  3  3  4  4  5
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  2  1  1  2  2  1  1  2  2  3  3  4  4  5  5  1  1  2
 5   8    0.168000000000D 03      10     1584
  1  2  2  1  1  2  2  1  1  2  2  3  3  4  4  5  5  1
 5   8    0.678000000000D 04       4     2016
  5  1  1  2  2  1  1  2  2  1  1  3  3  4  4  3  3  5
 5   8    0.232800000000D 04       4     2016
  4  3  3  5  5  1  1  2  2  1  1  2  2  1  1  3  3  4
 5   8    0.673000000000D 04       4     2016
  3  5  5  1  1  2  2  1  1  2  2  1  1  3  3  4  4  3
 5   8    0.232800000000D 04       4     2016
  3  4  4  3  3  5  5  1  1  2  2  1  1  2  2  1  1  3
 5   8    0.232800000000D 04       4     2688
  2  1  1  2  2  1  1  3  3  4  4  3  3  5  5  1  1  2
 5   8    0.735000000000D 04       4     2016
  1  3  3  4  4  3  3  5  5  1  1  2  2  1  1  2  2  1
 5   8    0.232800000000D 04       4     2688
  1  2  2  1  1  2  2  1  1  3  3  4  4  3  3  5  5  1
 5   8    0.735000000000D 04       4     2304
  5  3  3  1  1  2  2  1  1  2  2  1  1  3  3  4  4  5
 5   8    0.249600000000D 04       4     2016
  3  1  1  2  2  1  1  2  2  1  1  3  3  4  4  5  5  3
 5   8    0.249600000000D 04       4     2880
  2  1  1  2  2  1  1  3  3  4  4  5  5  3  3  1  1  2
 5   8    0.678000000000D 04       4     2304
  5  1  1  2  2  1  1  3  3  1  1  2  2  4  4  2  2  5
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  3  1  1  2  2  4  4  2  2  5  5  1  1  2  2  1  1  3
 5   8    0.232800000000D 04       2     2016
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 5   8    0.232800000000D 04       2     3808
  1  2  2  1  1  3  3  1  1  2  2  4  4  2  2  5  5  1
 5   8    0.735000000000D 04       4     1584
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 5   8    0.249600000000D 04       4     1584
  3  1  1  2  2  4  4  5  5  2  2  1  1  2  2  1  1  3
 5   8    0.249600000000D 04       4     2304
  2  1  1  3  3  1  1  2  2  4  4  5  5  2  2  1  1  2
```

```
 5  8   0.735000000000D 04     4    2016
  5 3 3 1 1 2 2 1 1 3 3 1 1 2 2 4 4 5
 5  8   0.168000000000D 03    20    2880
  3 1 1 2 2 4 4 5 5 3 3 1 1 2 2 1 1 3
 5  8   0.168000000000D 03    20    1584
  2 1 1 3 3 1 1 2 2 4 4 5 5 3 3 1 1 2
 5  8   0.232800000000D 04     4    2808
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 5  8   0.232800000000D 04     4    2808
  4 5 5 4 4 1 1 2 2 1 1 3 3 1 1 2 2 4
 5  8   0.735000000000D 04     4    2688
  4 1 1 2 2 1 1 3 3 1 1 2 2 4 4 5 5 4
 5  8   0.232800000000D 04     4    2808
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 5  8   0.678000000000D 04     4    2688
  2 4 4 5 5 4 4 1 1 2 2 1 1 3 3 1 1 2
 5  8   0.232800000000D 04     4    2336
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 5  8   0.232800000000D 04     4    2808
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 5  8   0.108000000000D 04     2    2464
  5 4 4 5 5 1 1 2 2 1 1 3 3 1 1 4 4 5
 5  8   0.678000000000D 04     2    3024
  5 1 1 2 2 1 1 3 3 1 1 4 4 5 5 4 4 5
 5  8   0.108000000000D 04     2    4432
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 5  8   0.108000000000D 04     8    3312
  3 1 1 4 4 5 5 4 4 5 5 1 1 2 2 1 1 3
 5  8   0.249600000000D 04     4    2880
  5 4 4 1 1 2 2 1 1 2 2 3 3 1 1 4 4 5
 5  8   0.249600000000D 04     4    2880
  4 5 5 4 4 1 1 2 2 1 1 2 2 3 3 1 1 4
 5  8   0.249600000000D 04     4    2688
  4 1 1 2 2 1 1 2 2 3 3 1 1 4 4 5 5 4
 5  8   0.735000000000D 04     4    2880
  3 1 1 4 4 5 5 4 4 1 1 2 2 1 1 2 2 3
 5  8   0.678000000000D 04     4    2880
  2 3 3 1 1 4 4 5 5 4 4 1 1 2 2 1 1 2
 5  8   0.249600000000D 04     4    2432
  2 1 1 2 2 3 3 1 1 4 4 5 5 4 4 1 1 2
 5  8   0.249600000000D 04     4    2688
  1 4 4 5 5 4 4 1 1 2 2 1 1 2 2 3 3 1
 5  8   0.249600000000D 04     4    4432
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 5  8   0.735000000000D 04     4    2520
  5 1 1 2 2 1 1 2 2 3 3 4 4 3 3 4 4 5
 5  8   0.168000000000D 03    20    2016
  4 3 3 4 4 5 5 1 1 2 2 1 1 2 2 3 3 4
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5  8   0.168000000000D 03    20    3528
 3 4 4 3 3 4 4 5 5 1 1 2 2 1 1 2 2 3
5  8   0.735000000000D 04     2    2520
 2 3 3 4 4 3 3 4 4 5 5 1 1 2 2 1 1 2
5  8   0.249600000000D 04     4    3816
 5 4 4 3 3 1 1 2 2 1 1 2 2 3 3 4 4 5
5  8   0.249600000000D 04     4    3696
 4 3 3 1 1 2 2 1 1 2 2 3 3 4 4 5 5 4
5  8   0.735000000000D 04     4    3528
 3 1 1 2 2 1 1 2 2 3 3 4 4 5 5 4 4 3
5  8   0.249600000000D 04     2    2364
 2 1 1 2 2 3 3 4 4 5 5 4 4 3 3 1 1 2
5  8   0.249600000000D 04     2    5144
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5  8   0.249600000000D 04     4    1584
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5  8   0.124800000000D 04     4    1584
 3 2 2 4 4 5 5 1 1 2 2 1 1 2 2 1 1 3
5  8   0.384000000000D 03     2    2304
 2 1 1 2 2 1 1 3 3 2 2 4 4 5 5 1 1 2
5  8   0.384000000000D 03     2    2304
 1 2 2 1 1 2 2 1 1 3 3 2 2 4 4 5 5 1
5  8   0.249600000000D 04     4    3168
 5 1 1 2 2 1 1 3 3 1 1 2 2 3 3 4 4 5
5  8   0.249600000000D 04     4    3168
 3 4 4 5 5 1 1 2 2 1 1 3 3 1 1 2 2 3
5  8   0.384000000000D 03     4    2380
 3 1 1 2 2 3 3 4 4 5 5 1 1 2 2 1 1 3
5  8   0.124800000000D 04     4    2880
 2 3 3 4 4 5 5 1 1 2 2 1 1 3 3 1 1 2
5  8   0.384000000000D 03     4    2592
 2 1 1 3 3 1 1 2 2 3 3 4 4 5 5 1 1 2
5  8   0.384000000000D 03     4    2808
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5  8   0.384000000000D 03     4    4824
 1 2 2 1 1 3 3 1 1 2 2 3 3 4 4 5 5 1
5  8   0.124800000000D 04     4    2880
 5 1 1 2 2 1 1 3 3 1 1 2 2 4 4 3 3 5
5  8   0.249600000000D 04     4    2880
 4 3 3 5 5 1 1 2 2 1 1 3 3 1 1 2 2 4
5  8   0.124800000000D 04     4    2380
 3 5 5.1 1 2 2 1 1 3 3 1 1 2 2 4 4 3
5  8   0.384000000000D 03     4    2688
 3 1 1 2 2 4 4 3 3 5 5 1 1 2 2 1 1 3
5  8   0.232800000000D 04     4    2880
 2 4 4 3 3 5 5 1 1 2 2 1 1 3 3 1 1 2
5  8   0.384000000000D 03     4    2432
 2 1 1 3 3 1 1 2 2 4 4 3 3 5 5 1 1 2
5  8   0.384000000000D 03     4    2683
 1 3 3 1 1 2 2 4 4 3 3 5 5 1 1 2 2 1
```

```
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5  8   0.2328000000000D 04    4   4896
 5 1 1 2 2 1 1 3 3 1 1 4 4 2 2 4 4 5
5  8   0.1080000000000D 04    8   4896
 4 5 5 1 1 2 2 1 1 3 3 1 1 4 4 2 2 4
5  8   0.6480000000000D 03    4   1440
 2 1 1 3 3 4 4 1 1 3 3 4 4 5 5 1 1 2
5  8   0.6480000000000D 03    4   2464
 1 3 3 4 4 1 1 3 3 4 4 5 5 1 1 2 2 1
5  8   0.6480000000000D 03    4   1440
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5  8   0.2328000000000D 04    4   1368
 5 4 4 1 1 2 2 1 1 3 3 4 4 1 1 3 3 5
5  8   0.6960000000000D 03    4   2336
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5  8   0.1248000000000D 04    2   1328
 3 4 4 1 1 3 3 5 5 4 4 1 1 2 2 1 1 3
5  8   0.6960000000000D 03    4   1368
 2 1 1 3 3 4 4 1 1 3 3 5 5 4 4 1 1 2
5  8   0.1248000000000D 04    4   3888
 5 4 4 1 1 2 2 1 1 2 2 3 3 4 4 3 3 5
5  8   0.3840000000000D 03    2   3408
 4 3 3 5 5 4 4 1 1 2 2 1 1 2 2 3 3 4
5  8   0.2496000000000D 04    4   3528
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5  8   0.3840000000000D 03    2   3552
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5  8   0.3840000000000D 03    2   2872
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5  8   0.3840000000000D 03    2   5200
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5  8   0.1248000000000D 04    4   2088
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5  8   0.2496000000000D 04    4   2016
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5  8   0.3840000000000D 03    2   3408
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5  8   0.3840000000000D 03    2   1624
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5  8   0.3840000000000D 03    2   2872
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5  8   0.2496000000000D 04    4   5712
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5  8   0.6960000000000D 03    4   5160
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5  8   0.6960000000000D 03    4   5040
 2 3 3 4 4 5 5 4 4 1 1 2 2 1 1 3 3 2
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```
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5  8   0.384000000000D 03    2   5112
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5  8   0.384000000000D 03    2   5200
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5  8   0.249600000000D 04    4   1680
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5  8   0.696000000000D 03    4   2824
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5  8   0.696000000000D 03    4   1728
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5  8   0.204000000000D 03   16   1440
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5  8   0.204000000000D 03    8   1368
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5  8   0.384000000000D 03    2   1624
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5  8   0.696000000000D 03    4   1368
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5  8   0.192000000000D 03    4   2336
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5  8   0.204000000000D 03    8   1328
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5  8   0.720000000000D 02   12   5544
 5 4 4 1 1 2 2 1 1 3 3 2 2 4 4 3 3 5
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5  8    0.720000000000D 02     6    5616
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5  8    0.192000000000D 03     4    5160
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5  8    0.240000000000D 02     4    4872
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5  8    0.720000000000D 02    12    3024
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5  8    0.480000000000D 02     4    2816
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5  8    0.192000000000D 03     4    2824
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5  8    0.192000000000D 03     4    2848
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6  8   -0.104160000000D 05     4    8064
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```

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 6  8   0.216480000000D 05       4    12096
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6  8   0.336000000000D 04    2   13824
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 6  8   0.7176000000000D 04       4     8208
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6  8   0.2400000000000D 04     4   14112
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6  8   0.9840000000000D 03     8   14112
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6  8   0.7104000000000D 04     2   14112
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6  8   0.6528000000000D 04     2   14112
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6  8   0.6600000000000D 04     2    6912
 6 1 1 2 2 3 3 1 1 2 2 4 4 1 1 5 5 6
```

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6   8    0.699240000000D 05      4   10080
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6   8    0.699240000000D 05      2   14688
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6   8    0.717600000000D 04      4   14832
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6   8    0.240000000000D 04      4   14112
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6   8    0.201600000000D 04      2   13536
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6   8    0.717600000000D 04      4   14832
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6   8    0.219600000000D 04     16   14112
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 6   8    0.203040000000D 05      4    12672
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7  8   0.932640000000D 05     4   40320
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7  8   0.242952000000D 06     2   24192
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7  8   0.590880000000D 05     4   42336
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7  8   0.269280000000D 05     2   40320
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7  8   0.247200000000D 04     6   40320
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7  8   0.719748000000D 06     2   36288
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7  8   0.310800000000D 05     8   36288
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7  8   0.667200000000D 05     4   40320
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7  8  -0.219480000000D 05    16   30240
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7  8  -0.571440000000D 05    12   30240
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7  8  -0.237840000000D 05     4   24192
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7  8   0.736140000000D 05     4   30240
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7  8   0.864000000000D 04     8   30240
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 7  8    0.164640000000D 05      2   40320
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 7  8    0.266928000000D 06      4   42336
  7 4 4 1 1 2 2 3 3 1 1 4 4 5 5 6 6 7
 7  8    0.221760000000D 05      8   40320
  4 1 1 2 2 3 3 1 1 4 4 5 5 6 6 7 7 4
 7  8    0.131040000000D 06      4   42336
  3 1 1 4 4 5 5 6 6 7 7 4 4 1 1 2 2 3
 7  8    0.131040000000D 06      4   24192
  7 1 1 2 2 3 3 4 4 1 1 2 2 5 5 6 6 7
```

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7  8   0.767520000000D 05    4   24192
 4 1 1 2 2 5 5 6 6 7 7 1 1 2 2 3 3 4
7  8   0.116160000000D 05    2   40320
 1 2 2 3 3 4 4 1 1 2 2 5 5 6 6 7 7 1
7  8   0.650880000000D 05    2   40320
 7 1 1 2 2 3 3 1 1 4 4 5 5 2 2 6 6 7
7  8   0.650880000000D 05    2   40320
 5 2 2 6 6 7 7 1 1 2 2 3 3 1 1 4 4 5
7  8   0.153720000000D 05    4   40320
 3 1 1 4 4 5 5 2 2 6 6 7 7 1 1 2 2 3
7  8   0.313200000000D 04    4   40320
 1 2 2 3 3 1 1 4 4 5 5 2 2 6 6 7 7 1
7  8   0.390720000000D 05    2   40320
 7 1 1 2 2 3 3 1 1 4 4 5 5 6 6 2 2 7
7  8   0.677520000000D 05    2   40320
 6 2 2 7 7 1 1 2 2 3 3 1 1 4 4 5 5 6
7  8   0.388800000000D 04    2   40320
 1 2 2 3 3 1 1 4 4 5 5 6 6 2 2 7 7 1
7  8   0.371760000000D 05    8   40320
 7 1 1 2 2 3 3 1 1 4 4 5 5 6 6 4 4 7
7  8   0.790080000000D 05    4   40320
 6 4 4 7 7 1 1 2 2 3 3 1 1 4 4 5 5 6
7  8   0.790080000000D 05    4   40320
 4 5 5 6 6 4 4 7 7 1 1 2 2 3 3 1 1 4
7  8   0.226320000000D 05    8   40320
 1 4 4 5 5 6 6 4 4 7 7 1 1 2 2 3 3 1
7  8   0.650880000000D 05    2   40320
 7 1 1 2 2 3 3 4 4 1 1 5 5 2 2 6 6 7
7  8   0.153720000000D 05    2   40320
 5 2 2 6 6 7 7 1 1 2 2 3 3 4 4 1 1 5
7  8   0.313200000000D 04    2   40320
 1 2 2 3 3 4 4 1 1 5 5 2 2 6 6 7 7 1
7  8   0.600000000000D 04    6   40320
 7 1 1 2 2 3 3 4 4 1 1 5 5 3 3 6 6 7
7  8   0.950400000000D 04    4   40320
 5 3 3 6 6 7 7 1 1 2 2 3 3 4 4 1 1 5
7  8   0.950400000000D 04    2   40320
 4 1 1 5 5 3 3 6 6 7 7 1 1 2 2 3 3 4
8  8  -0.495234600000D 07    4  120960
 8 3 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 8
8  8  -0.479232000000D 06    4  120960
 4 3 3 5 5 6 6 7 7 8 8 3 1 2 2 1 3 4
8  8  -0.135792000000D 06    8  120960
 3 1 4 5 5 6 6 7 7 8 8 4 1 2 2 1 1 3
8  8  -0.166065600000D 07    4  120960
 8 3 1 2 2 1 3 4 4 5 5 3 3 6 6 7 7 8
8  8  -0.808920000000D 06    4  120960
 5 3 3 6 6 7 7 8 8 3 1 2 2 1 3 4 4 5
8  8  -0.732744000000D 06    8  120960
 8 4 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 8
```

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8  8  -0.243480000000D 06     8  120960
 8 4 1 2 2 3 3 1 4 5 5 6 6 4 4 7 7 8
8  8   0.118477800000D 07     4  120960
 8 5 1 2 2 1 3 4 4 3 5 6 6 5 5 7 7 8
8  8   0.393504000000D 06     4  120960
 6 5 5 7 7 8 8 5 1 2 2 1 3 4 4 3 5 6
8  8   0.314376000000D 06     8  120960
 8 6 1 2 2 1 3 4 4 5 5 3 6 7 7 6 6 8
8  8  -0.119328000000D 06     8  120960
 5 4 4 6 6 7 7 8 8 4 1 2 2 3 3 1 4 5
8  8  -0.299244000000D 06     8  120960
 8 5 1 2 2 3 3 4 4 1 5 6 6 5 5 7 7 8
8  8  -0.992160000000D 05     8  120960
 6 5 5 7 7 8 8 5 1 2 2 3 3 4 4 1 5 6
8  8  -0.451832400000D 07     4  120960
 7 8 8 3 1 2 2 1 3 4 4 3 3 5 5 6 6 7
8  8  -0.442117200000D 07     2  120960
 6 7 7 8 8 3 1 2 2 1 3 4 4 3 3 5 5 6
8  8  -0.479232000000D 06     4  120960
 2 1 3 4 4 3 3 5 5 6 6 7 7 8 8 3 1 2
8  8  -0.623757600000D 07     2  120960
 8 4 1 2 2 1 1 3 3 1 4 5 5 6 6 7 7 8
8  8  -0.137851200000D 07     4  120960
 7 8 8 3 1 2 2 1 3 4 4 5 5 3 3 6 6 7
8  8  -0.333288000000D 06     4  120960
 4 5 5 3 3 6 6 7 7 8 8 3 1 2 2 1 3 4
8  8  -0.127848000000D 06     8  120960
 2 1 3 4 4 5 5 3 3 6 6 7 7 8 8 3 1 2
8  8  -0.670200000000D 06     8  120960
 7 8 8 4 1 2 2 3 3 1 4 5 5 4 4 6 6 7
8  8  -0.102048000000D 07     4  120960
 3 1 4 5 5 4 4 6 6 7 7 8 8 4 1 2 2 3
8  8  -0.928560000000D 05    12  120960
 7 8 8 5 1 2 2 3 3 4 4 1 5 6 6 5 5 7
8  8  -0.221683200000D 07     4  120960
 4 1 5 6 6 5 5 7 7 8 8 5 1 2 2 3 3 4
8  8  -0.104232000000D 06     8  120960
 7 8 8 4 1 2 2 3 3 1 4 5 5 6 6 4 4 7
8  8  -0.166512000000D 06     8  120960
 3 1 4 5 5 6 6 4 4 7 7 8 8 4 1 2 2 3
8  8   0.368004000000D 06     6  120960
 7 8 8 5 1 2 2 1 3 4 4 3 5 6 6 5 5 7
8  8   0.393504000000D 06     8  120960
 4 3 5 6 6 5 5 7 7 8 8 5 1 2 2 1 3 4
8  8   0.134496000000D 07     4  120960
 5 3 6 7 7 6 6 8 8 6 1 2 2 1 3 4 4 5
8  8   0.314376000000D 06     4  120960
 2 1 3 4 4 5 5 3 6 7 7 6 6 8 8 6 1 2
8  8   0.739011600000D 07     4  120960
 7 8 8 1 1 2 2 1 1 3 3 4 4 5 5 6 6 7
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 8  8   0.143345280000D 08        2  120960
  6 7 7 8 8 1 1 2 2 1 1 3 3 4 4 5 5 6
 8  8   0.711531600000D 07        2  120960
  5 6 6 7 7 8 8 1 1 2 2 1 1 3 3 4 4 5
 8  8   0.226272000000D 07        4  120960
  7 8 8 1 1 2 2 3 3 1 1 4 4 5 5 6 6 7
 8  8   0.215452800000D 07        4  120960
  6 7 7 8 8 1 1 2 2 3 3 1 1 4 4 5 5 6
 8  8   0.204384000000D 06        4  120960
  2 3 3 1 1 4 4 5 5 6 6 7 7 8 8 1 1 2
 8  8   0.105348000000D 07        4  120960
  7 8 8 1 1 2 2 3 3 4 4 1 1 5 5 6 6 7
 8  8   0.501480000000D 06        4  120960
  6 7 7 8 8 1 1 2 2 3 3 4 4 1 1 5 5 6
 8  8   0.601488000000D 06        4  120960
  3 4 4 1 1 5 5 6 6 7 7 8 8 1 1 2 2 3
 8  8   0.808607400000D 07        4  120960
  8 1 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 8
 8  8   0.375600000000D 06        4  120960
  2 1 1 3 3 4 4 5 5 6 6 7 7 8 8 1 1 2
 8  8   0.274420800000D 07        4  120960
  8 1 1 2 2 3 3 1 1 4 4 5 5 6 6 7 7 8
 8  8   0.511404000000D 06        4  120960
  3 1 1 4 4 5 5 6 6 7 7 8 8 1 1 2 2 3
 8  8   0.134620800000D 07        4  120960
  8 1 1 2 2 3 3 4 4 1 1 5 5 6 6 7 7 8
 8  8   0.784320000000D 06        4  120960
  4 1 1 5 5 6 6 7 7 8 8 1 1 2 2 3 3 4
 9  8  -0.250616400000D 07        2  362880
  9 7 1 2 2 1 3 4 4 3 5 6 6 5 7 8 8 9
 9  8  -0.291336000000D 06       12  362880
  6 5 7 8 8 9 9 7 1 2 2 1 3 4 4 3 5 6
 9  8   0.173792400000D 08        2  362880
  9 5 1 2 2 1 3 4 4 3 5 6 6 7 7 8 8 9
 9  8   0.373680000000D 06        8  362880
  4 3 5 6 6 7 7 8 8 9 9 5 1 2 2 1 3 4
 9  8   0.491140800000D 07        4  362880
  9 6 1 2 2 1 3 4 4 5 5 3 6 7 7 8 8 9
 9  8   0.187058400000D 07        4  362880
  5 3 6 7 7 8 8 9 9 6 1 2 2 1 3 4 4 5
 9  8   0.217128000000D 06        8  362880
  2 1 3 4 4 5 5 3 6 7 7 8 8 9 9 6 1 2
 9  8   0.323040000000D 06        8  362880
  9 7 1 2 2 3 3 1 4 5 5 6 6 4 7 8 8 9
 9  8  -0.592491480000D 08        2  362880
  9 3 1 2 2 1 3 4 4 5 5 6 6 7 7 8 8 9
 9  8  -0.446856000000D 06        4  362880
  2 1 3 4 4 5 5 6 6 7 7 8 8 9 9 3 1 2
 9  8  -0.899028000000D 07        4  362880
  9 4 1 2 2 3 3 1 4 5 5 6 6 7 7 8 8 9
```

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9  8  -0.922896000000D 06      4  362880
 3 1 4 5 5 6 6 7 7 8 8 9 9 4 1 2 2 3
9  8  -0.381223200000D 07      4  362880
 9 5 1 2 2 3 3 4 4 1 5 6 6 7 7 8 8 9
9  8  -0.183835200000D 07      4  362880
 4 1 5 6 6 7 7 8 8 9 9 5 1 2 2 3 3 4
9  8   0.828485220000D 08      2  362880
 9 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9
```

TABLE A.6

2	3	0.600000000000D 01	2	1 3 3 2 2 1 1 2 2 1	1	0	0	0
3	4	0.800000000000D 01	6	1 4 4 2 2 1 1 3 3 2 2 1	2	1	2	0
3	4	0.800000000000D 01	6	2 4 4 1 1 3 3 2 2 1 1 2	4	3	0	0
2	5	0.600000000000D 01	2	1 3 3 2 2 1 1 2 2 1 1 2 2 1	1	0	0	0
3	5	0.660000000000D 02	4	1 4 4 2 2 1 1 2 2 3 3 2 2 1	4	2	2	0
3	5	0.800000000000D 01	6	1 4 4 2 2 1 1 3 3 1 2 3 3 2	6	6	5	0
3	5	0.800000000000D 01	6	1 4 4 2 2 3 3 1 1 2 2 3 3 1	2	2	1	0
4	5	-0.690000000000D 02	4	1 5 5 2 2 1 1 2 2 1 3 4 4 3	20	8	2	0
4	5	0.702000000000D 03	2	3 5 5 2 2 1 1 2 2 3 3 4 4 3	14	14	12	0
4	5	0.330000000000D 02	8	1 5 5 2 2 1 1 2 2 3 3 4 4 1	20	16	6	0
4	5	0.330000000000D 02	8	2 5 5 1 1 2 2 3 3 4 4 1 1 2	10	6	8	0
4	5	0.360000000000D 02	4	4 5 5 2 2 3 3 4 4 1 1 2 2 4	14	14	12	0
4	5	0.360000000000D 02	2	3 5 5 1 1 4 4 3 3 1 1 2 2 3	16	16	8	0
3	6	0.800000000000D 01	6	1 4 4 2 2 1 1 2 2 1 1 2 2 3 3 1	6	3	0	4
3	6	0.800000000000D 01	6	2 4 4 1 1 2 2 1 1 2 2 3 3 1 1 2	4	1	2	2
3	6	0.660000000000D 02	2	1 4 4 2 2 3 3 2 2 3 3 1 1 3 3 1	4	4	4	4
3	6	0.800000000000D 01	12	1 4 4 3 3 1 1 2 2 3 3 2 2 3 3 1	4	3	4	2
3	6	0.800000000000D 01	12	3 4 4 1 1 2 2 3 3 2 2 3 3 1 1 3	8	7	4	6
4	6	0.240000000000D 03	2	2 5 5 3 3 2 2 3 3 1 1 4 4 1 1 2	44	36	16	14
4	6	0.240000000000D 03	2	3 5 5 2 2 3 3 1 1 4 4 1 1 2 2 3	22	14	14	14
4	6	0.702000000000D 03	4	3 5 5 1 1 4 4 1 1 2 2 3 3 2 2 3	22	22	18	16
4	6	0.240000000000D 03	4	2 5 5 3 3 4 4 2 2 3 3 2 2 1 1 2	32	28	16	24
4	6	0.240000000000D 03	4	3 5 5 2 2 3 3 4 4 2 2 1 1 2 2 3	16	12	16	8
4	6	0.240000000000D 03	4	1 5 5 4 4 1 1 4 4 1 1 2 2 3 3 1	24	14	12	12
4	6	0.330000000000D 02	8	1 5 5 3 3 4 4 1 1 2 2 3 3 2 2 1	34	34	26	16

```
4 6   0.360000000000D 02  8
 3 5 5 2 2 1 1 3 3 4 4 1 1 2 2 3        34    32    26    28
4 6   0.360000000000D 02  8
 2 5 5 3 3 4 4 1 1 3 3 2 2 1 1 2        34    32    26    22
4 6   0.330000000000D 02  8
 1 5 5 3 3 2 2 1 3 2 2 1 1 4 4 3        10    10    10     8
4 6   0.360000000000D 02  8
 2 5 5 1 1 3 3 2 2 1 1 4 4 3 3 2        20    20    12    10
5 6   0.168000000000D 03  10
 2 6 6 1 1 2 2 3 3 4 4 5 5 1 1 2        60    40    44    48
5 6   0.168000000000D 03  10
 1 6 6 2 2 3 3 4 4 5 5 1 1 2 2 1       120   100    56    36
5 6   0.384000000000D 03  2
 2 6 6 1 1 4 4 3 3 2 2 1 1 5 5 2        96    96    64    48
5 6   0.384000000000D 03  4
 1 6 6 2 2 1 1 4 4 3 3 2 2 5 5 1        84    84    76    72
5 6   0.249600000000D 04  4
 1 6 6 2 2 3 3 2 2 1 1 4 4 5 5 1        84    84    76    72
5 6   0.735000000000D 04  2
 4 6 6 1 1 2 2 1 1 3 3 4 4 5 5 4        80    80    80    80
5 6  -0.264000000000D 03  4
 5 6 6 4 4 5 5 4 4 5 1 2 2 3 3 1       120    60    24    12
5 6  -0.264000000000D 03  6
 1 6 6 2 2 1 1 2 2 3 3 1 4 5 5 4       120   100    56    36
5 6  -0.264000000000D 03  6
 2 6 6 1 1 2 2 3 3 1 1 2 4 5 5 4        60    40    44    48
5 6   0.360000000000D 02  6
 3 6 6 1 1 4 4 3 3 2 2 1 1 5 5 3        80    80    80    80
2 7   0.600000000000D 01  2
 1 3 3 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1     1     0     0     0
3 7   0.800000000000D 01  6
 1 4 4 3 3 1 1 3 3 1 1 2 2 3 3 2 2 1    20    14    11    13
3 7   0.800000000000D 01  12
 3 4 4 2 2 1 1 2 2 3 3 1 1 3 3 1 1 3    10    10     9     9
3 7   0.800000000000D 01  12
 3 4 4 2 2 1 1 3 3 2 2 1 1 3 3 1 1 3     4     4     3     3
3 7   0.800000000000D 01  6
 1 4 4 3 3 1 1 3 3 2 2 1 1 3 3 2 2 1     6     5     1     4
3 7   0.800000000000D 01  6
 3 4 4 1 1 3 3 2 2 1 1 3 3 2 2 1 1 3     2     1     2     1
3 7   0.660000000000D 02  4
 1 4 4 2 2 3 3 2 2 3 3 2 2 1 1 2 2 1     6     4     4     4
3 7   0.660000000000D 02  4
 1 4 4 2 2 3 3 2 2 1 1 2 2 1 1 2 2 1     6     2     2     2
4 7   0.702000000000D 03  2
 2 5 5 3 3 4 4 3 3 2 2 1 1 2 2 3 3 2    44    30    24    30
4 7   0.702000000000D 03  4
 1 5 5 2 2 3 3 4 4 3 3 2 2 1 1 2 2 1    64    40    30    26
4 7   0.702000000000D 03  4
 2 5 5 3 3 4 4 3 3 2 2 1 1 2 2 1 1 2    32    32    26    22
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4 7 -0.690000000000D 02     4
 1 5 5 2 2 1 1 2 2 1 3 4 4 3 3 4 4 3     70    40    20    10
4 7  0.330000000000D 02     8
 1 5 5 2 2 3 3 4 4 1 1 2 2 3 3 4 4 1     18    18    12     8
4 7  0.330000000000D 02     8
 1 5 5 2 2 3 3 4 4 1 1 4 4 3 3 2 2 1    100    90    68    54
4 7  0.330000000000D 02    16
 1 5 5 4 4 1 1 2 2 1 1 4 4 3 3 2 2 1     56    48    30    26
4 7  0.702000000000D 03     2
 1 5 5 2 2 3 3 2 2 3 3 4 4 1 1 4 4 1     42    42    32    24
4 7  0.330000000000D 02     8
 4 5 5 1 1 4 4 1 1 2 2 3 3 2 2 3 3 4     84    70    36    26
4 7  0.330000000000D 02     8
 1 5 5 4 4 1 1 2 2 3 3 2 2 3 3 4 4 1     42    28    24    22
4 7  0.360000000000D 02     4
 2 5 5 4 4 2 2 4 4 2 2 3 3 4 4 1 1 2     44    30    24    30
4 7  0.360000000000D 02     2
 2 5 5 4 4 2 2 3 3 4 4 2 2 1 1 4 4 2     16     8    16     8
4 7  0.240000000000D 03     4
 1 5 5 2 2 4 4 2 2 3 3 1 1 2 2 3 3 1     24    24    16    16
4 7  0.240000000000D 03     2
 1 5 5 2 2 3 3 4 4 3 3 1 1 2 2 3 3 1     24    24    16    12
4 7  0.240000000000D 03     4
 1 5 5 2 2 1 1 3 3 2 2 4 4 2 2 3 3 1     76    76    66    54
4 7  0.330000000000D 02     8
 1 5 5 2 2 1 1 2 2 1 1 2 2 3 3 4 4 1     42    24     6    16
4 7  0.330000000000D 02     8
 2 5 5 1 1 2 2 1 1 2 2 3 3 4 4 1 1 2     28    10    12    14
4 7  0.360000000000D 02     8
 1 5 5 3 3 4 4 1 1 4 4 1 1 2 2 3 3 1     44    44    40    32
4 7  0.360000000000D 02     8
 4 5 5 1 1 4 4 1 1 3 3 1 1 2 2 3 3 4     88    78    48    54
4 7  0.360000000000D 02     8
 1 5 5 4 4 1 1 3 3 1 1 2 2 3 3 4 4 1     44    34    38    28
4 7  0.240000000000D 03     4
 3 5 5 4 4 1 1 4 4 1 1 3 3 1 1 2 2 3     44    44    38    34
4 7  0.360000000000D 02     4
 2 5 5 3 3 1 1 3 3 4 4 2 2 4 4 1 1 2     90    90    68    60
4 7  0.200000000000D 01    24
 1 5 5 3 3 1 1 2 2 4 4 2 2 3 3 4 4 1     90    84    70    64
4 7  0.360000000000D 02     8
 3 5 5 2 2 4 4 2 2 1 1 3 3 4 4 1 1 3     50    50    42    34
4 7  0.200000000000D 01    24
 4 5 5 2 2 4 4 1 1 3 3 2 2 1 1 3 3 4     50    46    36    36
4 7  0.200000000000D 01    12
 1 5 5 3 3 4 4 2 2 4 4 1 1 3 3 2 2 1    100   100    60    52
4 7  0.330000000000D 02    16
 1 5 5 2 2 3 3 2 2 1 1 4 4 3 3 2 2 1     28    20    22    18
4 7 -0.690000000000D 02     4
 1 5 5 2 2 1 1 2 2 1 1 2 2 1 3 4 4 3     42    12     2     0
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4  7   0.360000000000D 02     2      48     40      8     32
 4 5 5 2 2 4 4 2 2 1 1 4 4 2 2 3 3 4
4  7   0.360000000000D 02     8      44     44     38     30
 3 5 5 1 1 2 2 3 3 4 4 1 1 4 4 1 1 3
4  7   0.360000000000D 02     8      48     48     30     30
 1 5 5 3 3 4 4 1 1 3 3 2 2 1 1 2 2 1
4  7   0.360000000000D 02     8      48     42     26     28
 2 5 5 1 1 3 3 4 4 1 1 3 3 2 2 1 1 2
4  7   0.360000000000D 02     8      24     18     20     14
 1 5 5 2 2 1 1 3 3 4 4 1 1 3 3 2 2 1
4  7   0.240000000000D 03     4      24     24     22     18
 3 5 5 2 2 1 1 2 2 1 1 3 3 4 4 1 1 3
4  7   0.220000000000D 03     6      40     28     28     24
 1 5 5 2 2 1 1 2 2 3 3 2 2 4 4 2 2 1
4  7   0.240000000000D 03     2      76     72     60     60
 1 5 5 2 2 1 1 3 3 4 4 3 3 2 2 3 3 1
5  7   0.124800000000D 04     4     168    108     88     84
 1 6 6 5 5 1 1 5 5 1 1 2 2 3 3 4 4 1
5  7   0.735000000000D 04     4     204    204    192    184
 1 6 6 3 3 4 4 5 5 4 4 3 3 1 1 2 2 1
5  7   0.678000000000D 04     2     176    176    160    160
 1 6 6 2 2 3 3 2 2 1 1 4 4 1 1 5 5 1
5  7   0.384000000000D 03     4     238    226    194    190
 5 6 6 1 1 4 4 3 3 2 2 1 1 5 5 4 4 5
5  7   0.696000000000D 03     2     206    202    178    182
 2 6 6 4 4 1 1 5 5 1 1 2 2 3 3 4 4 2
5  7   0.168000000000D 03    10     238    238    198    142
 1 6 6 4 4 5 5 1 1 5 5 4 4 3 3 2 2 1
5  7   0.384000000000D 03     4     238    226    194    166
 1 6 6 5 5 4 4 5 5 1 1 4 4 3 3 2 2 1
5  7   0.360000000000D 02    24     204    204    192    184
 5 6 6 3 3 4 4 1 1 2 2 3 3 5 5 1 1 5
5  7   0.384000000000D 03     4     140    140    100     76
 1 6 6 2 2 3 3 4 4 5 5 1 1 2 2 5 5 1
5  7   0.168000000000D 03    10      70     70     70     62
 2 6 6 5 5 1 1 2 2 3 3 4 4 5 5 1 1 2
5  7   0.384000000000D 03     4     212    212    196    164
 1 6 6 3 3 4 4 5 5 1 1 5 5 3 3 2 2 1
5  7   0.192000000000D 03     4     212    204    180    172
 1 6 6 5 5 3 3 4 4 5 5 1 1 3 3 2 2 1
5  7   0.384000000000D 03     4     206    206    194    178
 5 6 6 3 3 1 1 5 5 1 1 2 2 3 3 4 4 5
5  7   0.192000000000D 03     2     206    202    182    162
 5 6 6 1 1 2 2 3 3 4 4 5 5 3 3 1 1 5
5  7   0.192000000000D 03     2     206    202    178    182
 1 6 6 5 5 3 3 4 4 5 5 1 1 2 2 3 3 1
5  7   0.192000000000D 03     2     228    228    168    128
 1 6 6 5 5 3 3 1 1 5 5 4 4 3 3 2 2 1
5  7   0.384000000000D 03     4     114    114    110    110
 5 6 6 3 3 1 1 5 5 4 4 3 3 2 2 1 1 5
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5 7 0.360000000000D 02 12 136 136 104 72
3 6 6 5 5 1 1 2 2 3 3 5 5 1 1 4 4 3
5 7 -0.264000000000D 03 6 84 84 64 48
1 6 6 2 2 3 3 1 1 2 2 3 3 1 4 5 5 4
5 7 0.696000000000D 03 2 228 228 168 128
1 6 6 3 3 2 2 5 5 2 2 1 1 3 3 4 4 1
5 7 0.648000000000D 03 2 192 192 144 144
1 6 6 3 3 4 4 1 1 3 3 5 5 3 3 2 2 1
5 7 0.249600000000D 04 4 114 114 110 110
1 6 6 2 2 4 4 3 3 2 2 4 4 1 1 5 5 1
5 7 0.696000000000D 03 2 206 202 182 162
4 6 6 2 2 3 3 4 4 1 1 5 5 1 1 2 2 4
5 7 0.249600000000D 04 4 206 206 194 178
1 6 6 2 2 5 5 2 2 3 3 1 1 3 3 4 4 1
5 7 0.648000000000D 03 4 176 176 160 160
1 6 6 3 3 5 5 3 3 1 1 4 4 3 3 2 2 1
5 7 0.124800000000D 04 4 224 200 136 144
1 6 6 2 2 5 5 2 2 3 3 4 4 1 1 2 2 1
5 7 0.124800000000D 04 4 112 88 104 80
1 6 6 2 2 1 1 5 5 1 1 4 4 3 3 2 2 1
5 7 0.124800000000D 04 4 280 240 160 104
1 6 6 2 2 3 3 5 5 3 3 4 4 1 1 2 2 1
5 7 0.124800000000D 04 4 140 100 100 108
1 6 6 2 2 1 1 4 4 5 5 4 4 3 3 2 2 1
5 7 0.735000000000D 04 4 140 140 140 140
1 6 6 2 2 5 5 2 2 3 3 4 4 1 1 4 4 1
5 7 -0.264000000000D 03 6 252 252 232 216
1 6 6 2 2 1 1 3 3 2 2 3 3 1 4 5 5 4
5 7 0.204000000000D 03 8 308 260 152 104
1 6 6 2 2 3 3 4 4 5 5 3 3 1 1 2 2 1
5 7 0.204000000000D 03 8 154 106 98 98
1 6 6 2 2 1 1 3 3 4 4 5 5 3 3 2 2 1
5 7 0.249600000000D 04 4 154 154 134 118
1 6 6 2 2 3 3 2 2 3 3 1 1 5 5 4 4 1
5 7 0.204000000000D 03 16 224 200 136 144
1 6 6 2 2 3 3 1 1 2 2 1 1 4 4 5 5 1
5 7 0.204000000000D 03 16 112 88 104 80
1 6 6 3 3 4 4 5 5 3 3 1 1 2 2 3 3 1
5 7 -0.222000000000D 04 4 168 108 88 84
1 6 6 2 2 3 3 2 2 1 1 2 2 1 4 5 5 4
5 7 -0.222000000000D 04 2 280 160 80 40
1 6 6 2 2 1 1 2 2 1 3 4 4 5 5 4 4 3
6 7 -0.309780000000D 05 2 588 588 548 516
3 7 7 2 2 1 1 2 2 3 3 4 4 3 5 6 6 5
6 7 -0.153600000000D 04 2 672 672 512 384
4 7 7 2 2 1 1 4 4 2 2 3 3 4 5 6 6 5
6 7 -0.153600000000D 04 4 588 588 548 516
4 7 7 2 2 3 3 4 4 1 1 2 2 4 5 6 6 5
6 7 0.129200000000D 04 6 840 480 240 120
1 7 7 2 2 1 1 2 2 1 3 4 4 3 5 6 6 5

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6  7  -0.1416000000000D 04     8   840   720   480   312
 2  7  7  1  1  4  4  3  3  2  2  1  1  2  5  5  6  5
6  7  -0.1416000000000D 04     8   420   300   300   324
 1  7  7  2  2  1  1  4  4  3  3  2  2  1  5  6  6  5
6  7  -0.2440000000000D 03    24   840   720   480   312
 1  7  7  2  2  1  1  2  2  3  3  1  4  5  5  6  6  4
6  7  -0.2440000000000D 03    24   420   300   300   324
 1  7  7  2  2  1  1  3  3  2  2  1  4  5  5  6  6  4
6  7  -0.1416000000000D 04     4   840   480   240   120
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6  7   0.7626600000000D 05     2   560   560   560   560
 1  7  7  2  2  6  6  2  2  3  3  4  4  1  1  5  5  1
6  7   0.1274400000000D 05     4   588   588   548   516
 1  7  7  5  5  6  6  5  5  1  1  2  2  3  3  4  4  1
6  7   0.2400000000000D 04     2   672   672   512   384
 1  7  7  2  2  6  6  1  1  2  2  3  3  4  4  5  5  1
6  7   0.2400000000000D 04     4   588   588   548   516
 1  7  7  2  2  6  6  1  1  5  5  4  4  3  3  2  2  1
6  7   0.9660000000000D 03     4   588   588   548   516
 1  7  7  4  4  1  1  2  2  3  3  4  4  5  5  6  6  1
6  7   0.2196000000000D 04     8   588   588   548   516
 1  7  7  2  2  3  3  4  4  2  2  1  1  5  5  6  6  1
6  7   0.9660000000000D 03     2   672   672   512   384
 1  7  7  2  2  3  3  4  4  1  1  2  2  5  5  6  6  1
6  7   0.9700000000000D 03    12   840   720   480   312
 1  7  7  2  2  1  1  2  2  3  3  4  4  5  5  6  6  1
6  7   0.9700000000000D 03    12   420   300   300   324
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6  7   0.6000000000000D 03     2   560   560   560   560
 1  7  7  4  4  5  5  1  1  2  2  3  3  4  4  6  6  1
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3  8  0.800000000000D 01   6    8    3    0    4    0
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 3 4 4 1 1 2 2 3 3 1 1 2 2 1 1 2 2 1 1 3
3  8  0.660000000000D 02   4    6    6    6    6    6
 2 4 4 3 3 1 1 2 2 1 1 2 2 1 1 3 3 1 1 2
3  8  0.800000000000D 01  12   12    6    8    6    8
 2 4 4 1 1 2 2 1 1 3 3 1 1 2 2 3 3 1 1 2
3  8  0.800000000000D 01  12    6    5    6    4    6
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3  8  0.800000000000D 01   6   14   12   13    9   14
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3  8  0.800000000000D 01   6   28   26   18   22   20
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3  8  0.800000000000D 01   6    2    2    1    1    2
 3 4 4 1 1 2 2 3 3 1 1 2 2 3 3 1 1 2 2 3
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4  8  0.240000000000D 03   4   48   24   32   24   32
 2 5 5 1 1 2 2 1 1 3 3 1 1 2 2 4 4 1 1 2
4  8  0.240000000000D 03   4   72   48   24   48   24
 1 5 5 2 2 1 1 2 2 1 1 3 3 1 1 2 2 4 4 1
4  8  0.240000000000D 03   4   36   30   36   20   28
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4  8  0.240000000000D 03   4   72   52   48   40   40
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4  8  0.240000000000D 03   4   72   66   48   52   40
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4  8  0.240000000000D 03   4   72   52   48   44   40
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4  8  0.240000000000D 03   4  112  104   76   84   64
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4  8  0.220000000000D 03   6   56   56   52   48   48
 2 5 5 3 3 1 1 2 2 1 1 3 3 1 1 4 4 1 1 2
4  8  0.240000000000D 03   4   56   48   56   32   48
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4  8  0.702000000000D 03   4   44   44   36   30   28
 3 5 5 1 1 2 2 1 1 2 2 1 1 2 2 3 3 4 4 3
4  8  0.240000000000D 03   2   88   37   30   31   32
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 4 5 5 1 1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 4
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4  8   0.240000000000D 03    4    136   120   80   78   64
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4  8   0.702000000000D 03    4     68    68   60   54   52
 2 5 5 3 3 1 1 2 2 1 1 3 3 1 1 2 2 4 4 2
4  8   0.240000000000D 03    4     68    57   62   35   52
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4  8   0.240000000000D 03    4     68    52   52   44   44
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4  8   0.360000000000D 02    8     76    72   60   52   52
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4  8   0.360000000000D 02    8    152   107   78   87   72
 2 5 5 1 1 2 2 1 1 3 3 2 2 3 3 4 4 1 1 2
4  8   0.330000000000D 02   16     76    76   60   46   52
 1 5 5 3 3 2 2 3 3 4 4 1 1 2 2 1 1 2 2 1
4  8   0.360000000000D 02    8    152   107   78   69   80
 1 5 5 2 2 1 1 2 2 1 1 3 3 2 2 3 3 4 4 1
4  8   0.360000000000D 02    8    116   112   94   82   84
 3 5 5 2 2 4 4 1 1 2 2 1 1 3 3 1 1 2 2 3
4  8   0.360000000000D 02    8    116   112   98   92   84
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4  8   0.360000000000D 02    4    116    99  108   67   84
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4  8   0.360000000000D 02    4    232   215  128  145  136
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4  8   0.360000000000D 02    8    152   140  112   96   96
 4 5 5 3 3 4 4 1 1 2 2 1 1 3 3 1 1 2 2 4
4  8   0.330000000000D 02   16    152   152  112   76   80
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4  8   0.360000000000D 02    8    152   140  114  104   96
 3 5 5 4 4 1 1 2 2 1 1 3 3 1 1 2 2 4 4 3
4  8   0.360000000000D 02    8    152   143  112   89   80
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4  8   0.240000000000D 03    4    152   152  126  104   96
 2 5 5 4 4 3 3 4 4 1 1 2 2 1 1 3 3 1 1 2
4  8   0.360000000000D 02    8    152   113  108   83   80
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4  8   0.360000000000D 02    8    152   143  114   97   80
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4  8   0.330000000000D 02   16     28    28   28   22   20
 3 5 5 1 1 2 2 3 3 4 4 1 1 2 2 1 1 2 2 3
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 2 5 5 3 3 1 1 2 2 3 3 4 4 1 1 2 2 1 1 2
4  8   0.360000000000D 02    8     28    15    22    17    12
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4  8   0.360000000000D 02    8     84    71    22    39    44
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4  8   0.360000000000D 02    8     64    64    46    44    40
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4  8   0.360000000000D 02    4     32    27    30    17    24
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4  8   0.360000000000D 02    8     88    88    58    44    40
 3 5 5 4 4 1 1 2 2 3 3 4 4 1 1 2 2 1 1 3
4  8   0.240000000000D 03    4     44    44    36    30    28
 2 5 5 3 3 4 4 1 1 2 2 1 1 3 3 4 4 1 1 2
4  8   0.360000000000D 02    8     44    33    32    29    20
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4  8   0.330000000000D 02   16     44    44    38    26    28
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4  8   0.360000000000D 02    8     88    77    48    43    48
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4  8   0.360000000000D 02    8     24    24    18    14    16
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4  8   0.360000000000D 02    4     36    36    14    18    28
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4  8   0.200000000000D 01   48    244   233   190   161   148
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4  8   0.200000000000D 01   48    136   136    86    80    80
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4  8   0.360000000000D 02    4     68    68    62    50    52
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4  8   0.360000000000D 02    8     68    68    56    50    44
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4  8   0.200000000000D 01   48     68    65    56    45    44
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5  8   0.192000000000D 03    4    536   528   480   460   440
 3 6 6 1 1 4 4 2 2 3 3 5 5 1 1 2 2 1 1 3
5  8   0.204000000000D 03    8    536   536   492   432   440
 2 6 6 3 3 5 5 1 1 2 2 1 1 3 3 1 1 4 4 2
5  8   0.192000000000D 03    4    536   528   476   432   408
 2 6 6 1 1 3 3 1 1 4 4 2 2 3 3 5 5 1 1 2
5  8   0.240000000000D 02    6    256   216   240   168   256
 2 6 6 1 1 2 2 3 3 1 1 4 4 2 2 5 5 1 1 2
5  8   0.240000000000D 02    6    512   472   320   408   384
 1 6 6 2 2 1 1 2 2 3 3 1 1 4 4 2 2 5 5 1
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 2 6 6 1 1 2 2 1 1 2 2 3 3 4 4 5 5 1 1 2
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 1 6 6 2 2 1 1 2 2 1 1 2 2 3 3 4 4 5 5 1
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5  8  0.735000000000D 04   4  224  224  224  224  224
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 3 6 6 1 1 2 2 1 1 2 2 1 1 3 3 4 4 5 5 3
5  8  0.249600000000D 04   4  512  344  260  220  208
 2 6 6 1 1 2 2 1 1 3 3 4 4 5 5 3 3 1 1 2
5  8  0.232800000000D 04   2  256  216  240  168  256
 2 6 6 1 1 3 3 1 1 2 2 4 4 2 2 5 5 1 1 2
5  8  0.232800000000D 04   2  512  472  320  408  384
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5  8  0.249600000000D 04   4  352  254  204  222  240
 2 6 6 1 1 3 3 1 1 2 2 4 4 5 5 2 2 1 1 2
5  8  0.168000000000D 03  20  448  392  276  220  208
 3 6 6 1 1 2 2 4 4 5 5 3 3 1 1 2 2 1 1 3
5  8  0.168000000000D 03  20  224  168  172  156  144
 2 6 6 1 1 3 3 1 1 2 2 4 4 5 5 3 3 1 1 2
5  8  0.735000000000D 04   4  312  312  296  284  280
 4 6 6 1 1 2 2 1 1 3 3 1 1 2 2 4 4 5 5 4
5  8  0.678000000000D 04   4  312  312  296  284  280
 2 6 6 4 4 5 5 4 4 1 1 2 2 1 1 3 3 1 1 2
5  8  0.232800000000D 04   4  312  250  268  230  216
 2 6 6 1 1 3 3 1 1 2 2 4 4 5 5 4 4 1 1 2
5  8  0.232800000000D 04   4  624  562  404  402  368
 1 6 6 2 2 1 1 3 3 1 1 2 2 4 4 5 5 4 4 1
5  8  0.108000000000D 04   2  368  268  240  236  240
 5 6 6 4 4 5 5 1 1 2 2 1 1 3 3 1 1 4 4 5
5  8  0.678000000000D 04   2  368  368  320  304  304
 5 6 6 1 1 2 2 1 1 3 3 1 1 4 4 5 5 4 4 5
5  8  0.108000000000D 04   2  736  636  416  316  224
 4 6 6 5 5 4 4 5 5 1 1 2 2 1 1 3 3 1 1 4
5  8  0.249600000000D 04   4  320  320  292  276  272
 4 6 6 1 1 2 2 1 1 2 2 3 3 1 1 4 4 5 5 4
5  8  0.249600000000D 04   4  320  256  276  244  240
 2 6 6 1 1 2 2 3 3 1 1 4 4 5 5 4 4 1 1 2
5  8  0.249600000000D 04   4  320  320  292  276  272
 1 6 6 4 4 5 5 4 4 1 1 2 2 1 1 2 2 3 3 1
5  8  0.249600000000D 04   4  640  576  428  388  368
 1 6 6 2 2 1 1 2 2 3 3 1 1 4 4 5 5 4 4 1
5  8  0.168000000000D 03  20  280  210  200  210  216
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5  8  0.168000000000D 03  20  560  490  360  250  208
 3 6 6 4 4 3 3 4 4 5 5 1 1 2 2 1 1 2 2 3
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5 8 0.735000000000D 04  2  280   280 280 280 280
 2 6 6 3 3 4 4 3 3 4 4 5 5 1 1 2 2 1 1 2
5 8 0.249600000000D 04  4  424   424 408 396 392
 4 6 6 3 3 1 1 2 2 1 1 2 2 3 3 4 4 5 5 4
5 8 0.735000000000D 04  4  424   424 388 356 344
 3 6 6 1 1 2 2 1 1 2 2 3 3 4 4 5 5 4 4 3
5 8 0.249600000000D 04  2  424   310 280 278 280
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5 8 0.384000000000D 03  2  352   254 204 222 240
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5 8 0.384000000000D 03  4  352   352 328 280 256
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 2 6 6 3 3 4 4 5 5 1 1 2 2 1 1 3 3 1 1 2
5 8 0.384000000000D 03  4  352   282 296 254 224
 2 6 6 1 1 3 3 1 1 2 2 3 3 4 4 5 5 1 1 2
5 8 0.384000000000D 03  4  352   352 316 264 240
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5 8 0.384000000000D 03  4  320   320 292 276 272
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5 8 0.384000000000D 03  4  320   320 292 276 272
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5 8 0.648000000000D 03  4  544   524 472 428 416
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5 8 0.648000000000D 03  4  544   532 472 476 416
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5 8 0.124800000000D 04  4  544   544 488 416 416
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5 8 0.648000000000D 03  4  544   532 480 436 448
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5 8 0.124800000000D 04  2  536   536 492 432 440
 4 6 6 2 2 5 5 4 4 1 1 2 2 1 1 3 3 1 1 4
5 8 0.696000000000D 03  4  536   528 476 432 408
 4 6 6 1 1 2 2 1 1 3 3 1 1 4 4 2 2 5 5 4
5 8 0.696000000000D 03  4  536   528 480 460 440
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5 8 0.384000000000D 03  2  128    72 112  88  64
 2 6 6 1 1 2 2 3 3 1 1 2 2 4 4 5 5 1 1 2
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5  8  0.360000000000D 02   24   312   312   296   284   280
 3 6 6 1 1 4 4 3 3 5 5 1 1 2 2 1 1 2 2 3
5  8  0.648000000000D 03    4   312   312   296   284   280
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5  8  0.240000000000D 02   24   312   250   268   230   216
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5  8  0.240000000000D 02   24   624   562   404   402   368
 1 6 6 2 2 1 1 2 2 3 3 1 1 4 4 3 3 5 5 1
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5  8  0.240000000000D 02   12   320   256   272   256   192
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5  8  0.360000000000D 02   12   320   320   304   272   256
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5  8  0.240000000000D 02   12   640   576   416   368   448
 1 6 6 2 2 1 1 3 3 4 4 1 1 2 2 3 3 5 5 1
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 3 6 6 2 2 5 5 1 1 2 2 1 1 3 3 4 4 1 1 3
5  8  0.192000000000D 03    4   288   284   256   244   256
 2 6 6 1 1 3 3 4 4 1 1 3 3 2 2 5 5 1 1 2
5  8  0.192000000000D 03    4   576   576   432   384   416
 1 6 6 3 3 4 4 1 1 3 3 2 2 5 5 1 1 2 2 1
5  8  0.192000000000D 03    4   288   284   256   228   224
 1 6 6 2 2 1 1 3 3 4 4 1 1 3 3 2 2 5 5 1
5  8  0.480000000000D 02    8   616   600   544   532   536
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5  8  0.480000000000D 02    8   616   600   552   508   488
 3 6 6 4 4 5 5 1 1 2 2 1 1 3 3 2 2 4 4 3
5  8  0.360000000000D 02   12   616   616   568   496   520
 3 6 6 2 2 4 4 3 3 4 4 5 5 1 1 2 2 1 1 3
5  8  0.384000000000D 03    4   616   616   576   520   488
 2 6 6 4 4 3 3 4 4 5 5 1 1 2 2 1 1 3 3 2
5  8  0.384000000000D 03    4   352   352   340   332   320
 4 6 6 2 2 3 3 4 4 5 5 1 1 2 2 1 1 3 3 4
5  8  0.480000000000D 02    8   704   704   556   424   384
 3 6 6 4 4 2 2 3 3 4 4 5 5 1 1 2 2 1 1 3
5  8  0.360000000000D 02   24   352   352   320   276   272
 2 6 6 3 3 4 4 5 5 1 1 2 2 1 1 3 3 4 4 2
5  8  0.480000000000D 02    8   352   338   300   290   288
 2 6 6 1 1 3 3 4 4 2 2 3 3 4 4 5 5 1 1 2
5  8  0.384000000000D 03    4   352   352   324   276   256
 1 6 6 3 3 4 4 2 2 3 3 4 4 5 5 1 1 2 2 1
5  8  0.480000000000D 02    8   352   338   304   282   272
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5  8  0.108000000000D 04    8   320   236   224   204   192
 2 6 6 1 1 2 2 1 1 3 3 1 1 4 4 5 5 1 1 2
5  8  0.108000000000D 04    4   240   204   240   156   240
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5  8  0.108000000000D 04    4   480   444   336   396   288
 1 6 6 2 2 1 1 3 3 1 1 4 4 1 1 2 2 5 5 1
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5  8   0.204000000000D 03    8    608   580   504   480   480
 5 6 6 2 2 5 5 1 1 2 2 1 1 3 3 4 4 1 1 5
5  8   0.204000000000D 03   16    608   608   548   468   432
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5  8   0.124800000000D 04    4    160   160   152   144   160
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5  8   0.648000000000D 03    4    320   320   248   200   160
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5  8  -0.264000000000D 03    6    224    98    92   106   112
 4 6 6 3 3 4 4 3 3 4 4 5 5 3 1 2 2 1 3 4
5  8  -0.264000000000D 03    6    336   210    84    98   128
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5  8  -0.264000000000D 03   12    448   406   304   282   288
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5  8  -0.264000000000D 03   12    224   182   200   178   160
 4 6 6 3 3 5 5 3 3 4 4 5 5 3 1 2 2 1 3 4
5  8  -0.264000000000D 03    4    336   126    36     6     0
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5  8  -0.264000000000D 03    6    280   210   200   210   216
 4 6 6 3 3 4 4 5 5 3 1 2 2 1 1 2 2 1 3 4
5  8  -0.264000000000D 03    6    560   490   360   250   208
 3 6 6 4 4 3 3 4 4 5 5 3 1 2 2 1 1 2 2 1
5  8  -0.264000000000D 03   12    560   350   200   110    80
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5  8   0.480000000000D 02    4    616   616   592   540   504
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5  8   0.192000000000D 03    4    616   616   560   492   472
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5  8   0.192000000000D 03    4    616   616   552   524   504
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5  8   0.240000000000D 02    8    616   590   516   478   472
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3 6 6 4 4 2 2 3 3 5 5 4 4 1 1 2 2 1 1 3
5 8 0.240000000000D 02 4 624 588 508 476 480
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5 8 0.480000000000D 02 4 336 336 316 284 272
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5 8 0.192000000000D 03 4 336 336 316 288 272
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5 8 0.192000000000D 03 4 336 336 312 296 288
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5 8 0.648000000000D 03 4 320 320 248 232 224
1 6 6 3 3 4 4 1 1 3 3 4 4 5 5 1 1 2 2 1
5 8 0.696000000000D 03 4 304 304 236 220 208
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5 8 0.124800000000D 04 2 152 152 148 136 152
3 6 6 4 4 1 1 3 3 5 5 4 4 1 1 2 2 1 1 3
5 8 0.384000000000D 03 2 432 418 376 326 304
4 6 6 3 3 5 5 4 4 1 1 2 2 1 1 2 2 3 3 4
5 8 0.249600000000D 04 4 432 432 396 344 320
4 6 6 1 1 2 2 1 1 2 2 3 3 4 4 3 3 5 5 4
5 8 0.384000000000D 03 2 432 418 364 370 384
3 6 6 4 4 3 3 5 5 4 4 1 1 2 2 1 1 2 2 3
5 8 0.384000000000D 03 2 432 314 280 274 272
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5 8 0.384000000000D 03 2 864 746 508 330 304
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5 8 0.249600000000D 04 4 232 232 220 216 216
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5 8 0.384000000000D 03 2 464 464 364 284 256
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5 8 0.384000000000D 03 2 232 172 160 164 168
2 6 6 1 1 2 2 3 3 4 4 5 5 3 3 4 4 1 1 2
5 8 0.384000000000D 03 2 464 404 284 204 160
1 6 6 2 2 1 1 2 2 3 3 4 4 5 5 3 3 4 4 1
5 8 0.249600000000D 04 4 640 640 636 628 624
4 6 6 1 1 2 2 1 1 3 3 2 2 3 3 4 4 5 5 4
5 8 0.696000000000D 03 4 640 614 548 522 512
3 6 6 2 2 3 3 4 4 5 5 4 4 1 1 2 2 1 1 3
5 8 0.696000000000D 03 4 640 614 548 486 464
2 6 6 3 3 4 4 5 5 4 4 1 1 2 2 1 1 3 3 2
5 8 0.124800000000D 04 2 640 640 564 448 432
1 6 6 3 3 2 2 3 3 4 4 5 5 4 4 1 1 2 2 1
5 8 0.384000000000D 03 4 624 606 552 494 464
4 6 6 3 3 5 5 1 1 2 2 1 1 3 3 4 4 2 2 4
5 8 0.384000000000D 03 2 624 612 564 516 480
4 6 6 2 2 4 4 3 3 5 5 1 1 2 2 1 1 3 3 4
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5  8   0.384000000000D 03    2    624   612   568   532   528
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5  8   0.168000000000D 03   10    624   624   580   500   448
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5  8   0.249600000000D 04    4    192   192   188   180   176
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5  8   0.696000000000D 03    4    384   384   304   236   208
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5  8   0.204000000000D 03   16    192   192   144   128   128
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5  8   0.204000000000D 03    8    192   192   144   108    96
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5  8   0.168000000000D 03   10    112   112   108   108   112
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5  8   0.384000000000D 03    4    224   224   180   136   112
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5  8   0.384000000000D 03    2    224   224   180   128   112
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5  8   0.240000000000D 02    2    288   288   144   144   288
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5  8   0.192000000000D 03    4    304   304   236   220   208
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5  8   0.204000000000D 03    8    152   152   148   136   152
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6  8   0.763200000000D 04    4   1344   924   744   684   672
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6  8   0.763200000000D 04    4    896   728   800   712   640
 2 7 7 1 1 3 3 1 1 2 2 4 4 5 5 6 6 1 1 2
6  8   0.763200000000D 04    4   1792  1624  1216  1128  1152
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6  8   0.699240000000D 05    2   1344  1344  1344  1344  1344
 1 7 7 4 4 5 5 4 4 6 6 1 1 2 2 1 1 3 3 1
6  8   0.117840000000D 05    4   1408  1408  1312  1280  1280
 4 7 7 1 1 2 2 1 1 3 3 1 1 4 4 5 5 6 6 4
6  8   0.216480000000D 05    4   1408  1408  1312  1280  1280
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6  8   0.762660000000D 05    4   1120  1120  1120  1120  1120
 2 7 7 3 3 4 4 3 3 5 5 6 6 1 1 2 2 1 1 2
6  8   0.763200000000D 04    4   1120   840   800   840   864
 2 7 7 1 1 2 2 3 3 4 4 3 3 5 5 6 6 1 1 2
6  8   0.763200000000D 04    4   2240  1960  1440  1000   832
 1 7 7 2 2 1 1 2 2 3 3 4 4 3 3 5 5 6 6 1
6  8   0.763200000000D 04    2   1120   840   800   840   864
 2 7 7 1 1 2 2 3 3 4 4 5 5 4 4 6 6 1 1 2
6  8   0.763200000000D 04    2   2240  1960  1440  1000   832
 1 7 7 2 2 1 1 2 2 3 3 4 4 5 5 4 4 6 6 1
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6  8   0.685080000000D 05   2   1504  1504  1496  1480  1472
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6  8   0.477600000000D 05   2   1568  1568  1488  1408  1376
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6  8   0.762660000000D 05   4   1568  1568  1568  1568  1568
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6  8   0.258720000000D 05   4   1632  1632  1560  1496  1472
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6  8   0.105600000000D 04   2   1504  1504  1496  1480  1472
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6  8   0.105600000000D 04   4   1536  1536  1504  1440  1408
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6  8   0.105600000000D 04   2   1536  1536  1504  1440  1408
 1 7 7 2 2 3 3 1 1 4 4 2 2 5 5 4 4 6 6 1
6  8   0.105600000000D 04   2   1504  1504  1496  1480  1472
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6  8   0.652800000000D 04   2   1408  1408  1312  1280  1280
 2 7 7 1 1 3 3 1 1 4 4 2 2 5 5 6 6 1 1 2
6  8   0.652800000000D 04   2   1408  1408  1312  1280  1280
 1 7 7 2 2 1 1 3 3 1 1 4 4 2 2 5 5 6 6 1
6  8   0.204000000000D 04   8    896   728   800   712   640
 2 7 7 1 1 2 2 3 3 1 1 4 4 5 5 6 6 1 1 2
6  8   0.204000000000D 04   8   1792  1624  1216  1128  1152
 1 7 7 2 2 1 1 2 2 3 3 1 1 4 4 5 5 6 6 1
6  8   0.204000000000D 04   8    896   728   800   712   640
 2 7 7 1 1 3 3 4 4 1 1 2 2 5 5 6 6 1 1 2
6  8   0.204000000000D 04   8   1792  1624  1216  1128  1152
 1 7 7 2 2 1 1 3 3 4 4 1 1 2 2 5 5 6 6 1
6  8   0.652800000000D 04   2   1536  1536  1248  1152  1152
 1 7 7 3 3 4 4 1 1 3 3 5 5 6 6 1 1 2 2 1
6  8   0.258720000000D 05   4   1120  1120  1120  1120  1120
 2 7 7 3 3 4 4 5 5 3 3 6 6 1 1 2 2 1 1 2
6  8   0.204000000000D 04   8   1120   840   800   840   864
 2 7 7 1 1 2 2 3 3 4 4 5 5 3 3 6 6 1 1 2
6  8   0.204000000000D 04   8   2240  1960  1440  1000   832
 1 7 7 2 2 1 1 2 2 3 3 4 4 5 5 3 3 6 6 1
6  8   0.127440000000D 05   4   1232  1232  1112   992   944
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6  8   0.204000000000D 04   4   1232   896   800   784   784
 2 7 7 1 1 2 2 3 3 4 4 5 5 6 6 3 3 1 1 2
6  8   0.204000000000D 04   4   2464  2128  1432   976   832
 1 7 7 2 2 1 1 2 2 3 3 4 4 5 5 6 6 3 3 1
6  8   0.240000000000D 04   4   1904  1820  1616  1532  1520
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6  8   0.240000000000D 04   4   1904  1820  1616  1412  1328
 2 7 7 3 3 4 4 5 5 6 6 1 1 2 2 1 1 3 3 2
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6 8 0.970000000000D 03 12 1904 1904 1664 1304 1136
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6 8 0.710400000000D 04 2 1568 1568 1488 1408 1376
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6 8 0.710400000000D 04 2 1568 1568 1488 1408 1376
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6 8 0.600000000000D 03 8 1632 1632 1560 1496 1472
 3 7 7 1 1 2 2 1 1 3 3 4 4 2 2 5 5 6 6 3
6 8 0.600000000000D 03 8 1632 1632 1560 1496 1472
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6 8 0.127440000000D 05 4 1648 1648 1576 1472 1424
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6 8 0.364800000000D 04 2 1648 1620 1496 1356 1296
 2 7 7 1 1 3 3 4 4 2 2 5 5 6 6 5 5 1 1 2
6 8 0.364800000000D 04 2 1648 1620 1472 1444 1456
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6 8 0.710400000000D 04 2 1792 1792 1472 1152 1024
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6 8 0.258720000000D 05 4 896 896 896 896 896
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6 8 0.127440000000D 05 4 912 912 888 880 880
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6 8 0.364800000000D 04 2 1824 1824 1464 1144 1024
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6 8 0.970000000000D 03 12 560 560 560 520 496
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6 8 0.240000000000D 04 4 1120 1120 880 680 608
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6 8 0.600000000000D 03 8 1088 1088 896 672 576
 2 7 7 3 3 4 4 1 1 2 2 3 3 5 5 6 6 1 1 2
6 8 0.103200000000D 04 8 1408 1408 1312 1280 1280
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6 8 0.600000000000D 03 6 1344 1344 1344 1344 1344
 1 7 7 3 3 4 4 1 1 5 5 3 3 6 6 1 1 2 2 1
6 8 0.966000000000D 03 8 1648 1648 1576 1472 1424
 3 7 7 2 2 4 4 3 3 5 5 6 6 1 1 2 2 1 1 3
6 8 0.201600000000D 04 2 1648 1620 1472 1444 1456
 2 7 7 1 1 3 3 2 2 4 4 3 3 5 5 6 6 1 1 2
6 8 0.240000000000D 04 4 1648 1648 1576 1472 1424
 1 7 7 3 3 2 2 4 4 3 3 5 5 6 6 1 1 2 2 1
6 8 0.201600000000D 04 2 1648 1620 1496 1356 1296
 1 7 7 2 2 1 1 3 3 2 2 4 4 3 3 5 5 6 6 1
6 8 0.219600000000D 04 16 1648 1648 1576 1472 1424
 4 7 7 1 1 2 2 1 1 3 3 2 2 4 4 5 5 6 6 4
6 8 0.117600000000D 04 4 1648 1620 1496 1356 1296
 2 7 7 1 1 3 3 2 2 4 4 5 5 6 6 4 4 1 1 2
6 8 0.117600000000D 04 4 1648 1620 1472 1444 1456
 1 7 7 2 2 1 1 3 3 2 2 4 4 5 5 6 6 4 4 1
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 6  8   0.966000000000D 03     8    1696   1696   1600   1408   1312
  2 7 7 3 3 5 5 6 6 1 1 2 2 1 1 3 3 4 4 2
 6  8   0.201600000000D 04     2    1696   1640   1488   1400   1376
  2 7 7 1 1 3 3 4 4 2 2 3 3 5 5 6 6 1 1 2
 6  8   0.240000000000D 04     4    1696   1696   1600   1408   1312
  1 7 7 3 3 4 4 2 2 3 3 5 5 6 6 1 1 2 2 1
 6  8   0.201600000000D 04     2    1696   1640   1488   1400   1376
  1 7 7 2 2 1 1 3 3 4 4 2 2 3 3 5 5 6 6 1
 6  8   0.528000000000D 03     4    1568   1568   1488   1408   1376
  2 7 7 1 1 3 3 4 4 2 2 5 5 3 3 6 6 1 1 2
 6  8   0.600000000000D 03     8    1568   1568   1568   1568   1568
  1 7 7 3 3 4 4 2 2 5 5 3 3 6 6 1 1 2 2 1
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  1 7 7 2 2 1 1 3 3 4 4 2 2 5 5 3 3 6 6 1
 6  8   0.660000000000D 04     4    1504   1504   1496   1480   1472
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 6  8   0.984000000000D 03     4    1504   1504   1496   1480   1472
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 6  8   0.660000000000D 04     2    1536   1536   1504   1440   1408
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 6  8   0.103200000000D 04     4    1536   1536   1248   1152   1152
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 6  8   0.240000000000D 04     4     912    912    888    880    880
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 6  8   0.966000000000D 03     8     912    912    888    880    880
  2 7 7 3 3 1 1 2 2 4 4 3 3 5 5 6 6 1 1 2
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 6  8   0.117600000000D 04     4    1824   1824   1464   1144   1024
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 6  8   0.600000000000D 03     4     896    896    896    896    896
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 6  8   0.528000000000D 03     2    1792   1792   1472   1152   1024
  1 7 7 2 2 3 3 4 4 1 1 2 2 5 5 3 3 6 6 1
 6  8  -0.104160000000D 05     4    1344    924    744    684    672
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 6  8  -0.104160000000D 05     4     896    728    800    712    640
  4 7 7 3 3 5 5 3 3 4 4 6 6 3 1 2 2 1 3 4
 6  8  -0.104160000000D 05     4    1792   1624   1216   1128   1152
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 6  8  -0.104160000000D 05     2    1232    896    800    784    784
  4 7 7 3 3 4 4 5 5 6 6 5 5 3 1 2 2 1 3 4
 6  8  -0.104160000000D 05     2    2464   2128   1432    976    832
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6  8  -0.415200000000D 04   6  1120   840   800   840   864
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6  8  -0.415200000000D 04   6  2240  1960  1440  1000   832
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6  8  -0.153600000000D 04   8  1904  1820  1616  1412  1328
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6  8  -0.141600000000D 04   8   560   560   560   520   496
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6  8  -0.153600000000D 04   8  1120  1120   880   680   608
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6  8  -0.244000000000D 03  24  2016  2016  1896  1776  1728
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6  8  -0.244000000000D 03  24   672   672   552   432   384
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7  8   0.616800000000D 04  14  6720  5880  4320  3000  2496
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7  8   0.786858000000D 06   2  4480  4480  4480  4480  4480
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7  8   0.767520000000D 05   4  4704  4704  4464  4224  4128
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7  8   0.164640000000D 05   2  4704  4704  4464  4224  4128
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7  8   0.164640000000D 05   2  4704  4704  4464  4224  4128
 1 8 8 2 2 1 1 3 3 2 2 4 4 5 5 6 6 7 7 1
7  8   0.116160000000D 05   2  4704  4704  4464  4224  4128
 2 8 8 1 1 3 3 4 4 2 2 5 5 6 6 7 7 1 1 2
7  8   0.116160000000D 05   2  4704  4704  4464  4224  4128
 1 8 8 2 2 1 1 3 3 4 4 2 2 5 5 6 6 7 7 1
7  8   0.266928000000D 06   4  4480  4480  4480  4480  4480
 1 8 8 3 3 4 4 5 5 3 3 6 6 7 7 1 1 2 2 1
7  8   0.131040000000D 06   4  4480  4480  4480  4480  4480
 1 8 8 3 3 4 4 5 5 6 6 3 3 7 7 1 1 2 2 1
7  8   0.164640000000D 05   2  5376  5376  4416  3456  3072
 1 8 8 2 2 3 3 1 1 2 2 4 4 5 5 6 6 7 7 1
7  8   0.221760000000D 05   8  4704  4704  4464  4224  4128
 4 8 8 1 1 2 2 3 3 1 1 4 4 5 5 6 6 7 7 4
7  8   0.116160000000D 05   2  5376  5376  4416  3456  3072
 1 8 8 2 2 3 3 4 4 1 1 2 2 5 5 6 6 7 7 1
```

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 7  8     0.313200000000D 04      4     4480   4480   4480   4480   4480
  1 8 8 2 2 3 3 1 1 4 4 5 5 2 2 6 6 7 7 1
 7  8     0.388800000000D 04      2     4480   4480   4480   4480   4480
  1 8 8 2 2 3 3 1 1 4 4 5 5 6 6 2 2 7 7 1
 7  8     0.226320000000D 05      8     4480   4480   4480   4480   4480
  1 8 8 4 4 5 5 6 6 4 4 7 7 1 1 2 2 3 3 1
 7  8     0.313200000000D 04      2     4480   4480   4480   4480   4480
  1 8 8 2 2 3 3 4 4 1 1 5 5 2 2 6 6 7 7 1
 7  8    -0.885600000000D 04     10     3360   2520   2400   2520   2592
  4 8 8 3 3 4 4 5 5 6 6 7 7 3 1 2 2 1 3 4
 7  8    -0.885600000000D 04     10     6720   5880   4320   3000   2496
  3 8 8 4 4 3 3 4 4 5 5 6 6 7 7 3 1 2 2 1
 7  8    -0.400944000000D 06      2     4480   4480   4480   4480   4480
  3 8 8 5 5 6 6 5 5 7 7 3 1 2 2 1 3 4 4 3
 7  8    -0.134304000000D 06      4     4704   4704   4464   4224   4128
  5 8 8 3 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 5
 7  8    -0.571440000000D 05      4     4704   4704   4464   4224   4128
  6 8 8 4 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 6
 7  8    -0.885600000000D 04      4     6720   4200   2400   1320    960
  2 8 8 1 1 2 2 1 3 4 4 5 5 6 6 7 7 3 1 2
 7  8    -0.201600000000D 05      2     4704   4704   4464   4224   4128
  4 8 8 3 3 5 5 4 4 6 6 7 7 3 1 2 2 1 3 4
 7  8    -0.201600000000D 05      2     4704   4704   4464   4224   4128
  3 8 8 4 4 3 3 5 5 4 4 6 6 7 7 3 1 2 2 1
 7  8    -0.201600000000D 05      2     5376   5376   4416   3456   3072
  3 8 8 4 4 5 5 3 3 4 4 6 6 7 7 3 1 2 2 1
 7  8    -0.256800000000D 04     16     3360   2520   2400   2520   2592
  5 8 8 4 4 5 5 6 6 7 7 4 1 2 2 3 3 1 4 5
 7  8    -0.256800000000D 04     16     6720   5880   4320   3000   2496
  4 8 8 5 5 4 4 5 5 6 6 7 7 4 1 2 2 3 3 1
 7  8     0.864000000000D 04      6     3360   2520   2400   2520   2592
  6 8 8 5 5 6 6 7 7 5 1 2 2 1 3 4 4 3 5 6
 7  8     0.864000000000D 04      6     6720   5880   4320   3000   2496
  5 8 8 6 6 5 5 6 6 7 7 5 1 2 2 1 3 4 4 3
 7  8     0.864000000000D 04      8     6720   4200   2400   1320    960
  7 8 8 6 6 7 7 6 1 2 2 1 3 4 4 5 5 3 6 7
 7  8    -0.256800000000D 04     12     3360   2520   2400   2520   2592
  6 8 8 5 5 6 6 7 7 5 1 2 2 3 3 4 4 1 5 6
 7  8    -0.256800000000D 04     12     6720   5880   4320   3000   2496
  5 8 8 6 6 5 5 6 6 7 7 5 1 2 2 3 3 4 4 1
 7  8    -0.278400000000D 04      4     5376   5376   4416   3456   3072
  4 8 8 5 5 6 6 4 4 5 5 7 7 4 1 2 2 3 3 1
 7  8    -0.187200000000D 04      6     4480   4480   4480   4480   4480
  3 8 8 4 4 5 5 3 3 6 6 4 4 7 7 3 1 2 2 1
 7  8    -0.278400000000D 04      8     4704   4704   4464   4224   4128
  5 8 8 4 4 6 6 5 5 7 7 4 1 2 2 3 3 1 4 5
```

TABLE A.7

2 2	0.600000000000D 01	1 3 3 1 1 2 2 1	2	1	0	0	0
3 3	0.800000000000D 01	1 4 4 1 1 2 2 3 3 1	6	3	1	0	0
2 4	0.600000000000D 01	1 3 3 1 1 2 2 1 1 2 2 1	2	1	0	0	0
3 4	0.660000000000D 02	1 4 4 1 1 2 2 1 1 3 3 1	1	4	0	4	0
3 4	0.660000000000D 02	2 4 4 2 1 2 2 1 1 3 3 1	2	4	2	2	0
4 4	0.330000000000D 02	1 5 5 1 1 2 2 3 3 4 4 1	8	12	6	4	0
4 4	-0.690000000000D 02	1 5 5 1 1 2 2 1 3 4 4 3	4	12	6	4	0
3 5	0.800000000000D 01	1 4 4 1 1 2 2 1 1 2 2 3 3 1	12	5	1	2	0
3 5	0.800000000000D 01	3 4 4 3 1 2 2 1 1 2 2 3 3 1	6	5	3	3	0
4 5	0.240000000000D 03	1 5 5 1 1 2 2 1 1 3 3 4 4 1	2	20	4	12	0
4 5	0.240000000000D 03	2 5 5 2 1 2 2 1 1 3 3 4 4 1	2	20	12	10	0
4 5	0.240000000000D 03	3 5 5 3 1 2 2 1 1 3 3 4 4 1	4	20	12	8	0
5 5	-0.264000000000D 03	1 6 6 1 1 2 2 1 3 4 4 5 5 3	4	60	36	24	0
5 5	-0.264000000000D 03	3 6 6 3 1 2 2 1 3 4 4 5 5 3	6	60	36	24	0
5 5	0.168000000000D 03	1 6 6 1 1 2 2 3 3 4 4 5 5 1	10	60	36	24	0
2 6	0.600000000000D 01	1 3 3 1 1 2 2 1 1 2 2 1 1 2 2 1	2	1	0	0	0
3 6	0.660000000000D 02	1 4 4 1 1 2 2 1 1 2 2 1 1 3 3 1	2	6	0	4	0
3 6	0.660000000000D 02	2 4 4 2 1 2 2 1 1 2 2 1 1 3 3 1	2	6	2	2	2
3 6	0.660000000000D 02	3 4 4 3 1 2 2 1 1 2 2 1 1 3 3 1	2	6	4	4	4
3 6	0.800000000000D 01	1 4 4 1 1 2 2 3 3 1 1 2 2 3 3 1	6	3	1	1	2
3 6	0.800000000000D 01	1 4 4 1 1 2 2 1 1 3 3 2 2 3 3 1	3	18	6	10	8
4 6	0.330000000000D 02	1 5 5 1 1 2 2 1 1 2 2 3 3 4 4 1	16	30	10	10	12
4 6	0.330000000000D 02	3 5 5 3 1 2 2 1 1 2 2 3 3 4 4 1	16	30	20	14	12
4 6	0.702000000000D 03	2 5 5 2 1 2 2 1 1 3 3 4 4 3 3 1	2	42	28	22	20
4 6	0.220000000000D 03	1 5 5 1 1 2 2 1 1 3 3 1 1 4 4 1	1	36	0	36	0

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4  6   0.220000000000D 03    3      36    24    20    16
 2 5 5 2 1 2 2 1 1 3 3 1 1 4 4 1
4  6   0.360000000000D 02    4      24     8     8    16
 1 5 5 1 1 2 2 3 3 1 1 2 2 4 4 1
4  6   0.360000000000D 02    4      24    16    12    10
 3 5 5 3 1 2 2 3 3 1 1 2 2 4 4 1
4  6   0.360000000000D 02    4      42    14    22    20
 1 5 5 1 1 2 2 1 1 3 3 2 2 4 4 1
4  6   0.360000000000D 02    4      42    28    22    22
 3 5 5 3 1 2 2 1 1 3 3 2 2 4 4 1
4  6   0.702000000000D 03    2      42    14    22    20
 1 5 5 1 1 2 2 1 1 3 3 4 4 3 3 1
4  6  -0.690000000000D 02    4      30    20    14    12
 1 5 5 1 1 2 2 1 3 4 4 3 3 4 4 3
4  6  -0.690000000000D 02    4      30    10     2     0
 3 5 5 3 1 2 2 1 3 4 4 3 3 4 4 3
5  6   0.124800000000D 04    2     120    40    56    72
 1 6 6 1 1 2 2 1 1 3 3 4 4 5 5 1
5  6   0.124800000000D 04    2     120    80    64    60
 2 6 6 2 1 2 2 1 1 3 3 4 4 5 5 1
5  6   0.124800000000D 04    4     120    80    56    48
 3 6 6 3 1 2 2 1 1 3 3 4 4 5 5 1
5  6   0.124800000000D 04    2     120    80    56    48
 4 6 6 4 1 2 2 1 1 3 3 4 4 5 5 1
5  6   0.204000000000D 03   16     120    80    56    48
 2 6 6 2 1 2 2 3 3 1 1 4 4 5 5 1
5  6   0.204000000000D 03    4     120    40    56    72
 1 6 6 1 1 2 2 3 3 1 1 4 4 5 5 1
5  6  -0.222000000000D 04    1     120    40    56    72
 3 6 6 3 1 2 2 1 3 4 4 3 3 5 5 3
5  6  -0.222000000000D 04    2     120    80    56    48
 1 6 6 1 1 2 2 1 3 4 4 3 3 5 5 3
5  6  -0.222000000000D 04    2     120    80    64    60
 4 6 6 4 1 2 2 1 3 4 4 3 3 5 5 3
6  6  -0.141600000000D 04    8     360   240   168   144
 3 7 7 3 1 2 2 1 3 4 4 5 5 6 6 3
6  6  -0.244000000000D 03   24     360   240   168   144
 1 7 7 1 1 2 2 3 3 1 4 5 5 6 6 4
6  6  -0.141600000000D 04    4     360   240   168   144
 1 7 7 1 1 2 2 1 3 4 4 5 5 6 6 3
6  6   0.129200000000D 04    6     360   240   168   144
 1 7 7 1 1 2 2 1 3 4 4 3 5 6 6 5
6  6   0.970000000000D 03   12     360   240   168   144
 1 7 7 1 1 2 2 3 3 4 4 5 5 6 6 1
3  7   0.800000000000D 01   12       7     1     2     2
 1 4 4 1 1 2 2 1 1 2 2 1 1 2 2 3 3 1
3  7   0.800000000000D 01    6       7     5     5     5
 3 4 4 3 1 2 2 1 1 2 2 1 1 2 2 3 3 1
3  7   0.800000000000D 01    6      14     2     8     4
 1 4 4 1 1 2 2 1 1 3 3 1 1 2 2 3 3 1
```

```
3 7 0.800000000000D 01 12
2 4 4 2 1 2 2 1 1 3 3 1 1 2 2 3 3 1 14 6 7 7
4 7 0.240000000000D 03 4
1 5 5 1 1 2 2 1 1 2 2 3 3 4 4 3 3 1 77 33 23 23
4 7 0.240000000000D 03 2
3 5 5 3 1 2 2 1 1 2 2 3 3 4 4 3 3 1 77 33 39 35
4 7 0.240000000000D 03 2
4 5 5 4 1 2 2 1 1 2 2 3 3 4 4 3 3 1 77 55 43 37
4 7 0.240000000000D 03 4
1 5 5 1 1 2 2 1 1 3 3 1 1 2 2 4 4 1 56 8 36 20
4 7 0.240000000000D 03 4
2 5 5 2 1 2 2 1 1 3 3 1 1 2 2 4 4 1 56 24 24 24
4 7 0.240000000000D 03 4
3 5 5 3 1 2 2 1 1 3 3 1 1 2 2 4 4 1 56 40 34 30
4 7 0.240000000000D 03 4
4 5 5 4 1 2 2 1 1 3 3 1 1 2 2 4 4 1 56 40 32 28
4 7 0.240000000000D 03 2
1 5 5 1 1 2 2 1 1 2 2 1 1 3 3 4 4 1 42 6 20 12
4 7 0.240000000000D 03 2
2 5 5 2 1 2 2 1 1 2 2 1 1 3 3 4 4 1 42 18 14 14
4 7 0.240000000000D 03 4
3 5 5 3 1 2 2 1 1 2 2 1 1 3 3 4 4 1 42 30 22 18
4 7 0.360000000000D 02 8
1 5 5 1 1 2 2 1 1 3 3 2 2 3 3 4 4 1 119 51 51 51
4 7 0.360000000000D 02 4
2 5 5 2 1 2 2 1 1 3 3 2 2 3 3 4 4 1 119 51 53 45
4 7 0.360000000000D 02 4
4 5 5 4 1 2 2 1 1 3 3 2 2 3 3 4 4 1 119 85 63 53
4 7 0.360000000000D 02 8
1 5 5 1 1 2 2 3 3 1 1 2 2 3 3 4 4 1 35 15 13 17
4 7 0.360000000000D 02 4
2 5 5 2 1 2 2 3 3 1 1 2 2 3 3 4 4 1 35 15 9 17
4 7 0.360000000000D 02 4
4 5 5 4 1 2 2 3 3 1 1 2 2 3 3 4 4 1 35 25 19 17
5 7 0.108000000000D 04 2
1 6 6 1 1 2 2 1 1 3 3 1 1 4 4 5 5 1 252 36 180 108
5 7 0.108000000000D 04 4
2 6 6 2 1 2 2 1 1 3 3 1 1 4 4 5 5 1 252 180 148 124
5 7 0.108000000000D 04 4
4 6 6 4 1 2 2 1 1 3 3 1 1 4 4 5 5 1 252 180 132 108
5 7 0.168000000000D 03 20
1 6 6 1 1 2 2 1 1 2 2 3 3 4 4 5 5 1 210 90 70 78
5 7 0.168000000000D 03 20
3 6 6 3 1 2 2 1 1 2 2 3 3 4 4 5 5 1 210 150 110 90
5 7 0.168000000000D 03 10
4 6 6 4 1 2 2 1 1 2 2 3 3 4 4 5 5 1 210 150 110 90
5 7 0.232800000000D 04 4
1 6 6 1 1 2 2 1 1 3 3 4 4 3 3 5 5 1 280 120 120 152
5 7 0.232800000000D 04 4
2 6 6 2 1 2 2 1 1 3 3 4 4 3 3 5 5 1 280 200 160 144
```

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5  7    0.232800000000D 04    2     280    200    148    124
 5 6 6 5 1 2 2 1 1 3 3 4 4 3 3 5 5 1
5  7    0.249600000000D 04    2     294    126    138    146
 1 6 6 1 1 2 2 1 1 3 3 4 4 5 5 3 3 1
5  7    0.249600000000D 04    2     294    210    166    146
 2 6 6 2 1 2 2 1 1 3 3 4 4 5 5 3 3 1
5  7    0.249600000000D 04    2     294    126    138    146
 3 6 6 3 1 2 2 1 1 3 3 4 4 5 5 3 3 1
5  7    0.249600000000D 04    4     294    210    154    126
 4 6 6 4 1 2 2 1 1 3 3 4 4 5 5 3 3 1
5  7    0.384000000000D 03    2     294    210    166    154
 3 6 6 3 1 2 2 1 1 3 3 2 2 4 4 5 5 1
5  7    0.384000000000D 03    4     294    210    154    126
 4 6 6 4 1 2 2 1 1 3 3 2 2 4 4 5 5 1
5  7    0.384000000000D 03    4     168     72     56     88
 1 6 6 1 1 2 2 3 3 1 1 2 2 4 4 5 5 1
5  7    0.384000000000D 03    2     168    120     92     76
 3 6 6 3 1 2 2 3 3 1 1 2 2 4 4 5 5 1
5  7    0.384000000000D 03    4     168    120     88     72
 4 6 6 4 1 2 2 3 3 1 1 2 2 4 4 5 5 1
5  7    0.240000000000D 02   12     280    120    120    152
 1 6 6 1 1 2 2 3 3 1 1 4 4 2 2 5 5 1
5  7    0.240000000000D 02   12     280    200    148    124
 3 6 6 3 1 2 2 3 3 1 1 4 4 2 2 5 5 1
5  7    0.240000000000D 02    6     280    200    152    136
 4 6 6 4 1 2 2 3 3 1 1 4 4 2 2 5 5 1
5  7    0.384000000000D 03    4     294    126    138    146
 1 6 6 1 1 2 2 1 1 3 3 2 2 4 4 5 5 1
5  7   -0.264000000000D 03    6     210    150    110     90
 1 6 6 1 1 2 2 3 3 1 4 5 5 4 4 5 5 4
5  7   -0.264000000000D 03    4     210     90     30      6
 4 6 6 4 1 2 2 3 3 1 4 5 5 4 4 5 5 4
5  7   -0.264000000000D 03   12     210    150    110     90
 1 6 6 1 1 2 2 1 3 4 4 3 3 4 4 5 5 3
5  7   -0.264000000000D 03   12     210     90     70     78
 3 6 6 3 1 2 2 1 3 4 4 3 3 4 4 5 5 3
5  7   -0.264000000000D 03    6     210    150    130    126
 5 6 6 5 1 2 2 1 3 4 4 3 3 4 4 5 5 3
6  7    0.763200000000D 04    4     840    600    440    360
 4 7 7 4 1 2 2 1 1 3 3 4 4 5 5 6 6 1
6  7   -0.104160000000D 05    4     840    600    440    360
 1 7 7 1 1 2 2 1 3 4 4 3 3 5 5 6 6 3
6  7   -0.104160000000D 05    2     840    360    360    456
 3 7 7 3 1 2 2 1 3 4 4 3 3 5 5 6 6 3
6  7   -0.104160000000D 05    2     840    600    480    432
 4 7 7 4 1 2 2 1 3 4 4 3 3 5 5 6 6 3
6  7   -0.104160000000D 05    4     840    600    440    360
 5 7 7 5 1 2 2 1 3 4 4 3 3 5 5 6 6 3
6  7   -0.415200000000D 04    6     840    600    440    360
 1 7 7 1 1 2 2 3 3 1 4 5 5 4 4 6 6 4
```

```
6  7  -0.415200000000D 04    2    840   360   360   456
 4 7 7 4 1 2 2 3 3 1 4 5 5 4 4 6 6 4
6  7  -0.415200000000D 04    4    840   600   480   432
 5 7 7 5 1 2 2 3 3 1 4 5 5 4 4 6 6 4
6  7   0.204000000000D 04    4    840   360   360   456
 1 7 7 1 1 2 2 3 3 1 1 4 4 5 5 6 6 1
6  7   0.204000000000D 04    8    840   600   440   360
 2 7 7 2 1 2 2 3 3 1 1 4 4 5 5 6 6 1
6  7   0.204000000000D 04    8    840   600   440   360
 4 7 7 4 1 2 2 3 3 1 1 4 4 5 5 6 6 1
6  7   0.204000000000D 04    4    840   600   440   360
 5 7 7 5 1 2 2 3 3 1 1 4 4 5 5 6 6 1
6  7   0.763200000000D 04    2    840   360   360   456
 1 7 7 1 1 2 2 1 1 3 3 4 4 5 5 6 6 1
6  7   0.763200000000D 04    2    840   600   480   432
 2 7 7 2 1 2 2 1 1 3 3 4 4 5 5 6 6 1
6  7   0.763200000000D 04    4    840   600   440   360
 3 7 7 3 1 2 2 1 1 3 3 4 4 5 5 6 6 1
7  7   0.616800000000D 04   14   2520  1800  1320  1080
 1 8 8 1 1 2 2 3 3 4 4 5 5 6 6 7 7 1
7  7   0.864000000000D 04    8   2520  1800  1320  1080
 1 8 8 1 1 2 2 1 3 4 4 3 5 6 6 7 7 5
7  7   0.864000000000D 04    6   2520  1800  1320  1080
 5 8 8 5 1 2 2 1 3 4 4 3 5 6 6 7 7 5
7  7  -0.885600000000D 04    4   2520  1800  1320  1080
 1 8 8 1 1 2 2 1 3 4 4 5 5 6 6 7 7 3
7  7  -0.885600000000D 04   10   2520  1800  1320  1080
 3 8 8 3 1 2 2 1 3 4 4 5 5 6 6 7 7 3
7  7  -0.256800000000D 04   12   2520  1800  1320  1080
 1 8 8 1 1 2 2 3 3 1 4 5 5 6 6 7 7 4
7  7  -0.256800000000D 04   16   2520  1800  1320  1080
 4 8 8 4 1 2 2 3 3 1 4 5 5 6 6 7 7 4
```

```
 2  8   0.600000000000D 01    2       1     0     0     0     0
  1 3 3 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1
 3  8   0.660000000000D 02    2       8     2     2     2     2
  2 4 4 2 1 2 2 1 1 2 2 1 1 2 2 1 1 3 3 1
 3  8   0.660000000000D 02    2       8     6     6     6     6
  3 4 4 3 1 2 2 1 1 2 2 1 1 2 2 1 1 3 3 1
 3  8   0.660000000000D 02    1      12     0     8     0     8
  1 4 4 1 1 2 2 1 1 2 2 1 1 3 3 1 1 3 3 1
 3  8   0.800000000000D 01    3      40    20    24    22    24
  3 4 4 3 1 2 2 1 1 2 2 1 1 3 3 2 2 3 3 1
 3  8   0.660000000000D 02    2       8     0     4     0     4
  1 4 4 1 1 2 2 1 1 2 2 1 1 2 2 1 1 3 3 1
 3  8   0.660000000000D 02    2      12     6     6     6     6
  2 4 4 2 1 2 2 1 1 2 2 1 1 3 3 1 1 3 3 1
 3  8   0.800000000000D 01   12       8     2     3     4     2
  1 4 4 1 1 2 2 1 1 2 2 3 3 1 1 2 2 3 3 1
 3  8   0.800000000000D 01    6       8     4     4     5     4
  3 4 4 3 1 2 2 1 1 2 2 3 3 1 1 2 2 3 3 1
 3  8   0.800000000000D 01    6      40    10    20    14    18
  1 4 4 1 1 2 2 1 1 2 2 1 1 3 3 2 2 3 3 1
 4  8  -0.690000000000D 02    4      56    14     2     0     0
  3 5 5 3 1 2 2 1 3 4 4 3 3 4 4 3 3 4 4 3
 4  8  -0.690000000000D 02    4      56    42    32    26    24
  1 5 5 1 1 2 2 1 3 4 4 3 3 4 4 3 3 4 4 3
 4  8  -0.690000000000D 02    4     140    70    30    10     4
  1 5 5 1 1 2 2 1 1 2 2 1 3 4 4 3 3 4 4 3
 4  8   0.702000000000D 03    2      88    22    42    32    40
  1 5 5 1 1 2 2 1 1 3 3 1 1 2 2 4 4 2 2 1
 4  8   0.702000000000D 03    2      88    66    56    50    48
  3 5 5 3 1 2 2 1 1 3 3 1 1 2 2 4 4 2 2 1
 4  8   0.200000000000D 01   24     200   100    86    78    72
  1 5 5 1 1 2 2 1 1 3 3 4 4 2 2 3 3 4 4 1
 4  8   0.200000000000D 01   24     200   100    68    76    80
  3 5 5 3 1 2 2 1 1 3 3 4 4 2 2 3 3 4 4 1
 4  8   0.330000000000D 02    8      36    18    10    12    16
  1 5 5 1 1 2 2 3 3 4 4 1 1 2 2 3 3 4 4 1
 4  8   0.330000000000D 02    4     400   200   152   116   112
  1 5 5 1 1 2 2 1 1 3 3 4 4 2 2 4 4 3 3 1
 4  8   0.330000000000D 02   16     168    84    52    42    40
  1 5 5 1 1 2 2 1 1 2 2 3 3 4 4 3 3 4 4 1
 4  8   0.702000000000D 03    2     128    32    52    28    36
  1 5 5 1 1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 1
 4  8   0.702000000000D 03    2     128    64    42    34    32
  2 5 5 2 1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 1
 4  8   0.702000000000D 03    2     128    64    66    58    56
  3 5 5 3 1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 1
 4  8   0.702000000000D 03    2     128    96    76    64    60
  4 5 5 4 1 2 2 1 1 2 2 1 1 3 3 4 4 3 3 1
 4  8   0.220000000000D 03    3      80     0    68     0    64
  1 5 5 1 1 2 2 1 1 2 2 1 1 3 3 1 1 4 4 1
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```
 4  8   0.220000000000D 03    3   80    40    36    32    32
  2 5 5 2 1 2 2 1 1 2 2 1 1 3 3 1 1 4 4 1
 4  8   0.220000000000D 03    6   80    60    52    44    44
  3 5 5 3 1 2 2 1 1 2 2 1 1 3 3 1 1 4 4 1
 4  8   0.360000000000D 02    8   96    24    42    44    20
  1 5 5 1 1 2 2 1 1 2 2 3 3 1 1 4 4 3 3 1
 4  8   0.360000000000D 02    8   96    48    40    36    36
  2 5 5 2 1 2 2 1 1 2 2 3 3 1 1 4 4 3 3 1
 4  8   0.360000000000D 02    8   96    48    40    46    36
  3 5 5 3 1 2 2 1 1 2 2 3 3 1 1 4 4 3 3 1
 4  8   0.360000000000D 02    8   96    72    56    46    44
  4 5 5 4 1 2 2 1 1 2 2 3 3 1 1 4 4 3 3 1
 4  8   0.360000000000D 02    4   64    16    24    32    16
  1 5 5 1 1 2 2 1 1 2 2 3 3 1 1 2 2 4 4 1
 4  8   0.360000000000D 02    4   64    48    40    34    32
  3 5 5 3 1 2 2 1 1 2 2 3 3 1 1 2 2 4 4 1
 4  8   0.240000000000D 03    2   48    12    24    28     8
  1 5 5 1 1 2 2 1 1 3 3 4 4 1 1 3 3 4 4 1
 4  8   0.240000000000D 03    2   48    36    30    26    24
  2 5 5 2 1 2 2 1 1 3 3 4 4 1 1 3 3 4 4 1
 4  8   0.240000000000D 03    4   48    24    16    20    20
  3 5 5 3 1 2 2 1 1 3 3 4 4 1 1 3 3 4 4 1
 4  8   0.240000000000D 03    1  304    76   192   112   136
  1 5 5 1 1 2 2 1 1 3 3 1 1 4 4 2 2 4 4 1
 4  8   0.240000000000D 03    2  304   152   142   122   136
  2 5 5 2 1 2 2 1 1 3 3 1 1 4 4 2 2 4 4 1
 4  8   0.240000000000D 03    1  304   228   188   160   152
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```

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5 8 -0.264000000000D 03   2  1008   756   576   468   432
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5 8 -0.222000000000D 04   2   336   252   228   224   224
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5 8 -0.222000000000D 04   2   336   168   120   112   112
 4 6 6 4 1 2 2 1 3 4 4 3 3 4 4 3 3 5 5 3
5 8 -0.222000000000D 04   2   336    84   132   120    96
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5 8 -0.222000000000D 04   4   336   252   192   156   144
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5 8 -0.222000000000D 04   2   560   420   340   300   288
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5 8 -0.222000000000D 04   1   560   280   240   280   304
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5 8 -0.222000000000D 04   2   560   280   120    40    16
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5 8 -0.264000000000D 03   6   168    84    60    76    88
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5 8 -0.264000000000D 03   4   168   126    96    78    72
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5 8  0.204000000000D 03  16   616   462   352   286   264
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5 8  0.648000000000D 03   2   384    96   192   240    96
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5 8  0.648000000000D 03   2   384   288   240   208   192
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5 8  0.648000000000D 03   2   384   192   144   192   192
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5 8  0.648000000000D 03   4   384   288   224   184   176
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5 8  0.204000000000D 03  16   448   112   232   208   160
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5 8  0.204000000000D 03  16   448   224   192   192   192
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5 8  0.204000000000D 03  16   448   336   272   236   224
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5 8  0.204000000000D 03  16   448   336   256   208   192
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5 8  0.204000000000D 03  16   448   336   256   208   192
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5 8  0.384000000000D 03   2   280   140    84   112   136
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5 8  0.384000000000D 03   4   280   210   160   130   120
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 5   8   0.696000000000D 03     2    456    342   272   230   216
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 5   8   0.360000000000D 02    12    816    408   372   396   416
 2 6 6 2 1 2 2 1 1 3 3 4 4 2 2 5 5 3 3 1
 5   8   0.360000000000D 02    12    816    612   476   408   392
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 5   8   0.124800000000D 04     4    448    112   232   208   160
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 5   8   0.124800000000D 04     4    448    336   284   252   240
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 5   8   0.124800000000D 04     4    448    336   256   208   192
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 5   8   0.648000000000D 03     2    704    528   436   372   352
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 5   8   0.648000000000D 03     4    704    528   416   360   336
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 5   8   0.696000000000D 03     4    824    412   364   376   400
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 5  8   0.495000000000D 03     4     576   432   360   288   288
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 5  8   0.678000000000D 04     1     704   352   336   320   384
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 5  8   0.735000000000D 04     1     816   408   400   392   400
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 5  8   0.124800000000D 04     2     336   252   192   156   144
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 5  8   0.192000000000D 03     4     848   424   376   392   368
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 5  8   0.192000000000D 03     2     848   424   336   392   464
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6 8 -0.244000000000D 03 48 1680 840 600 600 624
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6 8 -0.244000000000D 03 72 1680 1260 960 780 720
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6 8 -0.966000000000D 04 2 2016 1512 1152 936 864
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6 8 -0.175800000000D 05 2 2240 1120 960 1120 1216
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6 8 -0.153600000000D 04 4 2352 1176 1080 1144 1168
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6 8 -0.153600000000D 04 4 2352 1764 1344 1092 1008
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 6  8  -0.309780000000D 05      2    2352   1764   1344   1092   1008
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 6  8   0.580800000000D 04      4    2240   1680   1280   1040    960
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 6  8   0.127440000000D 05      2    2352   1176   1080   1144   1168
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 6  8   0.127440000000D 05      4    2352   1764   1344   1092   1008
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 6  8   0.114000000000D 05      4    2240   1120    960   1120   1216
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  2 7 7 2 1 2 2 1 1 3 3 4 4 3 3 5 5 6 6 1
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 6  8   0.900000000000D 01     24    2240   1680   1280   1040    960
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 6  8   0.384000000000D 03      4    2240   1680   1280   1040    960
  4 7 7 4 1 2 2 3 3 1 1 4 4 5 5 2 2 6 6 1
 6  8   0.384000000000D 03      8    2240   1120    960   1120   1216
  1 7 7 1 1 2 2 3 3 1 1 4 4 2 2 5 5 6 6 1
 6  8   0.384000000000D 03      4    2240   1680   1288   1064    992
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  4 7 7 4 1 2 2 3 3 1 1 4 4 2 2 5 5 6 6 1
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6  8  0.777600000000D 04   4  2240  1680  1280  1040   960
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6  8  0.777600000000D 04   4  2240  1680  1288  1064   992
 6 7 7 6 1 2 2 1 1 3 3 4 4 5 5 3 3 6 6 1
6  8  0.240000000000D 04   4  1344   672   480   608   704
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6  8  0.219600000000D 04  16  2352  1764  1344  1092  1008
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6  8  0.966000000000D 03   4  2352  1176  1080  1144  1168
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 1 7 7 1 1 2 2 1 3 4 4 3 5 6 6 5 5 6 6 5
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 3 7 7 3 1 2 2 1 1 2 2 3 3 4 4 5 5 6 6 1
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7  8   0.120960000000D 05    8   6720  5040  3840  3120  2880
 5 8 8 5 1 2 2 3 3 1 1 4 4 5 5 6 6 7 7 1
7  8   0.736140000000D 05    2   6720  5040  4080  3600  3456
 6 8 8 6 1 2 2 1 3 4 4 3 5 6 6 5 5 7 7 5
7  8  -0.663120000000D 05    2   6720  5040  4080  3600  3456
 4 8 8 4 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8  -0.663120000000D 05    2   6720  3360  2880  3360  3648
 3 8 8 3 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8  -0.663120000000D 05    4   6720  5040  3840  3120  2880
 1 8 8 1 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8  -0.219480000000D 05    8   6720  5040  3840  3120  2880
 4 8 8 4 1 2 2 1 1 3 3 1 4 5 5 6 6 7 7 4
7  8  -0.219480000000D 05    4   6720  5040  4080  3600  3456
 2 8 8 2 1 2 2 1 1 3 3 1 4 5 5 6 6 7 7 4
7  8  -0.219480000000D 05    2   6720  3360  2880  3360  3648
 1 8 8 1 1 2 2 1 1 3 3 1 4 5 5 6 6 7 7 4
7  8  -0.190320000000D 05    8   6720  5040  3840  3120  2880
 6 8 8 6 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 4
7  8  -0.190320000000D 05    4   6720  5040  4080  3600  3456
 5 8 8 5 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 4
7  8  -0.190320000000D 05    4   6720  3360  2880  3360  3648
 4 8 8 4 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 4
7  8  -0.190320000000D 05   12   6720  5040  3840  3120  2880
 1 8 8 1 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 4
7  8  -0.108240000000D 05   16   6720  5040  3840  3120  2880
 4 8 8 4 1 2 2 1 3 4 4 5 5 3 3 6 6 7 7 3
7  8  -0.663120000000D 05    4   6720  5040  3840  3120  2880
 5 8 8 5 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8  -0.663120000000D 05    2   6720  5040  3840  3120  2880
 6 8 8 6 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8  -0.108240000000D 05    4   6720  3360  2880  3360  3648
 3 8 8 3 1 2 2 1 3 4 4 5 5 3 3 6 6 7 7 3
7  8  -0.108240000000D 05    8   6720  5040  3840  3120  2880
 1 8 8 1 1 2 2 1 3 4 4 5 5 3 3 6 6 7 7 3
7  8   0.496800000000D 04    4   6720  3360  2880  3360  3648
 1 8 8 1 1 2 2 3 3 4 4 1 1 5 5 6 6 7 7 1
```

```
7  8   0.496800000000D 04   16   6720   5040   3840   3120   2880
 2 8 8 2 1 2 2 3 3 4 4 1 1 5 5 6 6 7 7 1
7  8   0.496800000000D 04    8   6720   5040   3840   3120   2880
 3 8 8 3 1 2 2 3 3 4 4 1 1 5 5 6 6 7 7 1
7  8   0.514680000000D 05    2   6720   3360   2880   3360   3648
 1 8 8 1 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
7  8   0.514680000000D 05    2   6720   5040   4080   3600   3456
 2 8 8 2 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
7  8   0.514680000000D 05    4   6720   5040   3840   3120   2880
 3 8 8 3 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
7  8   0.514680000000D 05    4   6720   5040   3840   3120   2880
 4 8 8 4 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
7  8   0.514680000000D 05    2   6720   5040   3840   3120   2880
 5 8 8 5 1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
7  8   0.736140000000D 05    4   6720   5040   3840   3120   2880
 1 8 8 1 1 2 2 1 3 4 4 3 5 6 6 5 5 7 7 5
7  8   0.736140000000D 05    1   6720   3360   2880   3360   3648
 5 8 8 5 1 2 2 1 3 4 4 3 5 6 6 5 5 7 7 5
8  8   0.183000000000D 05   24  20160  15120  11520   9360   8640
 3 9 9 3 1 2 2 1 3 4 4 5 5 3 6 7 7 8 8 6
8  8  -0.158400000000D 05   12  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 3 3 1 4 5 5 6 6 7 7 8 8 4
8  8  -0.158400000000D 05   20  20160  15120  11520   9360   8640
 4 9 9 4 1 2 2 3 3 1 4 5 5 6 6 7 7 8 8 4
8  8  -0.606540000000D 05   12  20160  15120  11520   9360   8640
 3 9 9 3 1 2 2 1 3 4 4 5 5 6 6 7 7 8 8 3
8  8  -0.606540000000D 05    4  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 1 3 4 4 5 5 6 6 7 7 8 8 3
8  8   0.530400000000D 05    8  20160  15120  11520   9360   8640
 5 9 9 5 1 2 2 1 3 4 4 3 5 6 6 7 7 8 8 5
8  8   0.530400000000D 05    8  20160  15120  11520   9360   8640
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8  8   0.420690000000D 05   16  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 1
8  8   0.183000000000D 05    8  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 1 3 4 4 5 5 3 6 7 7 8 8 6
8  8  -0.666750000000D 04   32  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 3 3 4 4 1 5 6 6 7 7 8 8 5
8  8  -0.300315000000D 05    8  20160  15120  11520   9360   8640
 1 9 9 1 1 2 2 1 3 4 4 3 5 6 6 5 7 8 8 7
```

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4  4  -0.690000000000D 02     4     2
 1 2 3 4 4 1 2 3
4  4  -0.690000000000D 02     4     2
 1 2 3 4 4 3 2 1
4  5   0.220000000000D 03    12     2
 1 2 3 4 4 1 2 1 1 3
5  5  -0.222000000000D 04     4     6
 1 2 3 4 4 5 5 1 2 3
5  5  -0.222000000000D 04     4     6
 1 2 3 4 4 5 5 3 2 1
4  6   0.702000000000D 03     2     2
 1 2 3 4 4 3 3 1 2 1 1 3
4  6   0.702000000000D 03     2     4
 1 2 4 3 3 1 2 1 1 3 3 4
4  6  -0.690000000000D 02     8     4
 2 3 4 1 1 2 2 1 1 2 3 4
4  6   0.702000000000D 03     2     2
 1 3 2 4 4 1 1 2 2 1 3 2
4  6   0.702000000000D 03     2     2
 2 3 4 1 1 2 3 1 1 2 2 4
4  6   0.702000000000D 03     2     4
 1 2 3 4 4 1 2 1 1 2 2 3
4  6   0.702000000000D 03     2     2
 2 1 3 4 4 1 1 2 1 2 2 3
4  6  -0.690000000000D 02     8     4
 1 2 3 4 4 3 3 4 4 3 2 1
5  6   0.678000000000D 04     4     8
 1 2 3 4 4 5 5 1 2 1 1 3
5  6   0.678000000000D 04     4     8
 1 2 4 5 5 1 2 1 1 3 3 4
5  6  -0.222000000000D 04     8     8
 1 3 4 5 5 1 1 2 2 1 3 4
5  6   0.678000000000D 04     4     8
 1 2 4 5 5 1 2 3 3 1 1 4
5  6   0.495000000000D 03    12     8
 2 3 4 5 5 1 1 2 3 1 1 4
5  6  -0.222000000000D 04     8     8
 1 2 3 4 4 3 3 5 5 3 2 1
6  6  -0.309780000000D 05     4    24
 1 2 3 4 4 5 5 6 6 1 2 3
6  6  -0.175800000000D 05     4    24
 1 2 4 5 5 6 6 1 2 3 3 4
6  6  -0.309780000000D 05     4    24
 1 2 3 4 4 5 5 6 6 3 2 1
6  6   0.129200000000D 04    12    24
 3 4 5 6 6 3 1 2 2 1 4 5
6  6  -0.175800000000D 05     4    24
 1 2 4 5 5 6 6 4 2 3 3 1
6  6   0.129200000000D 04    12    24
 1 2 3 4 4 3 5 6 6 5 2 1
```

```
 4   7    0.220000000000D 03     12          2
  1  3  2  4  4  1  1  2  2  1  3  1  1  2
 4   7    0.220000000000D 03     12          4
  3  1  2  4  4  1  1  2  2  1  1  3  1  2
 4   7    0.240000000000D 03      4          8
  1  2  3  4  4  3  3  1  2  1  1  2  2  3
 4   7    0.240000000000D 03      4          4
  2  1  3  4  4  3  3  1  1  2  1  2  2  3
 4   7    0.240000000000D 03      4          8
  1  2  3  4  4  1  2  1  1  3  3  2  2  3
 4   7    0.240000000000D 03      4          6
  2  1  3  4  4  1  1  2  1  3  3  2  2  3
 4   7    0.240000000000D 03      4          4
  1  2  3  4  4  1  2  3  3  1  1  2  2  3
 4   7    0.220000000000D 03     12          4
  1  2  3  4  4  1  2  1  1  2  2  1  1  3
 5   7    0.232800000000D 04      4         12
  2  3  1  4  4  2  2  5  5  1  1  2  3  1
 5   7    0.232800000000D 04      2         14
  2  3  5  1  1  2  3  1  1  4  4  2  2  5
 5   7   -0.222000000000D 04      4         20
  2  3  5  1  1  2  2  1  1  2  3  4  4  5
 5   7    0.232800000000D 04      4         12
  1  2  3  4  4  3  3  5  5  1  2  1  1  3
 5   7    0.232800000000D 04      2         16
  1  2  4  3  3  5  5  1  2  1  1  3  3  4
 5   7    0.678000000000D 04      4         12
  1  2  3  5  5  1  2  1  1  3  3  4  4  3
 5   7    0.232800000000D 04      2         14
  2  1  3  4  4  3  3  5  5  1  1  2  1  3
 5   7    0.678000000000D 04      4         14
  2  1  3  5  5  1  1  2  1  3  3  4  4  3
 5   7    0.735000000000D 04      4         10
  1  2  3  4  4  5  5  3  3  1  2  1  1  3
 5   7    0.735000000000D 04      4         20
  1  2  5  3  3  1  2  1  1  3  3  4  4  5
 5   7    0.735000000000D 04      4         10
  1  3  2  4  4  5  5  1  1  2  2  1  3  2
 5   7   -0.264000000000D 03     12         20
  2  4  5  1  1  2  2  1  1  3  3  2  4  5
 5   7    0.735000000000D 04      4         10
  2  3  5  1  1  2  3  1  1  2  2  4  4  5
 5   7   -0.264000000000D 03     12         10
  2  4  5  1  1  2  2  3  3  1  1  2  4  5
 5   7    0.495000000000D 03     48         12
  1  2  4  5  5  1  2  1  1  3  3  1  1  4
 5   7    0.735000000000D 04      4         20
  1  2  3  4  4  5  5  1  2  1  1  2  2  3
 5   7    0.735000000000D 04      4         10
  2  1  3  4  4  5  5  1  1  2  1  2  2  3
```

```
5  7  -0.222000000000D 04     8     10
 2 3 4 5 5 1 1 2 2 1 1 2 3 4
5  7   0.678000000000D 04     4     14
 1 2 4 5 5 3 3 1 2 1 1 3 3 4
5  7   0.678000000000D 04     4     14
 1 3 4 5 5 3 3 1 1 2 2 1 3 4
5  7   0.232800000000D 04     2     14
 1 2 4 5 5 1 2 1 1 3 3 2 2 4
5  7   0.232800000000D 04     2     14
 2 1 4 5 5 1 1 2 1 3 3 2 2 4
5  7   0.678000000000D 04     4     14
 1 3 4 5 5 1 1 2 2 1 3 2 2 4
5  7   0.232800000000D 04     2     16
 1 2 4 5 5 1 2 3 3 1 1 2 2 4
5  7   0.678000000000D 04     4      8
 2 3 4 5 5 1 1 2 3 1 1 2 2 4
5  7  -0.264000000000D 03    12     20
 1 2 3 4 4 3 3 4 4 5 5 3 2 1
5  7  -0.264000000000D 03    12     10
 1 2 4 3 3 4 4 5 5 3 2 1 3 4
5  7  -0.222000000000D 04     8     10
 1 2 4 5 5 3 2 1 3 4 4 3 3 4
5  7  -0.222000000000D 04     4     20
 1 2 4 5 5 4 4 5 5 4 2 3 3 1
6  7   0.685080000000D 05     4     40
 1 2 4 5 5 6 6 1 2 3 3 1 1 4
6  7   0.685080000000D 05     4     40
 1 2 5 6 6 1 2 3 3 1 1 4 4 5
6  7   0.699240000000D 05     4     40
 2 3 1 4 4 5 5 6 6 1 1 2 3 1
6  7   0.196200000000D 05    12     40
 2 3 4 5 5 6 6 1 1 2 3 1 1 4
6  7  -0.104160000000D 05     8     40
 1 4 5 6 6 1 1 2 2 3 3 1 4 5
6  7   0.699240000000D 05     4     40
 1 2 3 4 4 5 5 6 6 1 2 1 1 3
6  7   0.685080000000D 05     4     40
 1 2 4 5 5 6 6 1 2 1 1 3 3 4
6  7   0.699240000000D 05     4     40
 1 2 5 6 6 1 2 1 1 3 3 4 4 5
6  7  -0.309780000000D 05     8     40
 1 3 4 5 5 6 6 1 1 2 2 1 3 4
6  7  -0.175800000000D 05    16     40
 1 3 5 6 6 1 1 2 2 1 3 4 4 5
6  7  -0.966000000000D 04    12     40
 3 4 5 6 6 1 1 2 2 1 1 3 4 5
6  7  -0.104160000000D 05     8     40
 1 2 3 4 4 3 3 5 5 6 6 3 2 1
6  7  -0.309780000000D 05     8     40
 1 2 3 5 5 6 6 3 2 1 3 4 4 3
```

```
6  7  -0.966000000000D 04   12    40
 1 2 5 6 6 3 2 1 3 4 4 3 3 5
6  7  -0.966000000000D 04   12    40
 3 4 5 6 6 3 1 2 2 1 4 3 3 5
6  7  -0.175800000000D 05   16    40
 1 2 4 5 5 4 4 6 6 4 2 3 3 1
7  7  -0.400944000000D 06    4   120
 1 2 3 4 4 5 5 6 6 7 7 1 2 3
7  7  -0.485532000000D 06    4   120
 1 2 4 5 5 6 6 7 7 1 2 3 3 4
7  7  -0.400944000000D 06    4   120
 1 2 3 4 4 5 5 6 6 7 7 3 2 1
7  7   0.736140000000D 05    8   120
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7  7  -0.485532000000D 06    4   120
 1 2 4 5 5 6 6 7 7 4 2 3 3 1
7  7   0.864000000000D 04    8   120
 4 5 6 7 7 4 1 2 2 3 3 1 5 6
7  7   0.864000000000D 04    8   120
 1 2 3 4 4 3 5 6 6 7 7 5 2 1
7  7   0.736140000000D 05    8   120
 1 2 5 6 6 7 7 5 2 1 3 4 4 3
4  8   0.702000000000D 03    4     8
 1 2 3 4 4 3 3 1 2 1 1 2 2 1 1 3
4  8   0.702000000000D 03    4    12
 1 2 4 3 3 1 2 1 1 2 2 1 1 3 3 4
4  8   0.702000000000D 03    2     2
 1 3 2 4 4 2 2 1 1 2 2 1 3 1 1 2
4  8   0.702000000000D 03    2     6
 1 3 4 2 2 1 1 2 2 1 3 1 1 2 2 4
4  8  -0.690000000000D 02    8     6
 2 3 4 1 1 2 2 1 1 2 2 1 1 2 3 4
4  8   0.702000000000D 03    4    12
 1 2 4 3 3 1 2 1 1 3 3 1 1 2 2 4
4  8   0.702000000000D 03    4     4
 2 1 4 3 3 1 1 2 1 3 3 1 1 2 2 4
4  8   0.240000000000D 03    4    12
 1 3 4 2 2 4 4 1 1 2 2 1 3 1 1 4
4  8   0.240000000000D 03    4     4
 1 2 3 4 4 1 1 3 3 4 4 1 2 1 1 3
4  8   0.330000000000D 02    4    28
 1 2 3 4 4 3 3 4 4 1 2 1 1 2 2 3
4  8   0.330000000000D 02    8    12
 1 2 4 3 3 4 4 1 2 1 1 2 2 3 3 4
4  8   0.330000000000D 02    4     8
 2 1 4 3 3 4 4 1 1 2 1 2 2 3 3 4
4  8  -0.690000000000D 02    4    20
 2 3 4 1 1 2 2 1 1 2 3 4 4 3 3 4
4  8   0.330000000000D 02    4    12
 1 2 3 4 4 2 2 4 4 3 3 1 2 1 1 3
```

```
4  8   0.330000000000D 02    4     28
 1 2 4 3 3 1 2 1 1 3 3 4 4 2 2 4
4  8   0.330000000000D 02    4      8
 1 2 3 4 4 1 1 2 2 3 3 4 4 1 2 3
4  8   0.702000000000D 03    2      2
 1 3 2 4 4 1 1 2 2 1 1 2 2 1 3 2
4  8   0.240000000000D 03    4     12
 1 2 3 4 4 1 2 1 1 3 3 1 1 2 2 3
4  8   0.240000000000D 03    4      8
 2 1 3 4 4 1 1 2 1 3 3 1 1 2 2 3
4  8   0.702000000000D 03    4      8
 2 3 4 1 1 2 2 1 1 3 3 1 1 2 3 4
4  8   0.702000000000D 03    2      4
 2 3 4 1 1 2 2 1 1 2 3 1 1 2 2 4
4  8   0.240000000000D 03    4      8
 1 2 4 3 3 1 2 1 1 2 2 3 3 1 1 4
4  8   0.240000000000D 03    4      4
 2 1 4 3 3 1 1 2 1 2 2 3 3 1 1 4
4  8   0.702000000000D 03    4      4
 2 3 1 4 4 3 3 1 1 2 2 1 1 2 3 1
4  8   0.200000000000D 01   24     16
 1 2 3 4 4 2 2 3 3 4 4 1 2 1 1 3
4  8   0.330000000000D 02    8     12
 1 3 4 2 2 3 3 4 4 1 1 2 2 1 3 4
4  8   0.200000000000D 01   24     16
 1 2 4 3 3 4 4 1 2 1 1 3 3 2 2 4
4  8   0.330000000000D 02    4     12
 1 3 2 4 4 3 3 4 4 1 1 2 2 1 3 2
4  8  -0.690000000000D 02    4     20
 1 2 3 4 4 3 3 4 4 3 2 1 1 2 2 1
4  8   0.702000000000D 03    2      6
 1 2 3 4 4 1 2 1 1 2 2 1 1 2 2 3
4  8   0.702000000000D 03    2      4
 2 1 3 4 4 1 1 2 1 2 2 1 1 2 2 3
4  8  -0.690000000000D 02    8     12
 1 2 3 4 4 3 3 4 4 3 3 4 4 3 2 1
5  8   0.696000000000D 03    4     32
 1 2 4 3 3 5 5 1 2 1 1 3 3 2 2 4
5  8   0.696000000000D 03    4     30
 2 1 4 3 3 5 5 1 1 2 1 3 3 2 2 4
5  8   0.124800000000D 04    4     22
 1 3 2 4 4 3 3 5 5 1 1 2 2 1 3 2
5  8   0.232800000000D 04    4     26
 2 4 3 5 5 1 1 2 2 1 1 3 3 2 4 3
5  8   0.108000000000D 04    4     44
 2 4 5 1 1 2 2 1 1 3 3 2 4 3 3 5
5  8   0.696000000000D 03    4     30
 1 2 3 4 4 2 2 3 3 5 5 1 2 1 1 3
5  8   0.696000000000D 03    4     30
 1 2 3 5 5 1 2 1 1 3 3 4 4 2 2 3
```

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5  8   0.124800000000D 04     4     40
 1 3 4 2 2 3 3 5 5 1 1 2 2 1 3 4
5  8   0.232800000000D 04     4     34
 3 4 5 1 1 2 2 1 1 3 4 2 2 3 3 5
5  8   0.108000000000D 04     4     24
 4 2 5 1 1 2 2 1 1 3 3 4 2 3 3 5
5  8   0.696000000000D 03     4     32
 1 2 4 3 3 5 5 1 2 3 3 1 1 2 2 4
5  8   0.124800000000D 04     4     18
 2 3 5 1 1 2 3 1 1 2 2 4 4 3 3 5
5  8   0.232800000000D 04     4     14
 2 4 3 5 5 1 1 2 2 3 3 1 1 2 4 3
5  8   0.108000000000D 04     4     22
 2 4 5 1 1 2 2 3 3 1 1 2 4 3 3 5
5  8   0.678000000000D 04     4     20
 1 2 4 5 5 4 4 1 2 1 1 3 3 1 1 4
5  8   0.678000000000D 04     4     32
 1 2 5 4 4 1 2 1 1 3 3 1 1 4 4 5
5  8   0.735000000000D 04     4     22
 1 2 3 4 4 5 5 4 4 3 3 1 2 1 1 3
5  8   0.735000000000D 04     2     24
 1 2 4 5 5 4 4 3 3 1 2 1 1 3 3 4
5  8   0.735000000000D 04     2     34
 1 2 5 4 4 3 3 1 2 1 1 3 3 4 4 5
5  8   0.735000000000D 04     4     40
 1 2 4 3 3 1 2 1 1 3 3 4 4 5 5 4
5  8   0.678000000000D 04     4     12
 1 3 2 4 4 5 5 1 1 2 2 1 3 1 1 2
5  8   0.678000000000D 04     4     24
 3 1 2 4 4 5 5 1 1 2 2 1 1 3 1 2
5  8  -0.222000000000D 04     8     24
 2 4 5 1 1 2 2 1 1 3 3 1 1 2 4 5
5  8   0.124800000000D 04     4     40
 1 2 3 4 4 3 3 5 5 1 2 1 1 2 2 3
5  8   0.124800000000D 04     4     40
 1 2 4 3 3 5 5 1 2 1 1 2 2 3 3 4
5  8   0.735000000000D 04     4     40
 1 2 3 5 5 1 2 1 1 2 2 3 3 4 4 3
5  8   0.124800000000D 04     4     18
 2 1 3 4 4 3 3 5 5 1 1 2 1 2 2 3
5  8   0.124800000000D 04     4     24
 2 1 4 3 3 5 5 1 1 2 1 2 2 3 3 4
5  8   0.735000000000D 04     4     18
 2 1 3 5 5 1 1 2 1 2 2 3 3 4 4 3
5  8  -0.222000000000D 04     8     40
 2 3 5 1 1 2 2 1 1 2 3 4 4 3 3 5
5  8   0.678000000000D 04     4     22
 3 4 5 1 1 2 2 1 1 2 2 3 4 3 3 5
5  8   0.678000000000D 04     4     16
 4 3 5 1 1 2 2 1 1 2 2 3 3 4 3 5
```

```
 5   8    0.108000000000D 04     8        32
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 5   8    0.108000000000D 04     8        20
  1  3  2  5  5  1  1  2  2  1  3  1  1  4  4  2
 5   8    0.678000000000D 04     4        20
  1  4  2  5  5  1  1  2  2  1  1  3  3  1  4  2
 5   8    0.678000000000D 04     4        12
  2  3  1  4  4  5  5  1  1  2  2  1  1  2  3  1
 5   8    0.678000000000D 04     4        24
  2  3  5  1  1  2  2  1  1  2  3  1  1  4  4  5
 5   8    0.108000000000D 04     8        12
  1  2  3  4  4  1  1  3  3  5  5  1  2  1  1  3
 5   8    0.108000000000D 04     8        16
  2  1  3  4  4  1  1  3  3  5  5  1  1  2  1  3
 5   8    0.678000000000D 04     4        16
  3  4  5  1  1  2  2  1  1  3  4  1  1  3  3  5
 5   8    0.249600000000D 04     4        48
  1  2  3  4  4  5  5  3  3  1  2  1  1  2  2  3
 5   8    0.249600000000D 04     4        24
  2  1  3  4  4  5  5  3  3  1  1  2  1  2  2  3
 5   8    0.249600000000D 04     4        48
  1  2  3  4  4  5  5  1  2  1  1  3  3  2  2  3
 5   8    0.249600000000D 04     4        36
  2  1  3  4  4  5  5  1  1  2  1  3  3  2  2  3
 5   8   -0.264000000000D 03    12        36
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 5   8    0.696000000000D 03     4        30
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5  8   0.124800000000D 04     4      24
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5  8  -0.222000000000D 04     8      40
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5  8  -0.222000000000D 04     8      12
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5  8   0.678000000000D 04     4      16
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5  8   0.678000000000D 04     4      16
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5  8   0.735000000000D 04     2      10
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5  8  -0.222000000000D 04     8      24
 1 2 3 4 4 3 3 4 4 3 3 5 5 3 2 1
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  1 2 3 4 4 5 5 3 3 6 6 1 2 1 1 3
 6  8   0.477600000000D 05     2       96
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 6  8   0.117840000000D 05     8       72
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 6  8   0.117840000000D 05     8       84
  2 1 3 6 6 1 1 2 1 3 3 4 4 5 5 3
 6  8   0.685080000000D 05     4       84
  3 4 6 1 1 2 2 1 1 3 4 5 5 3 3 6
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 6  8  -0.415200000000D 04    12       60
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 6  8  -0.141600000000D 04    16       60
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 6  8   0.114000000000D 05     4       72
  2 3 1 4 4 2 2 5 5 6 6 1 1 2 3 1
 6  8   0.477600000000D 05     2       84
  2 3 6 1 1 2 3 1 1 4 4 2 2 5 5 6
 6  8   0.477600000000D 05     2       72
  1 4 2 5 5 6 6 1 1 2 2 3 3 1 4 2
 6  8  -0.153600000000D 04     8       84
  2 5 6 1 1 2 2 3 3 1 1 4 4 2 5 6
```

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 6  8   0.477600000000D 05     2      72
  2 3 1 4 4 5 5 2 2 6 6 1 1 2 3 1
 6  8   0.114000000000D 05     2      84
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 6  8  -0.153600000000D 04     4      96
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  1 2 3 4 4 1 1 5 5 3 3 6 6 1 2 3
 6  8   0.580800000000D 04     2      80
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 6  8   0.114000000000D 05     4      72
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 6  8   0.114000000000D 05     2      96
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 6  8   0.685080000000D 05     4      72
  1 2 3 5 5 6 6 1 2 1 1 3 3 4 4 3
 6  8   0.114000000000D 05     2      84
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 6  8  -0.309780000000D 05     2      60
  3 5 4 6 6 3 1 2 2 1 3 4 4 3 5 4
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   6  8   0.477600000000D 05     2      84
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   6  8   0.699240000000D 05     4      84
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   6  8   0.685080000000D 05     4      84
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   6  8  -0.104160000000D 05     8      84
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   6  8   0.114000000000D 05     2      84
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   6  8   0.203040000000D 05     4      80
    1 2 4 5 5 3 3 6 6 1 2 1 1 3 3 4
   6  8   0.203040000000D 05     4      80
    2 1 4 5 5 3 3 6 6 1 1 2 1 3 3 4
   6  8   0.699240000000D 05     4      80
    1 3 4 5 5 3 3 6 6 1 1 2 2 1 3 4
   6  8   0.157860000000D 05    16      80
    4 5 3 6 6 1 1 2 2 1 1 3 3 4 5 3
   6  8   0.196200000000D 05    12      80
    4 5 6 1 1 2 2 1 1 3 3 4 5 3 3 6
   6  8   0.477600000000D 05     2      96
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   6  8   0.685080000000D 05     4      48
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   6  8   0.699240000000D 05     4      48
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   6  8  -0.104160000000D 05     8      48
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```

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6  8   0.762660000000D 05      4      60
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6  8  -0.309780000000D 05      8      60
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6  8  -0.175800000000D 05     16      60
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6  8  -0.309780000000D 05      4      60
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6  8   0.157860000000D 05     16      80
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6  8   0.157860000000D 05     16      80
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6  8  -0.175800000000D 05      8      80
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6  8   0.685080000000D 05      4      84
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6  8   0.685080000000D 05      4      84
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6  8   0.685080000000D 05      4      84
 1 3 5 6 6 3 3 1 1 2 2 1 3 4 4 5
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  1 2 3 4 4 3 3 5 5 3 3 6 6 3 2 1
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 6  8  -0.153600000000D 04     4     96
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7 8 -0.162216000000D 06   8   240
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7 8 -0.576960000000D 05   8   240
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7 8 -0.663120000000D 05   8   240
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7 8 -0.485532000000D 06   8   240
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7 8 -0.663120000000D 05   8   240
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7 8 -0.400944000000D 06   8   240
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7 8 -0.367872000000D 06   8   240
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7 8 -0.367872000000D 06   4   240
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7 8 -0.367872000000D 06   4   240
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 3 5 6 7 7 3 1 2 2 1 3 4 4 3 5 6
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 8  8  -0.623757600000D 07    4     720
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  1 2 5 6 6 7 7 8 8 1 2 3 3 4 4 5
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 8  8   0.118477800000D 07    8     720
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 4  9   0.220000000000D 03     12        2
  1 3 2 4 4 1 1 2 2 1 1 2 2 1 3 1 1 2
 4  9   0.220000000000D 03     12        6
  3 1 2 4 4 1 1 2 2 1 1 2 2 1 1 3 1 2
 4  9   0.220000000000D 03     12        8
  1 2 3 4 4 1 2 1 1 2 2 1 1 3 3 1 1 3
 4  9   0.220000000000D 03     12       12
  2 1 3 4 4 1 1 2 1 2 2 1 1 3 3 1 1 3
 4  9   0.220000000000D 03     12        8
  1 4 2 3 3 1 1 2 2 1 1 3 3 1 4 1 1 2
 4  9   0.240000000000D 03      4       18
  1 2 3 4 4 3 3 1 2 1 1 2 2 1 1 2 2 3
 4  9   0.240000000000D 03      4       12
  2 1 3 4 4 3 3 1 1 2 1 2 2 1 1 2 2 3
 4  9   0.240000000000D 03      4       40
  1 2 3 4 4 3 3 4 4 1 2 1 1 2 2 1 1 3
 4  9   0.240000000000D 03      4       20
  1 2 4 3 3 4 4 1 2 1 1 2 2 1 1 3 3 4
 4  9   0.240000000000D 03      4        8
  1 3 2 4 4 2 2 3 3 1 1 2 2 1 3 1 1 2
 4  9   0.240000000000D 03      4       12
  1 3 4 2 2 3 3 1 1 2 2 1 3 1 1 2 2 4
 4  9   0.240000000000D 03      4       24
  3 1 2 4 4 2 2 3 3 1 1 2 2 1 1 3 1 2
 4  9   0.240000000000D 03      4       16
  3 1 4 2 2 3 3 1 1 2 2 1 1 3 1 2 2 4
 4  9   0.240000000000D 03      4       24
  1 2 3 4 4 1 2 1 1 2 2 1 1 3 3 2 2 3
 4  9   0.240000000000D 03      4       20
  2 1 3 4 4 1 1 2 1 2 2 1 1 3 3 2 2 3
 4  9   0.240000000000D 03      4       10
  3 2 4 1 1 2 2 1 1 2 2 1 1 3 2 3 3 4
 4  9   0.240000000000D 03      4       18
  2 3 4 1 1 2 2 1 1 2 2 1 1 3 3 2 3 4
 4  9   0.240000000000D 03      4       16
  1 3 2 4 4 1 1 2 2 1 3 1 1 2 2 3 3 2
 4  9   0.240000000000D 03      4       20
  3 1 2 4 4 1 1 2 2 1 1 3 1 2 2 3 3 2
 4  9   0.360000000000D 02      8       52
  1 2 4 3 3 4 4 1 2 1 1 3 3 1 1 2 2 4
```

```
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4  9   0.360000000000D 02      8       20
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4  9   0.360000000000D 02      8       28
 2 1 3 4 4 1 1 2 1 3 3 1 1 2 2 4 4 3
4  9   0.240000000000D 03      4       20
 1 3 2 4 4 3 3 4 4 1 1 2 2 1 3 1 1 2
4  9   0.240000000000D 03      4       40
 3 1 2 4 4 3 3 4 4 1 1 2 2 1 1 3 1 2
4  9   0.240000000000D 03      4       12
 1 2 3 4 4 1 2 1 1 2 2 3 3 1 1 2 2 3
4  9   0.240000000000D 03      4        4
 2 1 3 4 4 1 1 2 1 2 2 3 3 1 1 2 2 3
4  9   0.240000000000D 03      4       12
 2 3 4 1 1 2 2 1 1 2 3 1 1 2 2 3 3 4
4  9   0.240000000000D 03      4        8
 2 3 1 4 4 2 2 3 3 1 1 2 2 1 1 2 3 1
4  9   0.360000000000D 02      8       28
 1 2 3 4 4 1 1 2 2 3 3 4 4 1 2 1 1 3
4  9   0.360000000000D 02      8       12
 2 1 3 4 4 1 1 2 2 3 3 4 4 1 1 2 1 3
4  9   0.240000000000D 03      4       20
 4 1 2 3 3 4 4 1 1 2 2 1 1 3 3 4 1 2
4  9   0.240000000000D 03      4        4
 2 3 4 1 1 2 3 1 1 2 2 3 3 1 1 2 2 4
4  9   0.360000000000D 02      8       40
 1 2 3 4 4 1 2 1 1 3 3 1 1 4 4 2 2 3
4  9   0.360000000000D 02      8       12
 1 2 3 4 4 1 1 3 3 2 2 4 4 1 2 1 1 3
4  9   0.360000000000D 02      8       20
 1 3 2 4 4 1 1 2 2 1 3 4 4 1 1 3 3 2
5  9   0.249600000000D 04      4       36
 2 1 4 3 3 5 5 1 1 2 1 3 3 1 1 2 2 4
5  9   0.124800000000D 04      4       48
 2 1 3 5 5 1 1 2 1 3 3 1 1 2 2 4 4 3
5  9   0.232800000000D 04      4       32
 1 3 2 4 4 3 3 5 5 1 1 2 2 1 3 1 1 2
5  9   0.232800000000D 04      4       56
 3 1 2 4 4 3 3 5 5 1 1 2 2 1 1 3 1 2
5  9   0.678000000000D 04      4       36
 2 4 3 5 5 1 1 2 2 1 1 3 3 1 1 2 4 3
5  9   0.678000000000D 04      4       64
 2 4 5 1 1 2 2 1 1 3 3 1 1 2 4 3 3 5
5  9   0.735000000000D 04      4       28
 4 3 5 1 1 2 2 1 1 3 3 1 1 2 2 4 3 5
5  9   0.108000000000D 04      8       96
 1 2 4 5 5 1 2 1 1 3 3 1 1 4 4 2 2 4
5  9   0.108000000000D 04      8       64
 2 1 4 5 5 1 1 2 1 3 3 1 1 4 4 2 2 4
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5  9   0.384000000000D 03      4      62
 1 3 2 4 4 3 3 5 5 4 4 1 1 2 2 1 3 2
5  9   0.696000000000D 03      4      80
 1 3 5 4 4 1 1 2 2 1 3 2 2 4 4 3 3 5
5  9   0.696000000000D 03      4      72
 3 2 5 4 4 1 1 2 2 1 1 3 2 4 4 3 3 5
5  9   0.480000000000D 02      4      74
 1 2 3 4 4 2 2 3 3 5 5 4 4 1 2 1 1 3
5  9   0.720000000000D 02     12      82
 1 2 3 5 5 4 4 1 2 1 1 3 3 4 4 2 2 3
5  9   0.384000000000D 03      2     108
 1 3 4 2 2 3 3 5 5 4 4 1 1 2 2 1 3 4
5  9   0.696000000000D 03      4      74
 1 3 5 4 4 1 1 2 2 1 3 4 4 2 2 3 3 5
5  9   0.480000000000D 02      4      82
 1 2 4 3 3 5 5 4 4 1 2 3 3 1 1 2 2 4
5  9   0.720000000000D 02     12      86
 1 2 3 5 5 4 4 1 2 3 3 1 1 2 2 4 4 3
5  9   0.696000000000D 03      4      46
 2 3 5 4 4 1 1 2 3 1 1 2 2 4 4 3 3 5
5  9   0.384000000000D 03      2      50
 2 3 4 1 1 2 3 1 1 2 2 4 4 3 3 5 5 4
5  9   0.384000000000D 03      2      46
 3 1 2 4 4 3 3 5 5 4 4 1 1 2 2 3 1 2
5  9   0.696000000000D 03      4      40
 3 1 5 4 4 1 1 2 2 3 1 2 2 4 4 3 3 5
5  9   0.648000000000D 03      4      64
 1 2 3 5 5 1 2 1 1 3 3 1 1 4 4 2 2 3
5  9   0.648000000000D 03      4      80
 2 1 3 5 5 1 1 2 1 3 3 1 1 4 4 2 2 3
5  9   0.249600000000D 04      4      68
 1 4 2 3 3 5 5 1 1 2 2 1 1 3 3 1 4 2
5  9   0.232800000000D 04      4      52
 1 4 3 5 5 1 1 2 2 1 1 3 3 1 4 2 2 3
5  9   0.108000000000D 04      4      76
 4 2 3 5 5 1 1 2 2 1 1 3 3 1 1 4 2 3
5  9   0.232800000000D 04      4      24
 2 3 1 4 4 2 2 5 5 1 1 2 2 1 1 2 3 1
5  9   0.232800000000D 04      2      44
 2 3 5 1 1 2 2 1 1 2 3 1 1 4 4 2 2 5
5  9   0.648000000000D 03      4      80
 1 2 4 3 3 5 5 1 2 1 1 2 2 3 3 1 1 4
5  9   0.648000000000D 03      4      80
 1 2 3 5 5 1 2 1 1 2 2 3 3 1 1 4 4 3
5  9   0.648000000000D 03      4      44
 2 1 4 3 3 5 5 1 1 2 1 2 2 3 3 1 1 4
5  9   0.648000000000D 03      4      40
 2 1 3 5 5 1 1 2 1 2 2 3 3 1 1 4 4 3
5  9   0.232800000000D 04      4      32
 2 3 1 4 4 3 3 5 5 1 1 2 2 1 1 2 3 1
```

```
5  9   0.249600000000D 04      4      58
 2 1 3 4 4 5 5 4 4 3 3 1 1 2 1 2 2 3
5  9   0.249600000000D 04      4      52
 2 1 4 5 5 4 4 3 3 1 1 2 1 2 2 3 3 4
5  9   0.735000000000D 04      4      70
 2 3 4 5 5 4 4 3 3 1 1 2 2 1 1 2 3 4
5  9   0.735000000000D 04      4      42
 2 3 5 4 4 3 3 1 1 2 2 1 1 2 3 4 4 5
5  9   0.735000000000D 04      4      14
 1 3 2 4 4 5 5 1 1 2 2 1 1 2 2 1 3 2
5  9  -0.264000000000D 03     12      42
 2 4 5 1 1 2 2 1 1 2 2 1 1 3 3 2 4 5
5  9   0.249600000000D 04      4      84
 1 2 3 4 4 5 5 1 2 1 1 3 3 1 1 2 2 3
5  9   0.249600000000D 04      4      56
 2 1 3 4 4 5 5 1 1 2 1 3 3 1 1 2 2 3
5  9   0.735000000000D 04      4      56
 2 3 5 1 1 2 2 1 1 3 3 1 1 2 3 4 4 5
5  9  -0.264000000000D 03     24      56
 3 4 5 1 1 2 2 1 1 3 3 1 1 2 2 3 4 5
5  9   0.249600000000D 04      4     100
 1 2 4 3 3 5 5 1 2 1 1 3 3 1 1 2 2 4
5  9   0.124800000000D 04      4      68
 1 2 3 5 5 1 2 1 1 3 3 1 1 2 2 4 4 3
5  9   0.168000000000D 03     10      42
 2 3 4 1 1 2 2 3 3 4 4 5 5 1 1 2 3 4
5  9   0.124800000000D 04      4      34
 2 3 4 5 5 1 1 2 3 4 4 1 1 2 2 3 3 4
5  9   0.232800000000D 04      2      16
 2 3 4 1 1 2 2 5 5 1 1 2 3 1 1 2 2 4
5  9   0.648000000000D 03      4      40
 1 2 5 3 3 1 2 3 3 1 1 2 2 4 4 1 1 5
5  9   0.249600000000D 04      4      20
 2 3 4 1 1 5 5 3 3 1 1 2 3 1 1 2 2 4
5  9   0.232800000000D 04      4      16
 2 4 1 5 5 3 3 1 1 2 2 3 3 1 1 2 4 1
5  9   0.108000000000D 04      4      24
 2 4 5 3 3 1 1 2 2 3 3 1 1 2 4 1 1 5
5  9  -0.264000000000D 03     12     140
 1 2 3 4 4 3 3 4 4 5 5 3 2 1 1 2 2 1
5  9  -0.264000000000D 03     12      70
 1 2 4 3 3 4 4 5 5 3 2 1 1 2 2 1 3 4
5  9  -0.222000000000D 04      8      70
 1 2 4 5 5 3 2 1 1 2 2 1 3 4 4 3 3 4
5  9   0.480000000000D 02      8      86
 1 2 4 3 3 5 5 4 4 1 2 1 1 3 3 2 2 4
5  9   0.720000000000D 02     12      86
 1 2 3 5 5 4 4 1 2 1 1 3 3 2 2 4 4 3
5  9   0.720000000000D 02     12      82
 1 2 5 4 4 1 2 1 1 3 3 2 2 4 4 3 3 5
```

```
5   9    0.232800000000D 04      4       32
 1  3  4  5  5  4  4  1  1  2  2  1  3  1  1  2  2  4
5   9    0.232800000000D 04      4       44
 1  3  5  4  4  1  1  2  2  1  3  1  1  2  2  4  4  5
5   9    0.678000000000D 04      4       52
 3  1  2  4  4  5  5  4  4  1  1  2  2  1  1  3  1  2
5   9    0.232800000000D 04      4       48
 3  1  4  5  5  4  4  1  1  2  2  1  1  3  1  2  2  4
5   9    0.232800000000D 04      4       32
 3  1  5  4  4  1  1  2  2  1  1  3  1  2  2  4  4  5
5   9    0.108000000000D 04      8       96
 1  2  4  5  5  4  4  5  5  1  2  1  1  3  3  1  1  4
5   9    0.108000000000D 04      8       48
 1  2  5  4  4  5  5  1  2  1  1  3  3  1  1  4  4  5
5   9    0.249600000000D 04      4       68
 1  2  4  5  5  4  4  1  2  1  1  2  2  3  3  1  1  4
5   9    0.249600000000D 04      4      100
 1  2  5  4  4  1  2  1  1  2  2  3  3  1  1  4  4  5
5   9    0.249600000000D 04      4       48
 2  1  4  5  5  4  4  1  1  2  1  2  2  3  3  1  1  4
5   9    0.249600000000D 04      4       36
 2  1  5  4  4  1  1  2  1  2  2  3  3  1  1  4  4  5
5   9    0.678000000000D 04      4       32
 2  3  1  4  4  5  5  4  4  1  1  2  2  1  1  2  3  1
5   9    0.678000000000D 04      4       36
 2  3  4  5  5  4  4  1  1  2  2  1  1  2  3  1  1  4
5   9    0.678000000000D 04      4       44
 2  3  5  4  4  1  1  2  2  1  1  2  3  1  1  4  4  5
5   9    0.678000000000D 04      4       56
 2  3  4  1  1  2  2  1  1  2  3  1  1  4  4  5  5  4
5   9    0.735000000000D 04      4       56
 3  1  4  5  5  4  4  1  1  2  2  1  1  2  2  3  1  4
5   9    0.735000000000D 04      4       28
 3  1  5  4  4  1  1  2  2  1  1  2  2  3  1  4  4  5
5   9    0.168000000000D 03     10      140
 1  2  3  4  4  3  3  4  4  5  5  1  2  1  1  2  2  3
5   9    0.168000000000D 03     20       70
 1  2  4  3  3  4  4  5  5  1  2  1  1  2  2  3  3  4
5   9    0.735000000000D 04      4       70
 1  2  4  5  5  1  2  1  1  2  2  3  3  4  4  3  3  4
5   9    0.168000000000D 03     10       42
 2  1  4  3  3  4  4  5  5  1  1  2  1  2  2  3  3  4
5   9    0.735000000000D 04      4       28
 2  1  4  5  5  1  1  2  1  2  2  3  3  4  4  3  3  4
5   9   -0.222000000000D 04      8       70
 2  3  4  5  5  1  1  2  2  1  1  2  3  4  4  3  3  4
5   9    0.249600000000D 04      4      114
 1  2  3  4  4  5  5  4  4  3  3  1  2  1  1  2  2  3
5   9    0.249600000000D 04      4      106
 1  2  4  5  5  4  4  3  3  1  2  1  1  2  2  3  3  4
```

```
 5   9    0.232800000000D 04      4      48
  3 1 4 5 5 3 3 1 1 2 2 1 1 2 2 3 1 4
 5   9    0.108000000000D 04      8      76
  1 2 3 4 4 1 1 5 5 2 2 5 5 1 2 1 1 3
 5   9    0.103000000000D 04      4      76
  3 4 5 2 2 5 5 1 1 2 2 1 1 3 4 1 1 5
 5   9    0.108000000000D 04      8      24
  1 2 4 5 5 1 2 3 3 1 1 2 2 3 3 1 1 4
 5   9    0.103000000000D 04      4      24
  2 3 4 5 5 1 1 2 3 1 1 2 2 3 3 1 1 4
 5   9   -0.264000000000D 03     12      84
  1 2 3 4 4 3 3 4 4 3 3 4 4 5 5 3 2 1
 5   9   -0.264000000000D 03     12      28
  1 2 4 3 3 4 4 3 3 4 4 5 5 3 2 1 3 4
 5   9   -0.222000000000D 04      8      14
  1 2 4 5 5 3 2 1 3 4 4 3 3 4 4 3 3 4
 5   9   -0.264000000000D 03     24      56
  1 2 3 4 4 3 3 5 5 3 3 4 4 5 5 3 2 1
 5   9   -0.264000000000D 03     24      28
  1 2 4 3 3 5 5 3 3 4 4 5 5 3 2 1 3 4
 5   9   -0.222000000000D 04      4      28
  1 2 4 5 5 3 2 1 3 4 4 3 3 5 5 3 3 4
 5   9   -0.222000000000D 04      4      84
  1 2 4 5 5 4 4 5 5 4 4 5 5 4 2 3 3 1
 5   9    0.678000000000D 04      4      24
  1 3 2 5 5 1 1 2 2 1 3 1 1 2 2 4 4 2
 5   9    0.232800000000D 04      2      44
  3 1 2 4 4 2 2 5 5 1 1 2 2 1 1 3 1 2
 5   9    0.678000000000D 04      4      44
  3 1 2 5 5 1 1 2 2 1 1 3 1 2 2 4 4 2
 5   9    0.735000000000D 04      4      14
  1 3 2 4 4 5 5 2 2 1 1 2 2 1 3 1 1 2
 5   9    0.735000000000D 04      4      42
  1 3 5 2 2 1 1 2 2 1 3 1 1 2 2 4 4 5
 5   9    0.735000000000D 04      4      84
  1 2 5 3 3 1 2 1 1 3 3 1 1 2 2 4 4 5
 5   9    0.735000000000D 04      4      28
  2 1 5 3 3 1 1 2 1 3 3 1 1 2 2 4 4 5
 5   9   -0.222000000000D 04      4      28
  2 4 5 3 3 1 1 2 2 1 1 3 3 1 1 2 4 5
 5   9    0.232800000000D 04      4      80
  1 2 4 5 5 4 4 1 2 1 1 3 3 1 1 2 2 4
 5   9    0.232800000000D 04      4      80
  1 2 5 4 4 1 2 1 1 3 3 1 1 2 2 4 4 5
 5   9    0.232800000000D 04      4      40
  2 1 4 5 5 4 4 1 1 2 1 3 3 1 1 2 2 4
 5   9    0.232800000000D 04      4      44
  2 1 5 4 4 1 1 2 1 3 3 1 1 2 2 4 4 5
 5   9    0.678000000000D 04      4      32
  1 3 2 4 4 5 5 4 4 1 1 2 2 1 3 1 1 2
```

```
5  9   0.495000000000D 03    48      40
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5  9   0.495000000000D 03    48      20
 1 3 4 5 5 1 1 2 2 1 1 2 2 1 3 1 1 4
5  9   0.735000000000D 04     4      42
 1 2 3 4 4 5 5 1 2 1 1 2 2 1 1 2 2 3
5  9   0.735000000000D 04     4      28
 2 1 3 4 4 5 5 1 1 2 1 2 2 1 1 2 2 3
5  9  -0.222000000000D 04     8      14
 2 3 4 5 5 1 1 2 2 1 1 2 2 1 1 2 3 4
5  9   0.673000000000D 04     4      64
 1 2 4 5 5 3 3 1 2 1 1 2 2 1 1 3 3 4
5  9   0.678000000000D 04     4      32
 1 3 4 5 5 3 3 1 1 2 2 1 1 2 2 1 3 4
5  9   0.678000000000D 04     4      44
 1 2 4 5 5 2 2 1 2 1 1 3 3 1 1 2 2 4
5  9   0.678000000000D 04     4      22
 1 3 4 5 5 2 2 1 1 2 2 1 3 1 1 2 2 4
5  9   0.735000000000D 04     4      56
 1 2 4 5 5 3 3 1 2 1 1 3 3 1 1 2 2 4
5  9   0.735000000000D 04     4      28
 2 1 4 5 5 3 3 1 1 2 1 3 3 1 1 2 2 4
5  9   0.232800000000D 04     2      44
 1 2 4 5 5 1 2 1 1 2 2 1 1 3 3 2 2 4
5  9   0.232800000000D 04     2      44
 2 1 4 5 5 1 1 2 1 2 2 1 1 3 3 2 2 4
5  9   0.678000000000D 04     4      22
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5  9   0.232800000000D 04     4      88
 1 2 4 5 5 1 2 1 1 3 3 1 1 2 2 3 3 4
5  9   0.232800000000D 04     4      44
 2 1 4 5 5 1 1 2 1 3 3 1 1 2 2 3 3 4
5  9   0.232800000000D 04     4      44
 1 3 4 5 5 1 1 2 2 1 3 1 1 2 2 3 3 4
5  9   0.232800000000D 04     4      44
 3 1 4 5 5 1 1 2 2 1 1 3 1 2 2 3 3 4
5  9   0.678000000000D 04     4      44
 2 3 4 5 5 1 1 2 2 1 1 3 3 1 1 2 3 4
5  9   0.232800000000D 04     2      48
 1 2 4 5 5 1 2 1 1 2 2 3 3 1 1 2 2 4
5  9   0.232800000000D 04     2      16
 2 1 4 5 5 1 1 2 1 2 2 3 3 1 1 2 2 4
5  9   0.678000000000D 04     4      16
 2 3 4 5 5 1 1 2 2 1 1 2 3 1 1 2 2 4
5  9   0.232800000000D 04     4      48
 1 2 4 5 5 3 3 1 2 1 1 2 2 3 3 1 1 4
5  9   0.232800000000D 04     4      24
 2 1 4 5 5 3 3 1 1 2 1 2 2 3 3 1 1 4
5  9   0.678000000000D 04     4      24
 2 3 4 5 5 3 3 1 1 2 2 1 1 2 3 1 1 4
```

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5  9   0.735000000000D 04    4    28
 2 3 4 5 5 3 3 4 4 1 1 2 2 1 1 2 3 4
5  9  -0.264000000000D 03   12    70
 2 3 4 1 1 2 2 1 1 2 3 4 4 5 5 3 3 4
5  9   0.249600000000D 04    4   114
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5  9   0.696000000000D 03    4    80
 1 2 4 5 5 4 4 1 2 1 1 3 3 2 2 3 3 4
5  9   0.696000000000D 03    4    76
 1 2 5 4 4 1 2 1 1 3 3 2 2 3 3 4 4 5
5  9   0.249600000000D 04    4    76
 2 1 3 4 4 5 5 4 4 1 1 2 1 3 3 2 2 3
5  9   0.696000000000D 03    4    94
 2 1 4 5 5 4 4 1 1 2 1 3 3 2 2 3 3 4
5  9   0.696000000000D 03    4    74
 2 1 5 4 4 1 1 2 1 3 3 2 2 3 3 4 4 5
5  9   0.124800000000D 04    4    78
 1 3 4 5 5 4 4 1 1 2 2 1 3 2 2 3 3 4
5  9   0.384000000000D 03    4    62
 1 2 3 4 4 2 2 4 4 3 3 5 5 1 2 1 1 3
5  9   0.384000000000D 03    2   120
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5  9   0.124800000000D 04    4    78
 1 2 3 5 5 1 2 1 1 3 3 4 4 2 2 4 4 3
5  9   0.384000000000D 03    2   120
 2 1 3 4 4 2 2 4 4 3 3 5 5 1 1 2 1 3
5  9   0.124800000000D 04    4    64
 2 1 3 5 5 1 1 2 1 3 3 4 4 2 2 4 4 3
5  9   0.168000000000D 03   10   140
 1 3 4 2 2 4 4 3 3 5 5 1 1 2 2 1 3 4
5  9   0.168000000000D 03   10    42
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5  9   0.124800000000D 04    4    66
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5  9   0.124800000000D 04    4   112
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5  9   0.696000000000D 03    4    50
 1 2 4 5 5 3 3 4 4 5 5 1 2 1 1 3 3 4
5  9   0.124800000000D 04    4    26
 1 2 5 3 3 4 4 5 5 1 2 1 1 3 3 4 4 5
5  9   0.249600000000D 04    4    58
 1 3 4 5 5 3 3 4 4 5 5 1 1 2 2 1 3 4
5  9   0.249600000000D 04    4    28
 2 3 1 4 4 5 5 1 1 2 3 1 1 2 2 3 3 1
5  9   0.384000000000D 03    2    72
 1 2 3 4 4 1 1 2 2 3 3 4 4 5 5 1 2 3
5  9   0.124800000000D 04    4    26
 1 2 4 5 5 1 2 3 3 4 4 1 1 2 2 3 3 4
```

```
5  9    0.678000000000D 04      4      24
 3 4 2 5 5 4 4 1 1 2 2 1 1 3 4 1 1 2
5  9    0.232800000000D 04      4      64
 4 1 2 5 5 4 4 1 1 2 2 1 1 3 3 4 1 2
5  9    0.249600000000D 04      4      84
 1 3 5 2 2 5 5 1 1 2 2 1 3 4 4 1 1 5
5  9    0.648000000000D 03      4      40
 1 2 3 4 4 1 1 3 3 4 4 5 5 1 2 1 1 3
5  9    0.108000000000D 04      8      16
 1 2 4 5 5 1 2 1 1 3 3 4 4 1 1 3 3 4
5  9    0.648000000000D 03      4      44
 2 1 3 4 4 1 1 3 3 4 4 5 5 1 1 2 1 3
5  9    0.108000000000D 04      8      24
 2 1 4 5 5 1 1 2 1 3 3 4 4 1 1 3 3 4
5  9    0.108000000000D 04      8      48
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 3 4 5 1 1 2 2 1 1 3 4 1 1 3 3 4 4 5
5  9    0.124800000000D 04      4      20
 1 2 3 4 4 1 1 3 3 5 5 4 4 1 2 1 1 3
5  9    0.232800000000D 04      4      16
 1 2 3 5 5 4 4 1 2 1 1 3 3 4 4 1 1 3
5  9    0.232800000000D 04      4      24
 1 2 5 4 4 1 2 1 1 3 3 4 4 1 1 3 3 5
5  9    0.232800000000D 04      4      40
 1 3 5 4 4 1 1 2 2 1 3 4 4 1 1 3 3 5
5  9    0.384000000000D 03      2     120
 1 2 3 4 4 3 3 5 5 4 4 1 2 1 1 2 2 3
5  9    0.384000000000D 03      2     108
 1 2 4 3 3 5 5 4 4 1 2 1 1 2 2 3 3 4
5  9    0.124800000000D 04      4     112
 1 2 3 5 5 4 4 1 2 1 1 2 2 3 3 4 4 3
5  9    0.384000000000D 03      2      46
 2 1 3 4 4 3 3 5 5 4 4 1 1 2 1 2 2 3
5  9    0.384000000000D 03      2      72
 2 1 4 3 3 5 5 4 4 1 1 2 1 2 2 3 3 4
5  9    0.124800000000D 04      4      54
 2 1 3 5 5 4 4 1 1 2 1 2 2 3 3 4 4 3
5  9    0.735000000000D 04      4      42
 2 3 5 4 4 1 1 2 2 1 1 2 3 4 4 3 3 5
5  9   -0.264000000000D 03     12     140
 2 3 4 1 1 2 2 1 1 2 3 4 4 3 3 5 5 4
5  9    0.384000000000D 03      2     120
 1 2 3 4 4 5 5 3 3 4 4 1 2 1 1 2 2 3
5  9    0.124800000000D 04      4      58
 1 2 4 5 5 3 3 4 4 1 2 1 1 2 2 3 3 4
5  9    0.384000000000D 03      2      50
 2 1 3 4 4 5 5 3 3 4 4 1 1 2 1 2 2 3
5  9    0.124800000000D 04      4      34
 2 1 4 5 5 3 3 4 4 1 1 2 1 2 2 3 3 4
```

```
5  9    0.648000000000D 03      4       80
 1 3 4 2 2 4 4 5 5 1 1 2 2 1 3 1 1 4
5  9    0.648000000000D 03      4       64
 1 3 2 4 4 5 5 1 1 2 2 1 3 1 1 4 4 2
5  9    0.108000000000D 04      8       56
 1 3 4 5 5 1 1 2 2 1 3 1 1 4 4 2 2 4
5  9    0.648000000000D 03      4       64
 3 1 4 2 2 4 4 5 5 1 1 2 2 1 1 3 1 4
5  9    0.648000000000D 03      4       80
 3 1 2 4 4 5 5 1 1 2 2 1 1 3 1 4 4 2
5  9    0.108000000000D 04      8       76
 3 1 4 5 5 1 1 2 2 1 1 3 1 4 4 2 2 4
5  9    0.232800000000D 04      4       64
 4 2 5 1 1 2 2 1 1 3 3 1 1 4 2 4 4 5
5  9    0.232800000000D 04      4       80
 2 4 5 1 1 2 2 1 1 3 3 1 1 4 4 2 4 5
5  9    0.232800000000D 04      4       80
 1 2 5 4 4 1 2 1 1 3 3 1 1 4 4 2 2 5
5  9    0.232800000000D 04      4       64
 2 1 5 4 4 1 1 2 1 3 3 1 1 4 4 2 2 5
5  9    0.124800000000D 04      4       68
 1 3 4 2 2 5 5 4 4 1 1 2 2 1 3 1 1 4
5  9    0.232800000000D 04      4       52
 1 3 2 5 5 4 4 1 1 2 2 1 3 1 1 4 4 2
5  9    0.232800000000D 04      4       88
 1 3 5 4 4 1 1 2 2 1 3 1 1 4 4 2 2 5
5  9    0.735000000000D 04      4       28
 2 3 5 1 1 2 2 1 1 2 3 1 1 2 2 4 4 5
5  9   -0.264000000000D 03     12       28
 2 4 5 1 1 2 2 1 1 2 2 3 3 1 1 2 4 5
5  9    0.249600000000D 04      4       56
 1 2 5 3 3 1 2 1 1 2 2 3 3 1 1 4 4 5
5  9    0.249600000000D 04      4       28
 2 1 5 3 3 1 1 2 1 2 2 3 3 1 1 4 4 5
5  9    0.735000000000D 04      4       28
 2 3 1 4 4 5 5 3 3 1 1 2 2 1 1 2 3 1
5  9   -0.264000000000D 03     24       28
 1 4 5 3 3 1 1 2 2 1 1 2 2 3 3 1 4 5
5  9    0.124800000000D 04      4       48
 1 2 3 4 4 1 1 2 2 5 5 4 4 1 2 1 1 3
5  9    0.249600000000D 04      4       48
 1 2 5 4 4 1 2 1 1 3 3 4 4 1 1 2 2 5
5  9    0.124800000000D 04      4       20
 2 1 3 4 4 1 1 2 2 5 5 4 4 1 1 2 1 3
5  9    0.249600000000D 04      4       20
 2 1 5 4 4 1 1 2 1 3 3 4 4 1 1 2 2 5
5  9    0.678000000000D 04      4       16
 1 3 2 5 5 4 4 1 1 2 2 1 3 4 4 1 1 2
5  9    0.735000000000D 04      4       28
 1 3 5 4 4 1 1 2 2 1 3 4 4 1 1 2 2 5
```

```
5 9   0.2328000000000D 04     4     52
 2 3 5 1 1 2 2 1 1 2 3 1 1 4 4 3 3 5
5 9   0.2328000000000D 04     4     32
 1 4 3 5 5 1 1 2 2 1 1 2 2 3 3 1 4 3
5 9   0.2328000000000D 04     4     32
 4 3 5 1 1 2 2 1 1 2 2 3 3 1 1 4 3 5
5 9   0.6480000000000D 03     4     80
 1 2 3 4 4 1 1 2 2 3 3 5 5 1 2 1 1 3
5 9   0.6480000000000D 03     4     40
 2 1 3 4 4 1 1 2 2 3 3 5 5 1 1 2 1 3
5 9   0.2328000000000D 04     4     44
 3 4 5 1 1 2 2 1 1 3 4 1 1 2 2 3 3 5
5 9   0.2328000000000D 04     4     56
 4 1 2 3 3 5 5 1 1 2 2 1 1 3 3 4 1 2
5 9   0.6480000000000D 03     4     40
 1 2 3 4 4 1 1 3 3 2 2 5 5 1 2 1 1 3
5 9   0.6480000000000D 03     4     40
 2 1 3 4 4 1 1 3 3 2 2 5 5 1 1 2 1 3
5 9   0.6480000000000D 03     4     64
 1 3 2 5 5 1 1 2 2 1 3 4 4 1 1 3 3 2
5 9   0.1080000000000D 04     8     32
 3 4 2 5 5 1 1 2 2 1 1 3 4 1 1 3 3 2
5 9   0.2328000000000D 04     4     44
 3 4 5 1 1 2 2 1 1 3 4 1 1 3 3 2 2 5
5 9   0.2496000000000D 04     4     36
 4 1 3 2 2 5 5 1 1 2 2 1 1 3 3 4 1 3
5 9   0.2328000000000D 04     4     48
 4 1 2 5 5 1 1 2 2 1 1 3 3 4 1 3 3 2
5 9   0.2496000000000D 04     4     36
 3 2 5 1 1 2 2 1 1 3 3 4 4 1 1 3 2 5
5 9   0.4800000000000D 02     8     94
 1 2 4 3 3 4 4 5 5 1 2 1 1 3 3 2 2 4
5 9   0.4800000000000D 02     4     82
 1 2 3 4 4 5 5 1 2 1 1 3 3 2 2 4 4 3
5 9   0.6960000000000D 03     4     76
 1 2 4 5 5 1 2 1 1 3 3 2 2 4 4 3 3 4
5 9   0.4800000000000D 02     4     74
 2 1 4 3 3 4 4 5 5 1 1 2 1 3 3 2 2 4
5 9   0.6960000000000D 03     4     72
 2 1 4 5 5 1 1 2 1 3 3 2 2 4 4 3 3 4
5 9   0.1680000000000D 03    10     42
 1 3 2 4 4 3 3 4 4 5 5 1 1 2 2 1 3 2
5 9   0.2496000000000D 04     4    106
 1 3 4 5 5 1 1 2 2 1 3 2 2 4 4 3 3 4
5 9   0.1248000000000D 04     4     66
 3 2 4 5 5 1 1 2 2 1 1 3 2 4 4 3 3 4
5 9   0.4800000000000D 02     8     86
 1 2 3 4 4 2 2 3 3 4 4 5 5 1 2 1 1 3
5 9   0.6960000000000D 03     4     50
 1 2 4 5 5 1 2 1 1 3 3 4 4 2 2 3 3 4
```

```
 5  9   0.480000000000D 02    8     94
  2 1 3 4 4 2 2 3 3 4 4 5 5 1 1 2 1 3
 5  9   0.696000000000D 03    4     40
  2 1 4 5 5 1 1 2 1 3 3 4 4 2 2 3 3 4
 5  9   0.168000000000D 03   20     70
  1 3 4 2 2 3 3 4 4 5 5 1 1 2 2 1 3 4
 5  9   0.249600000000D 04    4     52
  1 3 4 5 5 1 1 2 2 1 3 4 4 2 2 3 3 4
 5  9   0.696000000000D 03    4     94
  3 4 5 1 1 2 2 1 1 3 4 2 2 3 3 4 4 5
 5  9   0.249600000000D 04    4     36
  4 2 5 1 1 2 2 1 1 3 3 4 2 3 3 4 4 5
 5  9   0.124800000000D 04    4     54
  2 3 4 5 5 1 1 2 2 1 1 3 3 4 4 2 3 4
 5  9   0.124800000000D 04    4     58
  2 3 5 1 1 2 2 1 1 3 3 4 4 2 3 4 4 5
 5  9   0.495000000000D 03   48     24
  1 3 2 5 5 1 1 2 2 1 3 1 1 4 4 1 1 2
 5  9   0.495000000000D 03   48     40
  3 1 2 5 5 1 1 2 2 1 1 3 1 4 4 1 1 2
 5  9  -0.222000000000D 04    4     42
  2 3 5 1 1 2 2 1 1 2 2 1 1 2 3 4 4 5
 5  9   0.232800000000D 04    4     52
  1 2 3 4 4 3 3 5 5 1 2 1 1 2 2 1 1 3
 5  9   0.232800000000D 04    4     64
  1 2 4 3 3 5 5 1 2 1 1 2 2 1 1 3 3 4
 5  9   0.678000000000D 04    4     52
  1 2 3 5 5 1 2 1 1 2 2 1 1 3 3 4 4 3
 5  9   0.232800000000D 04    4     56
  2 1 3 4 4 3 3 5 5 1 1 2 1 2 2 1 1 3
 5  9   0.232800000000D 04    4     56
  2 1 4 3 3 5 5 1 1 2 1 2 2 1 1 3 3 4
 5  9   0.678000000000D 04    4     56
  2 1 3 5 5 1 1 2 1 2 2 1 1 3 3 4 4 3
 5  9   0.678000000000D 04    4     32
  3 4 5 1 1 2 2 1 1 2 2 1 1 3 4 3 3 5
 5  9   0.678000000000D 04    4     20
  4 3 5 1 1 2 2 1 1 2 2 1 1 3 3 4 3 5
 5  9   0.735000000000D 04    4     56
  1 2 3 4 4 5 5 3 3 1 2 1 1 2 2 1 1 3
 5  9   0.735000000000D 04    4     84
  1 2 5 3 3 1 2 1 1 2 2 1 1 3 3 4 4 5
 5  9   0.232800000000D 04    4     24
  1 3 2 4 4 2 2 5 5 1 1 2 2 1 3 1 1 2
 5  9   0.232800000000D 04    2     48
  1 3 4 2 2 5 5 1 1 2 2 1 3 1 1 2 2 4
 6  9   0.580800000000D 04    8    204
  1 2 5 6 6 3 3 1 2 1 1 3 3 4 4 2 2 5
 6  9   0.580800000000D 04    8    204
  2 1 5 6 6 3 3 1 1 2 1 3 3 4 4 2 2 5
```

```
 6   9    0.699240000000D 05      4      204
  3  4  5  6  6  3  3  1  1  2  2  1  1  3  4  2  2  5
 6   9    0.729600000000D 04      6      206
  1  2  3  4  4  2  2  5  5  6  6  5  5  1  2  1  1  3
 6   9    0.729600000000D 04      6      206
  2  1  3  4  4  2  2  5  5  6  6  5  5  1  1  2  1  3
 6   9    0.685080000000D 05      4      206
  3  4  2  5  5  6  6  5  5  1  1  2  2  1  1  3  4  2
 6   9    0.729600000000D 04     12      206
  3  4  5  6  6  5  5  1  1  2  2  1  1  3  4  2  2  5
 6   9    0.216480000000D 05      4      112
  2  1  4  5  5  6  6  1  1  2  1  2  2  3  3  1  1  4
 6   9    0.216480000000D 05      4      112
  2  1  5  6  6  1  1  2  1  2  2  3  3  1  1  4  4  5
 6   9    0.196200000000D 05     12      112
  2  3  4  5  5  6  6  1  1  2  2  1  1  2  3  1  1  4
 6   9    0.196200000000D 05     12      112
  2  3  5  6  6  1  1  2  2  1  1  2  3  1  1  4  4  5
 6   9    0.685080000000D 05      4      112
  3  1  4  5  5  6  6  1  1  2  2  1  1  2  2  3  1  4
 6   9    0.685080000000D 05      4      112
  3  1  5  6  6  1  1  2  2  1  1  2  2  3  1  4  4  5
 6   9   -0.104160000000D 05      8      112
  1  4  5  6  6  1  1  2  2  1  1  2  2  3  3  1  4  5
 6   9   -0.104160000000D 05      8      112
  4  5  6  1  1  2  2  1  1  2  2  3  3  1  1  4  5  6
 6   9    0.529200000000D 04      8      224
  1  2  3  4  4  1  1  2  2  5  5  6  6  1  2  1  1  3
 6   9    0.216480000000D 05      4      224
  1  2  5  6  6  1  2  1  1  3  3  4  4  1  1  2  2  5
 6   9    0.529200000000D 04      8      112
  2  1  3  4  4  1  1  2  2  5  5  6  6  1  1  2  1  3
 6   9    0.216480000000D 05      4      112
  2  1  5  6  6  1  1  2  1  3  3  4  4  1  1  2  2  5
 6   9    0.685080000000D 05      4      112
  1  3  5  6  6  1  1  2  2  1  3  4  4  1  1  2  2  5
 6   9    0.196200000000D 05     12      112
  3  4  2  5  5  6  6  1  1  2  2  1  1  3  4  1  1  2
 6   9    0.196200000000D 05     12      112
  3  4  5  6  6  1  1  2  2  1  1  3  4  1  1  2  2  5
 6   9    0.699240000000D 05      4      112
  3  4  6  1  1  2  2  1  1  3  4  1  1  2  2  5  5  6
 6   9    0.685080000000D 05      4      112
  4  1  5  6  6  1  1  2  2  1  1  3  3  4  1  2  2  5
 6   9    0.203040000000D 05      4       96
  1  2  5  6  6  1  2  1  1  3  3  4  4  1  1  3  3  5
 6   9    0.203040000000D 05      4       96
  2  1  5  6  6  1  1  2  1  3  3  4  4  1  1  3  3  5
 6   9    0.203040000000D 05      4      192
  1  3  5  6  6  1  1  2  2  1  3  4  4  1  1  3  3  5
```

```
 6  9   0.196200000000D 05     12      96
  3 4 5 6 6 1 1 2 2 1 1 3 4 1 1 3 3 5
 6  9   0.157860000000D 05     16      96
  4 1 5 6 6 1 1 2 2 1 1 3 3 4 1 3 3 5
 6  9   0.529200000000D 04      8     280
  1 2 4 5 5 3 3 6 6 1 2 1 1 2 2 3 3 4
 6  9   0.529200000000D 04      8     140
  2 1 4 5 5 3 3 6 6 1 1 2 1 2 2 3 3 4
 6  9   0.699240000000D 05      4     140
  2 3 4 5 5 3 3 6 6 1 1 2 2 1 1 2 3 4
 6  9   0.699240000000D 05      4     140
  4 5 3 6 6 1 1 2 2 1 1 2 2 3 3 4 5 3
 6  9   0.196200000000D 05     12     140
  4 5 6 1 1 2 2 1 1 2 2 3 3 4 5 3 3 6
 6  9   0.216480000000D 05      4     308
  1 2 4 5 5 6 6 3 3 1 2 1 1 2 2 3 3 4
 6  9   0.216480000000D 05      4     154
  2 1 4 5 5 6 6 3 3 1 1 2 1 2 2 3 3 4
 6  9   0.685080000000D 05      4     154
  2 3 4 5 5 6 6 3 3 1 1 2 2 1 1 2 3 4
 6  9   0.685080000000D 05      4     154
  2 3 5 6 6 3 3 1 1 2 2 1 1 2 3 4 4 5
 6  9  -0.104160000000D 05      8     154
  3 4 5 6 6 3 3 1 1 2 2 1 1 2 2 3 4 5
 6  9   0.477600000000D 05      2     238
  1 2 4 5 5 6 6 1 2 1 1 3 3 2 2 3 3 4
 6  9   0.477600000000D 05      2     238
  1 2 5 6 6 1 2 1 1 3 3 2 2 3 3 4 4 5
 6  9   0.477600000000D 05      2     238
  2 1 4 5 5 6 6 1 1 2 1 3 3 2 2 3 3 4
 6  9   0.477600000000D 05      2     238
  2 1 5 6 6 1 1 2 1 3 3 2 2 3 3 4 4 5
 6  9   0.762660000000D 05      4     238
  1 3 4 5 5 6 6 1 1 2 2 1 3 2 2 3 3 4
 6  9  -0.104160000000D 05      8     238
  3 4 5 6 6 1 1 2 2 1 1 3 3 2 2 3 4 5
 6  9   0.302400000000D 04      4     228
  1 4 5 2 2 6 6 1 1 2 2 3 3 1 4 3 3 5
 6  9   0.121440000000D 05      2     206
  1 2 5 6 6 1 2 1 1 3 3 2 2 4 4 3 3 5
 6  9   0.121440000000D 05      2     206
  2 1 5 6 6 1 1 2 1 3 3 2 2 4 4 3 3 5
 6  9   0.477600000000D 05      2     206
  1 3 5 6 6 1 1 2 2 1 3 2 2 4 4 3 3 5
 6  9   0.114000000000D 05      4     206
  3 2 5 6 6 1 1 2 2 1 1 3 2 4 4 3 3 5
 6  9   0.203040000000D 05      4     206
  2 4 5 6 6 1 1 2 2 1 1 3 3 2 4 3 3 5
 6  9   0.729600000000D 04     12     206
  4 3 5 6 6 1 1 2 2 1 1 3 3 2 2 4 3 5
```

```
 6   9    0.302400000000D 04      4      206
  1  2  5  6  6  4  4  1  2  1  1  3  3  2  2  4  4  5
 6   9    0.302400000000D 04      4      206
  2  1  5  6  6  4  4  1  1  2  1  3  3  2  2  4  4  5
 6   9    0.203040000000D 05      4      206
  1  3  5  6  6  4  4  1  1  2  2  1  3  2  2  4  4  5
 6   9    0.117840000000D 05      8      206
  2  4  5  6  6  4  4  1  1  2  2  1  1  3  3  2  4  5
 6   9    0.121440000000D 05      2      212
  1  2  5  6  6  1  2  1  1  3  3  4  4  2  2  3  3  5
 6   9    0.121440000000D 05      2      212
  2  1  5  6  6  1  1  2  1  3  3  4  4  2  2  3  3  5
 6   9    0.477600000000D 05      2      212
  1  3  5  6  6  1  1  2  2  1  3  4  4  2  2  3  3  5
 6   9    0.729600000000D 04     12      212
  3  4  5  6  6  1  1  2  2  1  1  3  4  2  2  3  3  5
 6   9    0.203040000000D 05      4      212
  4  2  5  6  6  1  1  2  2  1  1  3  3  4  2  3  3  5
 6   9    0.114000000000D 05      4      212
  2  3  5  6  6  1  1  2  2  1  1  3  3  4  4  2  3  5
 6   9    0.259200000000D 04      4      192
  1  2  5  6  6  1  2  3  3  1  1  2  2  4  4  1  1  5
 6   9    0.238000000000D 04     24       96
  2  3  5  6  6  1  1  2  3  1  1  2  2  4  4  1  1  5
 6   9    0.203040000000D 05      4       96
  3  1  5  6  6  1  1  2  2  3  1  2  2  4  4  1  1  5
 6   9    0.121440000000D 05      2      228
  1  2  5  6  6  1  2  3  3  1  1  2  2  4  4  3  3  5
 6   9    0.114000000000D 05      4      114
  2  3  5  6  6  1  1  2  3  1  1  2  2  4  4  3  3  5
 6   9    0.477600000000D 05      2      114
  3  1  5  6  6  1  1  2  2  3  1  2  2  4  4  3  3  5
 6   9    0.203040000000D 05      4      114
  2  4  5  6  6  1  1  2  2  3  3  1  1  2  4  3  3  5
 6   9    0.729600000000D 04     12      114
  4  3  5  6  6  1  1  2  2  3  3  1  1  2  2  4  3  5
 6   9    0.203040000000D 05      4      176
  1  2  5  6  6  1  2  1  1  3  3  1  1  4  4  2  2  5
 6   9    0.203040000000D 05      4      176
  2  1  5  6  6  1  1  2  1  3  3  1  1  4  4  2  2  5
 6   9    0.203040000000D 05      4      176
  1  3  5  6  6  1  1  2  2  1  3  1  1  4  4  2  2  5
 6   9    0.203040000000D 05      4      176
  3  1  5  6  6  1  1  2  2  1  1  3  1  4  4  2  2  5
 6   9    0.157860000000D 05     16      176
  1  4  5  6  6  1  1  2  2  1  1  3  3  1  4  2  2  5
 6   9    0.196200000000D 05     12      176
  4  2  5  6  6  1  1  2  2  1  1  3  3  1  1  4  2  5
 6   9    0.216480000000D 05      4      224
  1  2  4  5  5  6  6  1  2  1  1  2  2  3  3  1  1  4
```

```
 6  9   0.216480000000D 05     4     224
  1 2 5 6 6 1 2 1 1 2 2 3 3 1 1 4 4 5
 6  9   0.729600000000D 04    12     114
  1 2 5 6 6 3 3 4 4 1 2 1 1 3 3 4 4 5
 6  9   0.685080000000D 05     4     114
  1 3 5 6 6 3 3 4 4 1 1 2 2 1 3 4 4 5
 6  9   0.729600000000D 04     6     228
  3 4 5 6 6 3 3 4 4 1 1 2 2 1 1 3 4 5
 6  9   0.477600000000D 05     2     140
  1 2 4 5 5 6 6 1 2 3 3 1 1 2 2 3 3 4
 6  9   0.477600000000D 05     2     140
  1 2 5 6 6 1 2 3 3 1 1 2 2 3 3 4 4 5
 6  9   0.762660000000D 05     4      70
  3 1 4 5 5 6 6 1 1 2 2 3 1 2 2 3 3 4
 6  9  -0.104160000000D 05     8      70
  3 4 5 6 6 1 1 2 2 3 3 1 1 2 2 3 4 5
 6  9   0.530800000000D 04     8     136
  1 2 5 6 6 1 2 3 3 4 4 1 1 2 2 3 3 5
 6  9   0.699240000000D 05     4      68
  3 4 5 6 6 1 1 2 2 3 4 1 1 2 2 3 3 5
 6  9   0.259200000000D 04     8     176
  1 2 3 4 4 1 1 5 5 2 2 6 6 1 2 1 1 3
 6  9   0.203040000000D 05     4     176
  3 4 1 5 5 2 2 6 6 1 1 2 2 1 1 3 4 1
 6  9   0.238000000000D 04    24     176
  3 4 5 2 2 6 6 1 1 2 2 1 1 3 4 1 1 5
 6  9   0.302400000000D 04     4     228
  1 2 5 6 6 4 4 1 2 3 3 1 1 2 2 4 4 5
 6  9   0.203040000000D 05     4     114
  2 3 5 6 6 4 4 1 1 2 3 1 1 2 2 4 4 5
 6  9   0.117840000000D 05     8     114
  2 4 5 6 6 4 4 1 1 2 2 3 3 1 1 2 4 5
 6  9   0.792000000000D 03   120     144
  1 2 5 6 6 1 2 1 1 3 3 1 1 4 4 1 1 5
 6  9   0.699240000000D 05     4     168
  1 2 3 4 4 5 5 6 6 1 2 1 1 2 2 1 1 3
 6  9  -0.104160000000D 05     8     168
  1 2 3 4 4 3 3 4 4 3 3 5 5 6 6 3 2 1
 6  9  -0.309780000000D 05     8      84
  1 2 3 5 5 6 6 3 2 1 3 4 4 3 3 4 4 3
 6  9  -0.966000000000D 04    12      84
  1 2 5 6 6 3 2 1 3 4 4 3 3 4 4 3 3 5
 6  9  -0.966000000000D 04    12     168
  3 4 5 6 6 3 1 2 2 1 4 3 3 4 4 3 3 5
 6  9  -0.104160000000D 05     8     224
  1 2 3 4 4 3 3 5 5 3 3 4 4 6 6 3 2 1
 6  9  -0.104160000000D 05     8     112
  1 2 4 3 3 5 5 3 3 4 4 6 6 3 2 1 3 4
 6  9  -0.104160000000D 05     8     112
  1 2 3 5 5 3 3 4 4 6 6 3 2 1 3 4 4 3
```

```
 6  9  -0.104160000000D 05     8     112
  1 2 5 3 3 4 4 6 6 3 2 1 3 4 4 3 3 5
 6  9  -0.966000000000D 04    24     112
  1 2 4 6 6 3 2 1 3 4 4 3 3 5 5 3 3 4
 6  9  -0.309780000000D 05     8     112
  1 2 6 3 2 1 3 4 4 3 3 5 5 3 3 4 4 6
 6  9  -0.104160000000D 05     4     308
  1 2 3 4 4 3 3 4 4 5 5 6 6 5 5 3 2 1
 6  9  -0.104160000000D 05     4     154
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 6  9  -0.309780000000D 05     8     154
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 6  9  -0.104160000000D 05     8     154
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 6  9  -0.175800000000D 05    16     168
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 6  9  -0.175800000000D 05    16      84
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 6  9  -0.966000000000D 04    12     280
  1 2 5 6 6 3 2 1 1 2 2 1 3 4 4 3 3 5
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 6  9  -0.153600000000D 04    16     238
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 6  9  -0.141600000000D 04    16     238
  1 2 3 5 5 4 4 5 5 6 6 3 2 1 3 4 4 3
 6  9  -0.104160000000D 05     8     238
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 6  9  -0.153600000000D 04    16     140
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 6  9  -0.141600000000D 04    16      70
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 6  9  -0.104160000000D 05     8      70
  1 2 5 6 6 3 2 1 3 4 4 5 5 3 3 4 4 5
 6  9  -0.415200000000D 04    12     252
  1 2 4 5 5 4 4 6 6 5 5 6 6 4 2 3 3 1
 6  9  -0.415200000000D 04    12      84
  1 2 4 5 5 6 6 4 4 5 5 6 6 4 2 3 3 1
 6  9   0.685080000000D 05     4     168
  1 2 4 5 5 6 6 1 2 1 1 2 2 1 1 3 3 4
 6  9   0.699240000000D 05     4     168
  1 2 5 6 6 1 2 1 1 2 2 1 1 3 3 4 4 5
 6  9  -0.309780000000D 05     8      84
  1 3 4 5 5 6 6 1 1 2 2 1 1 2 2 1 3 4
 6  9  -0.175800000000D 05    16      84
  1 3 5 6 6 1 1 2 2 1 1 2 2 1 3 4 4 5
 6  9  -0.966000000000D 04    12      84
  3 4 5 6 6 1 1 2 2 1 1 2 2 1 1 3 4 5
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 6   9    0.685080000000D 05      4      224
  1  2  4  5  5  6  6  1  2  1  1  3  3  1  1  2  2  4
 6   9    0.699240000000D 05      4      224
  1  2  5  6  6  1  2  1  1  3  3  1  1  2  2  4  4  5
 6   9    0.685080000000D 05      4      112
  2  1  4  5  5  6  6  1  1  2  1  3  3  1  1  2  2  4
 6   9    0.699240000000D 05      4      112
  2  1  5  6  6  1  1  2  1  3  3  1  1  2  2  4  4  5
 6   9    0.685080000000D 05      4      112
  1  3  4  5  5  6  6  1  1  2  2  1  3  1  1  2  2  4
 6   9    0.699240000000D 05      4      112
  1  3  5  6  6  1  1  2  2  1  3  1  1  2  2  4  4  5
 6   9    0.685080000000D 05      4      112
  3  1  4  5  5  6  6  1  1  2  2  1  1  3  1  2  2  4
 6   9    0.699240000000D 05      4      112
  3  1  5  6  6  1  1  2  2  1  1  3  1  2  2  4  4  5
 6   9   -0.966000000000D 04     24      112
  2  4  5  6  6  1  1  2  2  1  1  3  3  1  1  2  4  5
 6   9   -0.309780000000D 05      8      112
  4  5  6  1  1  2  2  1  1  3  3  1  1  2  2  4  5  6
 6   9    0.157860000000D 05     16      176
  1  2  5  6  6  4  4  1  2  1  1  3  3  1  1  4  4  5
 6   9    0.157860000000D 05      8      176
  1  4  5  6  6  4  4  1  1  2  2  1  1  3  3  1  4  5
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  1  2  3  4  4  1  1  5  5  6  6  5  5  1  2  1  1  3
 6   9    0.196200000000D 05     12      176
  3  4  1  5  5  6  6  5  5  1  1  2  2  1  1  3  4  1
 6   9    0.196200000000D 05     12      176
  3  4  5  6  6  5  5  1  1  2  2  1  1  3  4  1  1  5
 6   9    0.699240000000D 05      4      280
  1  2  5  6  6  1  2  1  1  2  2  3  3  4  4  3  3  5
 6   9    0.699240000000D 05      4      140
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 6   9   -0.175800000000D 05     16      140
  2  3  5  6  6  1  1  2  2  1  1  2  3  4  4  3  3  5
 6   9    0.699240000000D 05      4      140
  3  4  5  6  6  1  1  2  2  1  1  2  2  3  4  3  3  5
 6   9    0.699240000000D 05      4      140
  4  3  5  6  6  1  1  2  2  1  1  2  2  3  3  4  3  5
 6   9    0.699240000000D 05      4      204
  1  2  5  6  6  4  4  3  3  1  2  1  1  3  3  4  4  5
 6   9    0.699240000000D 05      4      204
  1  3  5  6  6  4  4  3  3  1  1  2  2  1  3  4  4  5
 6   9    0.699240000000D 05      4      204
  3  4  5  6  6  4  4  3  3  1  1  2  2  1  1  3  4  5
 6   9    0.699240000000D 05      4       84
  1  3  2  4  4  5  5  6  6  1  1  2  2  1  3  1  1  2
 6   9    0.699240000000D 05      4      168
  3  1  2  4  4  5  5  6  6  1  1  2  2  1  1  3  1  2
```

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  2 4 6 1 1 2 2 1 1 3 3 1 1 2 4 5 5 6
 6  9   0.203040000000D 05     4    156
  1 2 4 5 5 4 4 6 6 1 2 1 1 3 3 1 1 4
 6  9   0.203040000000D 05     4    192
  1 2 5 4 4 6 6 1 2 1 1 3 3 1 1 4 4 5
 6  9   0.196200000000D 05    12    156
  1 2 4 6 6 1 2 1 1 3 3 1 1 4 4 5 5 4
 6  9   0.203040000000D 05     4    176
  2 1 4 5 5 4 4 6 6 1 1 2 1 3 3 1 1 4
 6  9   0.203040000000D 05     4    152
  2 1 5 4 4 6 6 1 1 2 1 3 3 1 1 4 4 5
 6  9   0.196200000000D 05    12    176
  2 1 4 6 6 1 1 2 1 3 3 1 1 4 4 5 5 4
 6  9   0.157860000000D 05     8    176
  4 5 6 1 1 2 2 1 1 3 3 1 1 4 5 4 4 6
 6  9   0.157860000000D 05     8    152
  5 4 6 1 1 2 2 1 1 3 3 1 1 4 4 5 4 6
 6  9   0.699240000000D 05     4    140
  1 2 4 5 5 6 6 4 4 1 2 1 1 3 3 1 1 4
 6  9   0.699240000000D 05     4    224
  1 2 6 4 4 1 2 1 1 3 3 1 1 4 4 5 5 6
 6  9   0.216480000000D 05     4    140
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 6  9   0.216480000000D 05     4    224
  1 2 6 5 5 1 2 1 1 3 3 4 4 1 1 5 5 6
 6  9   0.685080000000D 05     4    140
  1 3 5 6 6 5 5 1 1 2 2 1 3 4 4 1 1 5
 6  9   0.685080000000D 05     4    224
  1 3 6 5 5 1 1 2 2 1 3 4 4 1 1 5 5 6
 6  9   0.763200000000D 04     4    280
  1 2 3 4 4 3 3 5 5 6 6 1 2 1 1 2 2 3
 6  9   0.763200000000D 04     4    280
  1 2 4 3 3 5 5 6 6 1 2 1 1 2 2 3 3 4
 6  9   0.762660000000D 05     4    280
  1 2 3 5 5 6 6 1 2 1 1 2 2 3 3 4 4 3
 6  9   0.763200000000D 04     4    126
  2 1 3 4 4 3 3 5 5 6 6 1 1 2 1 2 2 3
 6  9   0.763200000000D 04     4    168
  2 1 4 3 3 5 5 6 6 1 1 2 1 2 2 3 3 4
 6  9   0.762660000000D 05     4    126
  2 1 3 5 5 6 6 1 1 2 1 2 2 3 3 4 4 3
 6  9  -0.309780000000D 05     8    280
  2 3 6 1 1 2 2 1 1 2 3 4 4 3 3 5 5 6
 6  9   0.685080000000D 05     4    154
  3 4 6 1 1 2 2 1 1 2 2 3 4 3 3 5 5 6
 6  9   0.685080000000D 05     4    112
  4 3 6 1 1 2 2 1 1 2 2 3 3 4 3 5 5 6
 6  9  -0.309780000000D 05     8    154
  3 5 6 1 1 2 2 1 1 2 2 3 3 4 4 3 5 6
```

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  1 2 3 4 4 5 5 4 4 6 6 1 2 1 1 2 2 3
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  1 2 4 5 5 4 4 6 6 1 2 1 1 2 2 3 3 4
 6  9   0.762660000000D 05      4      140
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 6  9   0.763200000000D 04      4      140
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 6  9   0.699240000000D 05      4      140
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 6  9   0.699240000000D 05      4      140
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 6  9  -0.175800000000D 05     16      140
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 6  9  -0.966000000000D 04     12      280
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 6  9   0.729600000000D 04     12      166
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 6  9   0.729600000000D 04      6      228
  1 2 4 3 3 5 5 6 6 5 5 1 2 1 1 3 3 4
 6  9   0.685080000000D 05      4      178
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 6  9   0.729600000000D 04      6      206
  1 2 6 5 5 1 2 1 1 3 3 4 4 3 3 5 5 6
 6  9   0.477600000000D 05      2      180
  1 2 3 4 4 5 5 4 4 3 3 6 6 1 2 1 1 3
 6  9   0.477600000000D 05      2      176
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 6  9   0.477600000000D 05      2      212
  1 2 5 4 4 3 3 6 6 1 2 1 1 3 3 4 4 5
 6  9   0.477600000000D 05      2      232
  1 2 4 3 3 6 6 1 2 1 1 3 3 4 4 5 5 4
 6  9   0.699240000000D 05      4      180
  1 2 3 6 6 1 2 1 1 3 3 4 4 5 5 4 4 3
 6  9   0.477600000000D 05      2      204
  2 1 3 4 4 5 5 4 4 3 3 6 6 1 1 2 1 3
 6  9   0.477600000000D 05      2      206
  2 1 4 5 5 4 4 3 3 6 6 1 1 2 1 3 3 4
 6  9   0.477600000000D 05      2      188
  2 1 5 4 4 3 3 6 6 1 1 2 1 3 3 4 4 5
 6  9   0.477600000000D 05      2      178
  2 1 4 3 3 6 6 1 1 2 1 3 3 4 4 5 5 4
 6  9   0.699240000000D 05      4      204
  2 1 3 6 6 1 1 2 1 3 3 4 4 5 5 4 4 3
 6  9   0.762660000000D 05      4      280
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 6  9   0.302400000000D 04      8      172
  2 3 4 6 6 1 1 2 3 1 1 4 4 2 2 5 5 4
 6  9   0.121440000000D 05      2      206
  2 3 6 1 1 2 3 1 1 4 4 2 2 5 5 4 4 6
```

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6  9   0.121440000000D 05     2     172
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6  9   0.302400000000D 04     4     206
 2 5 6 1 1 2 2 3 3 1 1 4 4 2 5 4 4 6
6  9   0.710400000000D 04     2     178
 1 2 4 3 3 5 5 2 2 6 6 1 2 3 3 1 1 4
6  9   0.121440000000D 05     2     166
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6  9  -0.966000000000D 04    12      84
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6  9   0.762660000000D 05     4     140
 1 3 5 4 4 3 3 6 6 1 1 2 2 1 3 4 4 5
6  9   0.685080000000D 05     4     204
 3 4 6 1 1 2 2 1 1 3 4 5 5 4 4 3 3 6
6  9   0.699240000000D 05     4     140
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6  9   0.685080000000D 05     4     206
 4 5 6 1 1 2 2 1 1 3 3 4 5 4 4 3 3 6
6  9   0.699240000000D 05     4     280
 5 4 3 6 6 1 1 2 2 1 1 3 3 4 4 5 4 3
6  9   0.685080000000D 05     4     188
 5 4 6 1 1 2 2 1 1 3 3 4 4 5 4 3 3 6
6  9   0.685080000000D 05     4     178
 4 3 6 1 1 2 2 1 1 3 3 4 4 5 5 4 3 6
6  9   0.258720000000D 05     4     154
 1 2 3 4 4 5 5 6 6 4 4 3 3 1 2 1 1 3
6  9   0.762660000000D 05     4     168
 1 2 4 5 5 6 6 4 4 3 3 1 2 1 1 3 3 4
6  9   0.762660000000D 05     4     238
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6  9   0.258720000000D 05     4     280
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6  9   0.762660000000D 05     4     280
 1 3 4 5 5 6 6 4 4 3 3 1 1 2 2 1 3 4
6  9   0.762660000000D 05     4     154
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6  9   0.710400000000D 04     2     178
 1 2 5 3 3 6 6 1 2 3 3 1 1 4 4 2 2 5
6  9   0.121440000000D 05     2     166
 1 4 2 5 5 3 3 6 6 1 1 2 2 3 3 1 4 2
6  9   0.302400000000D 04     4     206
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6  9   0.710400000000D 04     2     208
 1 2 5 4 4 6 6 1 2 3 3 1 1 4 4 2 2 5
6  9   0.710400000000D 04     2     180
 2 3 1 4 4 2 2 5 5 4 4 6 6 1 1 2 3 1
6  9   0.121440000000D 05     2     212
 2 3 5 4 4 6 6 1 1 2 3 1 1 4 4 2 2 5
```

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6  9  -0.966000000000D 04     12      168
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6  9  -0.104160000000D 05      4      336
 3 4 5 6 6 5 5 3 1 2 2 1 4 3 3 4 4 5
6  9  -0.104160000000D 05      4      168
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6  9  -0.104160000000D 05      8      280
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6  9  -0.309780000000D 05      8      280
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6  9  -0.415200000000D 04     24      280
 1 2 4 5 5 4 4 5 5 6 6 4 2 1 1 3 3 1
6  9  -0.415200000000D 04     24      140
 1 2 5 4 4 5 5 6 6 4 2 1 1 3 3 1 4 5
6  9  -0.175800000000D 05     16      140
 1 2 5 6 6 4 2 1 1 3 3 1 4 5 5 4 4 5
6  9  -0.175800000000D 05     16      140
 1 2 6 4 2 1 1 3 3 1 4 5 5 4 4 5 5 6
6  9  -0.104160000000D 05      4      336
 3 4 5 6 6 3 1 2 2 1 4 3 3 5 5 4 4 5
6  9  -0.104160000000D 05      4      252
 4 3 5 6 6 3 1 2 2 1 3 4 3 5 5 4 4 5
6  9  -0.104160000000D 05      4      168
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6  9   0.529200000000D 04      8      224
 1 3 4 2 2 5 5 6 6 1 1 2 2 1 3 1 1 4
6  9   0.216480000000D 05      4      140
 1 3 2 5 5 6 6 1 1 2 2 1 3 1 1 4 4 2
6  9   0.529200000000D 04      8      140
 3 1 4 2 2 5 5 6 6 1 1 2 2 1 1 3 1 4
6  9   0.216480000000D 05      4      224
 3 1 2 5 5 6 6 1 1 2 2 1 1 3 1 4 4 2
6  9   0.685080000000D 05      4      140
 1 4 2 5 5 6 6 1 1 2 2 1 1 3 3 1 4 2
6  9   0.699240000000D 05      4      140
 4 2 6 1 1 2 2 1 1 3 3 1 1 4 2 5 5 6
6  9  -0.104160000000D 05      8      224
 2 5 6 1 1 2 2 1 1 3 3 1 1 4 4 2 5 6
6  9   0.699240000000D 05      4       84
 2 3 1 4 4 5 5 6 6 1 1 2 2 1 1 2 3 1
6  9   0.699240000000D 05      4      168
 2 3 6 1 1 2 2 1 1 2 3 1 1 4 4 5 5 6
6  9   0.685080000000D 05      4       84
 1 3 2 5 5 6 6 1 1 2 2 1 3 4 4 1 1 2
6  9   0.685080000000D 05      4      168
 4 1 2 5 5 6 6 1 1 2 2 1 1 3 3 4 1 2
6  9  -0.104160000000D 05      8      168
 2 5 6 1 1 2 2 1 1 3 3 4 4 1 1 2 5 6
6  9   0.529200000000D 04      8       84
 1 2 3 4 4 1 1 3 3 5 5 6 6 1 2 1 1 3
```

```
 6  9    0.216480000000D 05      4       84
  1 2 3 5 5 6 6 1 2 1 1 3 3 4 4 1 1 3
 6  9    0.529200000000D 04      8      112
  2 1 3 4 4 1 1 3 3 5 5 6 6 1 1 2 1 3
 6  9    0.216480000000D 05      4      112
  2 1 3 5 5 6 6 1 1 2 1 3 3 4 4 1 1 3
 6  9    0.699240000000D 05      4      112
  3 4 6 1 1 2 2 1 1 3 4 1 1 3 3 5 5 6
 6  9    0.685080000000D 05      4      112
  4 1 3 5 5 6 6 1 1 2 2 1 1 3 3 4 1 3
 6  9   -0.104160000000D 05      8      112
  3 5 6 1 1 2 2 1 1 3 3 4 4 1 1 3 5 6
 6  9    0.127440000000D 05      4      280
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 6  9    0.127440000000D 05      4      280
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 6  9    0.258720000000D 05      4      280
  1 2 3 6 6 1 2 1 1 2 2 3 3 4 4 5 5 3
 6  9    0.127440000000D 05      4      126
  2 1 3 4 4 5 5 3 3 6 6 1 1 2 1 2 2 3
 6  9    0.127440000000D 05      4      168
  2 1 5 3 3 6 6 1 1 2 1 2 2 3 3 4 4 5
 6  9    0.258720000000D 05      4      126
  2 1 3 6 6 1 1 2 1 2 2 3 3 4 4 5 5 3
 6  9   -0.104160000000D 05      8      280
  2 3 6 1 1 2 2 1 1 2 3 4 4 5 5 3 3 6
 6  9    0.685080000000D 05      4      154
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 6  9    0.685080000000D 05      4      112
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 6  9    0.258720000000D 05      4      336
  1 2 3 4 4 5 5 6 6 3 3 1 2 1 1 2 2 3
 6  9    0.258720000000D 05      4      168
  2 1 3 4 4 5 5 6 6 3 3 1 1 2 1 2 2 3
 6  9    0.258720000000D 05      4      336
  1 2 3 4 4 5 5 6 6 1 2 1 1 3 3 2 2 3
 6  9    0.258720000000D 05      4      252
  2 1 3 4 4 5 5 6 6 1 1 2 1 3 3 2 2 3
 6  9   -0.415200000000D 04     12      252
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 6  9    0.710400000000D 04      2      204
  1 2 4 5 5 4 4 6 6 1 2 1 1 3 3 2 2 4
 6  9    0.710400000000D 04      2      180
  1 2 5 4 4 6 6 1 2 1 1 3 3 2 2 4 4 5
 6  9    0.477600000000D 05      2      204
  1 2 4 6 6 1 2 1 1 3 3 2 2 4 4 5 5 4
 6  9    0.710400000000D 04      2      178
  2 1 4 5 5 4 4 6 6 1 1 2 1 3 3 2 2 4
 6  9    0.710400000000D 04      2      232
  2 1 5 4 4 6 6 1 1 2 1 3 3 2 2 4 4 5
```

```
6  9   0.477600000000D 05      2      178
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6  9   0.762660000000D 05      4      140
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6  9   0.114000000000D 05      4      188
 1 3 4 5 5 4 4 6 6 1 1 2 2 1 3 2 2 4
6  9   0.114000000000D 05      4      212
 1 3 5 4 4 6 6 1 1 2 2 1 3 2 2 4 4 5
6  9   0.685080000000D 05      4      188
 1 3 4 6 6 1 1 2 2 1 3 2 2 4 4 5 5 4
6  9   0.580800000000D 04      8      204
 3 2 4 5 5 4 4 6 6 1 1 2 2 1 1 3 2 4
6  9   0.580800000000D 04      8      180
 3 2 5 4 4 6 6 1 1 2 2 1 1 3 2 4 4 5
6  9   0.699240000000D 05      4      204
 3 2 4 6 6 1 1 2 2 1 1 3 2 4 4 5 5 4
6  9   0.699240000000D 05      4      140
 3 2 6 1 1 2 2 1 1 3 2 4 4 5 5 4 4 6
6  9  -0.415200000000D 04     24      280
 2 4 6 1 1 2 2 1 1 3 3 2 4 5 5 4 4 6
6  9   0.117840000000D 05      8      206
 4 5 6 1 1 2 2 1 1 3 3 2 2 4 5 4 4 6
6  9   0.117840000000D 05      8      176
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6  9   0.763200000000D 04      4      154
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6  9   0.127440000000D 05      4      280
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6  9   0.763200000000D 04      4      280
 2 1 3 4 4 2 2 5 5 6 6 3 3 1 1 2 1 3
6  9   0.127440000000D 05      4      154
 2 1 6 3 3 1 1 2 1 3 3 4 4 2 2 5 5 6
6  9   0.762660000000D 05      4      168
 3 4 2 5 5 6 6 3 3 1 1 2 2 1 1 3 4 2
6  9  -0.141600000000D 04     16      238
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6  9   0.364800000000D 04      4      210
 1 2 5 6 6 5 5 1 2 1 1 3 3 4 4 2 2 5
6  9   0.364800000000D 04      4      224
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6  9  -0.104160000000D 05      4      308
 1 3 4 2 2 5 5 6 6 5 5 1 1 2 2 1 3 4
6  9   0.762660000000D 05      4      154
 1 3 2 5 5 6 6 5 5 1 1 2 2 1 3 4 4 2
6  9   0.477600000000D 05      2      182
 1 3 5 6 6 5 5 1 1 2 2 1 3 4 4 2 2 5
6  9   0.477600000000D 05      2      238
 1 3 6 5 5 1 1 2 2 1 3 4 4 2 2 5 5 6
6  9   0.710400000000D 04      2      208
 1 2 3 4 4 5 5 3 3 4 4 6 6 1 2 1 1 3
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```
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 6  9   0.580800000000D 04     8     136
  1 2 5 3 3 4 4 6 6 1 2 1 1 3 3 4 4 5
 6  9   0.117840000000D 05     8     108
  1 2 4 6 6 1 2 1 1 3 3 4 4 5 5 3 3 4
 6  9   0.710400000000D 04     2     232
  2 1 3 4 4 5 5 3 3 4 4 6 6 1 1 2 1 3
 6  9   0.114000000000D 05     4     114
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 6  9   0.580800000000D 04     8     100
  2 1 5 3 3 4 4 6 6 1 1 2 1 3 3 4 4 5
 6  9   0.117840000000D 05     8     114
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 6  9   0.762660000000D 05     4     140
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 6  9  -0.415200000000D 04    24     140
  1 3 4 6 6 1 1 2 2 1 3 4 4 5 5 3 3 4
 6  9   0.477600000000D 05     2     232
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 6  9   0.685080000000D 05     4     114
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 6  9   0.699240000000D 05     4     140
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 6  9   0.699240000000D 05     4     100
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 6  9   0.364800000000D 04     4     224
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 6  9   0.477600000000D 05     2      98
  1 2 4 5 5 6 6 3 3 4 4 1 2 1 1 3 3 4
 6  9   0.477600000000D 05     2     140
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 6  9   0.762660000000D 05     4     126
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 6  9  -0.104160000000D 05     4     154
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 6  9   0.258720000000D 05     4     168
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 6  9  -0.415200000000D 04    12      84
  3 4 6 1 1 2 2 3 3 1 1 2 2 3 4 5 5 6
 6  9   0.763200000000D 04     4     168
  1 2 3 4 4 1 1 2 2 3 3 5 5 6 6 1 2 3
 6  9   0.127440000000D 05     4     168
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 6  9   0.762660000000D 05     4      70
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 6  9  -0.141600000000D 04    16      70
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 6  9   0.216480000000D 05     4     224
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6 9 0.216480000000D 05 4 140
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6 9 0.259200000000D 04 8 156
 1 2 3 4 4 1 1 5 5 3 3 6 6 1 2 1 1 3
6 9 0.259200000000D 04 4 192
 1 2 5 3 3 6 6 1 2 1 1 3 3 4 4 1 1 5
6 9 0.259200000000D 04 8 176
 2 1 3 4 4 1 1 5 5 3 3 6 6 1 1 2 1 3
6 9 0.259200000000D 04 4 152
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6 9 0.203040000000D 05 4 156
 3 4 1 5 5 3 3 6 6 1 1 2 2 1 1 3 4 1
6 9 0.203040000000D 05 4 176
 3 4 6 1 1 2 2 1 1 3 4 1 1 5 5 3 3 6
6 9 0.203040000000D 05 4 152
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6 9 0.364800000000D 04 4 224
 1 2 4 3 3 5 5 6 6 1 2 1 1 3 3 2 2 4
6 9 0.717600000000D 04 4 224
 1 2 3 5 5 6 6 1 2 1 1 3 3 2 2 4 4 3
6 9 0.364800000000D 04 4 210
 2 1 4 3 3 5 5 6 6 1 1 2 1 3 3 2 2 4
6 9 0.717600000000D 04 4 210
 2 1 3 5 5 6 6 1 1 2 1 3 3 2 2 4 4 3
6 9 0.763200000000D 04 4 154
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6 9 0.127440000000D 05 4 154
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6 9 0.477600000000D 05 2 182
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6 9 0.216480000000D 05 4 308
 2 4 6 1 1 2 2 1 1 3 3 2 4 3 3 5 5 6
6 9 0.477600000000D 05 2 182
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6 9 -0.153600000000D 04 16 238
 3 5 6 1 1 2 2 1 1 3 3 2 2 4 4 3 5 6
6 9 0.717600000000D 04 4 210
 1 2 4 5 5 6 6 4 4 1 2 1 1 3 3 2 2 4
6 9 0.717600000000D 04 4 224
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6 9 0.258720000000D 05 4 154
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6 9 0.477600000000D 05 2 182
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6 9 0.477600000000D 05 2 238
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6 9 0.364800000000D 04 4 210
 1 2 3 4 4 2 2 3 3 5 5 6 6 1 2 1 1 3
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 6  9   0.717600000000D 04     4     210
  2 1 3 5 5 6 6 1 1 2 1 3 3 4 4 2 2 3
 6  9   0.763200000000D 04     4     280
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 6  9   0.477600000000D 05     2     238
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 6  9   0.477600000000D 05     2     238
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 6  9  -0.153600000000D 04    16     238
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 6  9   0.710400000000D 04     2     178
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 6  9   0.710400000000D 04     2     232
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 6  9   0.984000000000D 03     8     178
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 6  9   0.710400000000D 04     2     204
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 6  9   0.710400000000D 04     2     180
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 6  9   0.984000000000D 03     8     204
  2 1 3 6 6 1 1 2 1 3 3 4 4 2 2 5 5 3
 6  9   0.763200000000D 04     4     280
  1 3 4 2 2 5 5 3 3 6 6 1 1 2 2 1 3 4
 6  9   0.763200000000D 04     4     140
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 6  9   0.477600000000D 05     2     188
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 6  9   0.477600000000D 05     2     176
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 6  9   0.114000000000D 05     4     206
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 6  9   0.529200000000D 04     8     140
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 6  9   0.114000000000D 05     4     188
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  2 5 6 1 1 2 2 1 1 3 3 4 4 2 5 3 3 6
 6  9   0.580800000000D 04     8     180
  5 3 6 1 1 2 2 1 1 3 3 4 4 2 2 5 3 6
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6  9   0.121440000000D 05    2    166
 1 2 3 6 6 4 4 1 2 1 1 3 3 4 4 5 5 3
6  9   0.121440000000D 05    2    206
 1 2 6 4 4 1 2 1 1 3 3 4 4 5 5 3 3 6
6  9   0.477600000000D 05    2    178
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6  9   0.477600000000D 05    2    178
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6  9   0.729600000000D 04   12    166
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6  9   0.121440000000D 05    2    172
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6  9   0.121440000000D 05    2    212
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6  9   0.984000000000D 03    4    208
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6  9   0.477600000000D 05    2    180
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6  9   0.729600000000D 04    6    206
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6  9   0.216480000000D 05    4     84
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6  9   0.216480000000D 05    4    112
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6  9   0.364800000000D 04    4    224
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6  9   0.717600000000D 04    4    224
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6  9   0.127440000000D 05    4    126
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6  9   0.763200000000D 04    4    126
 3 1 2 4 4 3 3 5 5 6 6 1 1 2 2 3 1 2
6  9   0.477600000000D 05    2     98
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6  9   0.216480000000D 05    4    154
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6  9   0.477600000000D 05    2     98
 4 3 6 1 1 2 2 3 3 1 1 2 2 4 3 5 5 6
6  9  -0.153600000000D 04   16    140
 3 5 6 1 1 2 2 3 3 1 1 2 2 4 4 3 5 6
6  9   0.717600000000D 04    4    224
 1 2 4 5 5 6 6 4 4 1 2 3 3 1 1 2 2 4
```

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 2 3 4 5 5 6 6 4 4 1 1 2 3 1 1 2 2 4
6  9   0.477600000000D 05     2     140
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6  9   0.258720000000D 05     4     126
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6  9   0.710400000000D 04     2     232
 1 2 3 4 4 1 1 2 2 5 5 3 3 6 6 1 2 3
6  9   0.984000000000D 03     4     208
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6  9   0.763200000000D 04     4     140
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6  9   0.580800000000D 04     8     100
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6  9   0.477600000000D 05     2     114
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6  9   0.529200000000D 04     8     140
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 2 3 6 7 7 1 1 2 2 1 1 2 3 4 4 5 5 6
7  9  -0.400944000000D 06     8     420
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7  9   0.627912000000D 06     4     560
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7  9   0.286638000000D 06     8     504
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7  9  -0.400944000000D 06     8     420
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7  9   0.786858000000D 06     4     840
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7  9   0.786858000000D 06     4     420
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7  9   0.786858000000D 06     4     840
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7  9   0.786858000000D 06     4     420
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7  9   0.199476000000D 06    12     504
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7  9  -0.367872000000D 06     4     504
 1 2 3 6 6 7 7 3 2 1 3 4 4 3 3 5 5 3
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7  9  -0.266400000000D 05   48    504
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7  9  -0.400944000000D 06    8    420
 1 2 4 5 5 6 6 7 7 3 2 1 3 4 4 3 3 4
7  9  -0.400944000000D 06    8    420
 1 2 5 6 6 7 7 3 2 1 3 4 4 3 3 4 4 5
7  9  -0.400944000000D 06    4    840
 3 4 5 6 6 7 7 3 1 2 2 1 4 3 3 4 4 5
7  9  -0.400944000000D 06    4    420
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7  9   0.736140000000D 05   16    420
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7  9  -0.124968000000D 06    8    560
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7  9  -0.124968000000D 06    8    560
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7  9  -0.400944000000D 06    4    560
 1 2 3 5 5 6 6 5 5 7 7 3 2 1 3 4 4 3
7  9  -0.367872000000D 06    8    560
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7  9  -0.134304000000D 06    8    588
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 1 2 3 5 5 6 6 7 7 5 5 3 2 1 3 4 4 3
7  9  -0.400944000000D 06    8    588
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7  9  -0.367872000000D 06    4    588
 1 2 6 7 7 5 5 3 2 1 3 4 4 3 3 5 5 6
7  9  -0.367872000000D 06    4    588
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7  9  -0.367872000000D 06    4    588
 3 5 6 7 7 5 5 3 1 2 2 1 3 4 4 3 5 6
7  9  -0.151032000000D 06   12    504
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7  9  -0.485532000000D 06    8    588
 1 2 4 5 5 4 4 6 6 7 7 6 6 4 2 3 3 1
7  9  -0.485532000000D 06    4    588
 1 2 4 6 6 7 7 6 6 4 2 3 3 1 4 5 5 4
7  9  -0.400944000000D 06    4    840
 1 2 3 4 4 5 5 6 6 7 7 3 2 1 1 2 2 1
7  9   0.736140000000D 05    8    420
 3 4 5 6 6 7 7 3 1 2 2 1 1 2 2 1 4 5
7  9  -0.151032000000D 06   24    560
 1 2 6 7 7 4 2 1 1 3 3 1 4 5 5 4 4 6
```

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7  9  -0.201600000000D 05    4   588
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7  9  -0.201600000000D 05    4   588
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7  9  -0.663120000000D 05    8   588
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7  9  -0.134304000000D 06    8   588
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7  9  -0.124968000000D 06    4   588
 1 2 6 7 7 3 2 1 3 4 4 3 3 5 5 4 4 6
7  9  -0.124968000000D 06    2   588
 3 4 6 7 7 3 1 2 2 1 4 3 3 5 5 4 4 6
7  9  -0.124968000000D 06    2   588
 4 3 6 7 7 3 1 2 2 1 3 4 3 5 5 4 4 6
7  9  -0.367872000000D 06    4   588
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7  9  -0.201600000000D 05    4   672
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.7  9  -0.663120000000D 05    8   336
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7  9  -0.134304000000D 06    8   336
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7  9  -0.124968000000D 06    4   336
 1 2 6 7 7 3 2 1 3 4 4 5 5 3 3 4 4 6
7  9  -0.124968000000D 06    2   672
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7  9  -0.367872000000D 06    4   336
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7  9  -0.219480000000D 05   16   840
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7  9  -0.219480000000D 05   16   420
 1 2 5 4 4 5 5 6 6 7 7 4 2 3 3 1 4 5
7  9  -0.485532000000D 06    8   420
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7  9  -0.571440000000D 05    4   340
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7  9  -0.571440000000D 05    4   420
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7  9   0.864000000000D 04   24   420
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7  9  -0.571440000000D 05   12   840
 1 2 5 6 6 5 5 6 6 7 7 5 2 3 3 4 4 1
7  9  -0.571440000000D 05   12   420
 1 2 6 5 5 6 6 7 7 5 2 3 3 4 4 1 5 6
7  9  -0.485532000000D 06    8   420
 1 2 6 7 7 5 2 3 3 4 4 1 5 6 6 5 5 6
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7 9 -0.342480000000D 05 8 560
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7 9 -0.342480000000D 05 4 560
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7 9 -0.237840000000D 05 8 588
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7 9 -0.162216000000D 06 8 588
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7 9 -0.237840000000D 05 4 672
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7 9 -0.162216000000D 06 8 336
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7 9 0.864000000000D 04 24 420
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7 9 0.864000000000D 04 24 840
1 2 5 6 6 5 5 6 6 7 7 5 2 1 3 4 4 3
7 9 0.864000000000D 04 24 420
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7 9 0.736140000000D 05 16 420
1 2 6 7 7 5 2 1 3 4 4 3 5 6 6 5 5 6
7 9 0.736140000000D 05 8 420
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7 9 0.864000000000D 04 16 840
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7 9 0.736140000000D 05 8 840
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7 9 0.199476000000D 06 12 504
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7 9 -0.367872000000D 06 4 504
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7 9 -0.151032000000D 06 12 504
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7 9 -0.266400000000D 05 24 504
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7 9 0.736140000000D 05 8 840
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7 9 -0.124968000000D 06 4 504
3 4 5 6 6 5 5 7 7 3 1 2 2 1 4 3 3 5
7 9 -0.124968000000D 06 2 672
3 4 6 5 5 7 7 3 1 2 2 1 4 3 3 5 5 6
7 9 -0.367872000000D 06 4 504
3 4 5 7 7 3 1 2 2 1 4 3 3 5 5 6 6 5
7 9 -0.124968000000D 06 2 588
4 3 5 6 6 5 5 7 7 3 1 2 2 1 3 4 3 5
7 9 -0.367872000000D 06 4 588
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7 9 -0.400944000000D 06 4 420
3 4 5 6 6 7 7 5 5 3 1 2 2 1 4 3 3 5
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 7  9   0.864000000000D 04     24      840
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 7  9   0.864000000000D 04     24      420
  4 6 7 3 1 2 2 1 3 4 4 5 5 3 3 4 6 7
 7  9   0.864000000000D 04     16      840
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 7  9  -0.124968000000D 06      2      588
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 7  9  -0.485532000000D 06      8      560
  1 3 5 6 6 7 7 1 1 2 2 1 3 4 4 3 3 5
 7  9  -0.367872000000D 06      8      560
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 7  9   0.140032800000D 07      2      588
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 7  9   0.226780000000D 06     12      588
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 7  9   0.140032800000D 07      2      588
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 7  9   0.140032800000D 07      2      588
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 7  9   0.226780000000D 06     12      588
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7  9  -0.400944000000D 06    8    588
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7  9  -0.485532000000D 06    8    588
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7  9  -0.367872000000D 06    4    588
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7  9   0.163926000000D 06   16    560
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7  9   0.163926000000D 06   16    560
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7  9  -0.151032000000D 06   24    560
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7  9   0.833280000000D 05    8    504
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7  9   0.504000000000D 04   24    504
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7  9   0.117672000000D 06    4    560
 1 2 5 6 6 7 7 1 2 3 3 1 1 4 4 2 2 5
7  9   0.401088000000D 06    2    560
 2 3 5 6 6 7 7 1 1 2 3 1 1 4 4 2 2 5
7  9   0.205584000000D 06    4    560
 2 3 6 7 7 1 1 2 3 1 1 4 4 2 2 5 5 6
7  9   0.205584000000D 06    4    560
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7  9   0.401088000000D 06    2    560
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7  9  -0.342480000000D 05    8    560
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7  9   0.132480000000D 05   24    504
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7  9   0.286638000000D 06    8    504
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7  9   0.199476000000D 06   12    504
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7  9   0.378000000000D 05   48    504
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7  9  -0.576960000000D 05   16    504
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7  9   0.491184000000D 06    2    588
 1 2 4 5 5 6 6 7 7 1 2 1 1 3 3 2 2 4
7  9   0.242952000000D 06    2    588
 1 2 5 6 6 7 7 1 2 1 1 3 3 2 2 4 4 5
```

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  2 1 4 5 5 6 6 7 7 1 1 2 1 3 3 2 2 4
 7  9    0.242952000000D 06     2      588
  2 1 5 6 6 7 7 1 1 2 1 3 3 2 2 4 4 5
 7  9    0.719748000000D 06     4      588
  1 3 4 5 5 6 6 7 7 1 1 2 2 1 3 2 2 4
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 7  9   -0.134304000000D 06     8      588
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 7  9    0.140032800000D 07     2      588
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  1 3 6 7 7 1 1 2 2 1 3 4 4 2 2 5 5 6
 7  9    0.140032800000D 07     2      588
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 7  9    0.627912000000D 06     4      588
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 7  9   -0.663120000000D 05     8      588
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 7  9    0.982800000000D 05     8      560
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  2 1 4 5 5 3 3 6 6 7 7 1 1 2 1 3 3 4
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  2 1 6 7 7 1 1 2 1 3 3 4 4 5 5 3 3 6
 7  9    0.719748000000D 06     4      560
  1 3 4 5 5 3 3 6 6 7 7 1 1 2 2 1 3 4
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 7  9    0.627912000000D 06     4      560
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7 9   0.627912000000D 06     4    560
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7 9   0.401088000000D 06     2    560
 1 2 4 5 5 6 6 3 3 7 7 1 2 1 1 3 3 4
7 9   0.401088000000D 06     2    560
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7 9   0.401088000000D 06     2    560
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7 9   0.401088000000D 06     2    560
 2 1 5 6 6 3 3 7 7 1 1 2 1 3 3 4 4 5
7 9   0.140032800000D 07     2    560
 1 3 4 5 5 6 6 3 3 7 7 1 1 2 2 1 3 4
7 9   0.140032800000D 07     2    560
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7 9  -0.124968000000D 06     8    560
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7 9  -0.124968000000D 06     8    560
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7 9   0.627912000000D 06     4    560
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7 9   0.286638000000D 06     8    560
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7 9   0.627912000000D 06     4    560
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7 9   0.286638000000D 06     8    560
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7 9   0.485280000000D 05     8    560
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7 9   0.199476000000D 06    12    560
 1 3 5 6 6 4 4 7 7 1 1 2 2 1 3 4 4 5
7 9   0.163926000000D 06    16    560
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7 9   0.491184000000D 06     2    672
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7 9   0.242952000000D 06     2    672
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7 9   0.140032800000D 07     2    336
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7 9   0.140032800000D 07     2    336
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7 9   0.719748000000D 06     4    336
 2 3 6 7 7 1 1 2 3 1 1 2 2 4 4 5 5 6
7 9  -0.134304000000D 06     8    336
 2 4 5 6 6 7 7 1 1 2 2 3 3 1 1 2 4 5
7 9  -0.162216000000D 06     8    336
 2 4 6 7 7 1 1 2 2 3 3 1 1 2 4 5 5 6
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7 9 -0.124968000000D 06 4
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7 9 0.140032800000D 07 2
1 2 5 6 6 7 7 4 4 1 2 3 3 1 1 4 4 5 588
7 9 0.140032800000D 07 2
1 2 6 7 7 4 4 1 2 3 3 1 1 4 4 5 5 6 588
7 9 0.590880000000D 05 8
2 3 1 4 4 5 5 6 6 7 7 4 4 1 1 2 3 1 588
7 9 0.719748000000D 06 4
2 3 4 5 5 6 6 7 7 4 4 1 1 2 3 1 1 4 588
7 9 0.627912000000D 06 4
2 3 5 6 6 7 7 4 4 1 1 2 3 1 1 4 4 5 588
7 9 0.235584000000D 06 4
1 4 5 6 6 7 7 4 4 1 1 2 2 3 3 1 4 5 588
7 9 0.235584000000D 06 4
1 4 6 7 7 4 4 1 1 2 2 3 3 1 4 5 5 6 588
7 9 -0.134304000000D 06 8
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7 9 0.667200000000D 05 2
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7 9 0.229368000000D 06 2
1 2 5 6 6 7 7 1 2 3 3 4 4 1 1 2 2 5 672
7 9 0.226780000000D 06 12
2 3 5 6 6 7 7 1 1 2 3 4 4 1 1 2 2 5 336
7 9 0.140032800000D 07 2
2 3 6 7 7 1 1 2 3 4 4 1 1 2 2 5 5 6 336
7 9 0.140032800000D 07 2
3 4 2 5 5 6 6 7 7 1 1 2 2 3 4 1 1 2 336
7 9 0.627912000000D 06 4
3 4 5 6 6 7 7 1 1 2 2 3 4 1 1 2 2 5 336
7 9 -0.663120000000D 05 8
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7 9 0.683040000000D 05 2
1 2 6 7 7 1 2 3 3 1 1 4 4 5 5 2 2 6 560
7 9 0.932640000000D 05 4
2 3 4 5 5 2 2 6 6 7 7 1 1 2 3 1 1 4 560
7 9 0.932640000000D 05 4
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7 9 0.401088000000D 06 2
1 4 6 7 7 1 1 2 2 3 3 1 4 5 5 2 2 6 560
7 9 0.401088000000D 06 2
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7 9 0.428400000000D 05 8
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7 9 0.117672000000D 06 2
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7 9 0.205584000000D 06 4
2 3 4 5 5 6 6 2 2 7 7 1 1 2 3 1 1 4 560
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7  9   0.205584000000D 06     4     560
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7  9   0.121920000000D 06     8     560
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7  9   0.205584000000D 06     4     560
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7  9   0.428400000000D 05     8     560
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7  9   0.333360000000D 05    24     560
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7  9   0.982800000000D 05     8     560
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7  9   0.683040000000D 05     2     560
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7  9   0.401088000000D 06     2     560
 2 3 6 7 7 1 1 2 3 4 4 1 1 5 5 2 2 6
7  9   0.932640000000D 05     4     560
 3 4 1 5 5 2 2 6 6 7 7 1 1 2 2 3 4 1
7  9   0.428400000000D 05     4     560
 3 4 6 7 7 1 1 2 2 3 4 1 1 5 5 2 2 6
7  9   0.485280000000D 05     8     560
 1 2 6 7 7 1 2 3 3 4 4 1 1 5 5 3 3 6
7  9   0.485280000000D 05     4     560
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7  9  -0.485532000000D 06     4     588
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7  9   0.786858000000D 06     4     420
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7  9   0.786858000000D 06     4     840
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7  9   0.719748000000D 06     4     560
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7  9   0.683040000000D 05     4     560
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7  9   0.683040000000D 05     2     560
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7  9   0.140032800000D 07     2     560
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7  9   0.719748000000D 06     4     560
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7  9   0.683040000000D 05     2     560
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7  9   0.140032800000D 07     2     560
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7  9  -0.485532000000D 06     8     560
 1 3 4 6 6 7 7 1 1 2 2 1 3 4 4 5 5 4
```

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7  9   0.667200000000D 05     4     504
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7  9   0.491184000000D 06     2     588
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7  9   0.491184000000D 06     2     504
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7  9  -0.237840000000D 05     8     588
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7  9   0.786858000000D 06     4     420
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7  9  -0.885600000000D 04    20     840
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7  9   0.786858000000D 06     4     420
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7  9  -0.219480000000D 05    16     840
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7  9   0.229368000000D 06     2     504
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7  9   0.229368000000D 06     2     672
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7  9   0.235584000000D 06     4     504
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7  9   0.229368000000D 06     2     588
 2 1 3 4 4 5 5 3 3 6 6 7 7 1 1 2 1 3
7  9   0.229368000000D 06     2     504
 2 1 5 3 3 6 6 7 7 1 1 2 1 3 3 4 4 5
7  9   0.235584000000D 06     4     588
 2 1 3 6 6 7 7 1 1 2 1 3 3 4 4 5 5 3
7  9   0.226780000000D 06    12     588
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7  9   0.226780000000D 06    12     504
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7  9  -0.134304000000D 06     8     588
 3 6 7 1 1 2 2 1 1 3 3 4 4 5 5 3 6 7
7  9   0.491184000000D 06     2     504
 1 2 3 4 4 5 5 6 6 3 3 7 7 1 2 1 1 3
7  9   0.491184000000D 06     2     672
 1 2 6 3 3 7 7 1 2 1 1 3 3 4 4 5 5 6
7  9   0.590880000000D 05     8     504
 1 2 3 7 7 1 2 1 1 3 3 4 4 5 5 6 6 3
7  9   0.491184000000D 06     2     588
 2 1 3 4 4 5 5 6 6 3 3 7 7 1 1 2 1 3
7  9   0.491184000000D 06     2     504
 2 1 6 3 3 7 7 1 1 2 1 3 3 4 4 5 5 6
7  9   0.590880000000D 05     8     588
 2 1 3 7 7 1 1 2 1 3 3 4 4 5 5 6 6 3
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7  9    0.140032800000D 07     2     504
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7  9    0.121920000000D 06     8     560
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7  9    0.117672000000D 06     4     560
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7  9    0.117672000000D 06     4     560
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7  9    0.121920000000D 06     8     560
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7  9    0.140032800000D 07     2     560
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7  9   -0.162216000000D 06     8     560
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7  9    0.786858000000D 06     4     420
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7  9   -0.571440000000D 05    12     420
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7  9   -0.201600000000D 05     4     672
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7  9    0.242952000000D 06     4     504
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7  9    0.667200000000D 05     2     588
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7  9   -0.237840000000D 05     4     672
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7  9    0.242952000000D 06     4     504
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7 9  0.235584000000D 06   4   504
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7 9  0.242952000000D 06   2   588
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7 9  0.235584000000D 06   4   588
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7 9 -0.201600000000D 05   4   588
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7 9  0.683040000000D 05   2   560
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7 9  0.117672000000D 06   4   560
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7 9  0.117672000000D 06   2   560
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7 9  0.667200000000D 05   4   504
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7 9  0.667200000000D 05   2   672
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7 9  0.667200000000D 05   2   588
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7 9  0.140032800000D 07   2   504
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8 9  0.739011600000D 07   4  1680
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8 9  0.143345280000D 08   2  1680
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8 9  0.711531600000D 07   4  1680
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8 9  0.143345280000D 08   2  1680
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8 9  0.739011600000D 07   4  1680
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8 9 -0.495234600000D 07   8  1680
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8 9 -0.623757600000D 07   8  1680
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 8   9  -0.570722400000D 07     8    1680
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 8   9  -0.206766000000D 07    12    1680
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 8   9  -0.442117200000D 07     4    1680
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 8   9   0.143345280000D 08     2    1680
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 8   9   0.688779600000D 07     4    1680
  1 2 5 6 6 7 7 8 8 1 2 3 3 1 1 4 4 5
 8   9   0.688779600000D 07     4    1680
  1 2 6 7 7 8 8 1 2 3 3 1 1 4 4 5 5 6
 8   9   0.143345280000D 08     2    1680
  1 2 7 8 8 1 2 3 3 1 1 4 4 5 5 6 6 7
 8   9   0.739011600000D 07     4    1680
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 8   9   0.203890800000D 07    12    1680
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 8   9   0.577592400000D 07     4    1680
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 8   9  -0.166065600000D 07     3    1680
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 8   9  -0.207808800000D 07     8    1680
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 8   9  -0.221683200000D 07     8    1680
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 8   9  -0.137851200000D 07     8    1680
  4 5 6 7 7 8 8 1 1 2 2 3 3 1 1 4 5 6
 8   9  -0.889608000000D 06     8    1680
  4 5 7 8 8 1 1 2 2 3 3 1 1 4 5 6 6 7
 8   9  -0.479232000000D 06     8    1680
  1 2 3 4 4 1 1 5 5 6 6 7 7 8 8 1 2 3
 8   9   0.711531600000D 07     4    1680
  1 2 5 6 6 7 7 8 8 1 2 3 3 4 4 1 1 5
 8   9   0.688779600000D 07     4    1680
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 8   9   0.711531600000D 07     4    1680
  1 2 7 8 8 1 2 3 3 4 4 1 1 5 5 6 6 7
 8   9   0.143345280000D 08     2    1680
  2 3 1 5 5 6 6 7 7 8 8 1 1 2 3 4 4 1
 8   9   0.577592400000D 07     4    1680
  2 3 5 6 6 7 7 8 8 1 1 2 3 4 4 1 1 5
 8   9   0.577592400000D 07     4    1680
  2 3 7 8 8 1 1 2 3 4 4 1 1 5 5 6 6 7
```

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8 9   0.143345280000D 08    2   1680
 2 3 8 1 1 2 3 4 4 1 1 5 5 6 6 7 7 8
8 9  -0.808920000000D 06    8   1680
 1 5 6 7 7 8 8 1 1 2 2 3 3 4 4 1 5 6
8 9  -0.102048000000D 07    8   1680
 1 5 7 8 8 1 1 2 2 3 3 4 4 1 5 6 6 7
8 9  -0.333288000000D 06    8   1680
 5 6 7 8 8 1 1 2 2 3 3 4 4 1 1 5 6 7
8 9  -0.479232000000D 06    8   1680
 1 2 3 4 4 3 3 5 5 6 6 7 7 8 8 3 2 1
8 9  -0.495234600000D 07    8   1680
 1 2 3 5 5 6 6 7 7 8 8 3 2 1 3 4 4 3
8 9  -0.451832400000D 07    8   1680
 1 2 5 6 6 7 7 8 8 3 2 1 3 4 4 3 3 5
8 9  -0.442117200000D 07    4   1680
 1 2 6 7 7 8 8 3 2 1 3 4 4 3 3 5 5 6
8 9  -0.451832400000D 07    4   1680
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8 9  -0.442117200000D 07    4   1680
 3 4 6 7 7 8 8 3 1 2 2 1 4 3 3 5 5 6
8 9  -0.451832400000D 07    4   1680
 3 4 7 8 8 3 1 2 2 1 4 3 3 5 5 6 6 7
8 9   0.118477800000D 07   16   1680
 3 5 6 7 7 8 8 3 1 2 2 1 3 4 4 3 5 6
8 9   0.134496000000D 07   16   1680
 3 5 7 8 8 3 1 2 2 1 3 4 4 3 5 6 6 7
8 9   0.368004000000D 06   24   1680
 5 6 7 8 8 3 1 2 2 1 3 4 4 3 3 5 6 7
8 9  -0.623757600000D 07    8   1680
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8 9   0.134496000000D 07    8   1680
 4 5 6 7 7 8 8 4 1 2 2 1 1 3 3 1 5 6
8 9  -0.808920000000D 06    8   1680
 1 2 3 4 4 5 5 3 3 6 6 7 7 8 8 3 2 1
8 9  -0.333288000000D 06    8   1680
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8 9  -0.166065600000D 07    8   1680
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8 9  -0.137851200000D 07    8   1680
 1 2 6 7 7 8 8 3 2 1 3 4 4 5 5 3 3 6
8 9  -0.442117200000D 07    4   1680
 3 4 6 7 7 8 8 3 1 2 2 1 4 5 5 3 3 6
8 9  -0.442117200000D 07    4   1680
 3 4 7 8 8 3 1 2 2 1 4 5 5 3 3 6 6 7
8 9  -0.451832400000D 07    4   1680
 4 5 3 6 6 7 7 8 8 3 1 2 2 1 3 4 5 3
8 9  -0.125624400000D 07   12   1680
 4 5 6 7 7 8 8 3 1 2 2 1 3 4 5 3 3 6
8 9   0.393504000000D 06   16   1680
 3 6 7 8 8 3 1 2 2 1 3 4 4 5 5 3 6 7
```

```
 8   9   -0.102048000000D 07      8     1680
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 8   9   -0.623757600000D 07      8     1680
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 8   9   -0.570722400000D 07      8     1680
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 8   9   -0.670200000000D 06      8     1680
  4  5  6  7  7  8  8  4  1  2  2  3  3  1  5  4  4  6
 8   9   -0.670200000000D 06      8     1680
  4  5  7  8  8  4  1  2  2  3  3  1  5  4  4  6  6  7
 8   9    0.314376000000D 06     16     1680
  4  6  7  8  8  4  1  2  2  3  3  1  4  5  5  4  6  7
 8   9    0.393504000000D 06      8     1680
  1  2  3  4  4  1  5  6  6  5  5  7  7  8  8  5  2  3
 8   9   -0.221683200000D 07      8     1680
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 8   9   -0.332822100000D 07     16     1680
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 8   9   -0.206766000000D 07     12     1680
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 8   9   -0.928560000000D 05     24     1680
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 8   9   -0.207808800000D 07      8     1680
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 8   9   -0.889608000000D 06      8     1680
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 8   9   -0.670200000000D 06      8     1680
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 8   9   -0.483120000000D 05     24     1680
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 8   9    0.393504000000D 06      8     1680
  1  2  3  4  4  3  5  6  6  5  5  7  7  8  8  5  2  1
 8   9    0.393504000000D 06     16     1680
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 8   9    0.118477800000D 07     16     1680
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 8   9    0.368004000000D 06     24     1680
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 8   9    0.368004000000D 06     12     1680
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 8   9    0.134496000000D 07      8     1680
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 8   9    0.314376000000D 06     16     1680
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 8   9    0.134496000000D 07     16     1680
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 9   9   -0.850603920000D 08      4     5040
  1  2  5  6  6  7  7  8  8  9  9  5  2  3  3  4  4  1
 9   9   -0.850603920000D 08      4     5040
  1  2  5  6  6  7  7  8  8  9  9  1  2  3  3  4  4  5
```

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9  9  -0.291336000000D 06    24    5040
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9  9  -0.250616400000D 07    12    5040
 1 2 7 8 8 9 9 7 2 1 3 4 4 3 5 6 6 5
9  9   0.373680000000D 06     8    5040
 1 2 3 4 4 3 5 6 6 7 7 8 8 9 9 5 2 1
9  9   0.173792400000D 08     8    5040
 1 2 5 6 6 7 7 8 8 9 9 5 2 1 3 4 4 3
9  9  -0.250616400000D 07    12    5040
 5 6 7 8 8 9 9 5 1 2 2 1 3 4 4 3 6 7
9  9   0.187058400000D 07     8    5040
 1 2 3 4 4 5 5 3 6 7 7 8 8 9 9 6 2 1
9  9   0.491140800000D 07     8    5040
 1 2 6 7 7 8 8 9 9 6 2 1 3 4 4 5 5 3
9  9   0.420950760000D 08     4    5040
 3 4 6 7 7 8 8 9 9 6 1 2 2 1 4 5 5 3
9  9  -0.291336000000D 06    24    5040
 6 7 8 9 9 6 1 2 2 1 3 4 4 5 5 3 7 8
9  9   0.278251200000D 07     8    5040
 1 2 4 5 5 6 6 4 7 8 8 9 9 7 2 3 3 1
9  9  -0.592491480000D 08     4    5040
 1 2 3 4 4 5 5 6 6 7 7 8 8 9 9 3 2 1
9  9   0.173792400000D 08     8    5040
 3 4 5 6 6 7 7 8 8 9 9 3 1 2 2 1 4 5
9  9   0.420950760000D 08     4    5040
 3 4 6 7 7 8 8 9 9 3 1 2 2 1 4 5 5 6
9  9  -0.766169400000D 08     4    5040
 1 2 4 5 5 6 6 7 7 8 8 9 9 4 2 3 3 1
9  9   0.491140800000D 07     8    5040
 4 5 6 7 7 8 8 9 9 4 1 2 2 3 3 1 5 6
9  9   0.278251200000D 07     8    5040
 4 5 7 8 8 9 9 4 1 2 2 3 3 1 5 6 6 7
9  9   0.373680000000D 06     8    5040
 1 2 3 4 4 1 5 6 6 7 7 8 8 9 9 5 2 3
9  9   0.187058400000D 07     8    5040
 5 6 7 8 8 9 9 5 1 2 2 3 3 4 4 1 6 7
9  9  -0.592491480000D 08     4    5040
 1 2 3 4 4 5 5 6 6 7 7 8 8 9 9 1 2 3
9  9  -0.766169400000D 08     4    5040
 1 2 4 5 5 6 6 7 7 8 8 9 9 1 2 3 3 4
```

Table A9

```
2  2     0.600000000000D 01      1      2
 1 2 2 1
3  3     0.800000000000D 01      2      6
 1 2 2 3 3 1
2  4     0.600000000000D 01      1      2
 1 2 2 1 1 2 2 1
3  4     0.660000000000D 02      1      8
 1 2 2 1 1 3 3 1
4  4     0.330000000000D 02      2     24
 1 2 2 3 3 4 4 1
4  4    -0.690000000000D 02      1     24
 1 2 2 1 3 4 4 3
4  5     0.240000000000D 03      2     40
 1 2 2 1 1 3 3 4 4 1
3  5     0.800000000000D 01      6     10
 1 2 2 1 1 2 2 3 3 1
5  5     0.168000000000D 03      2    120
 1 2 2 3 3 4 4 5 5 1
5  5    -0.264000000000D 03      2    120
 1 2 2 1 3 4 4 5 5 3
2  6     0.600000000000D 01      1      2
 1 2 2 1 1 2 2 1 1 2 2 1
3  6     0.660000000000D 02      2     12
 1 2 2 1 1 2 2 1 1 3 3 1
3  6     0.800000000000D 01      2      6
 1 2 2 3 3 1 1 2 2 3 3 1
3  6     0.800000000000D 01      1     36
 1 2 2 1 1 3 3 2 2 3 3 1
4  6     0.702000000000D 03      1     84
 1 2 2 1 1 3 3 4 4 3 3 1
4  6     0.220000000000D 03      1     72
 1 2 2 1 1 3 3 1 1 4 4 1
4  6     0.360000000000D 02      2     48
 1 2 2 3 3 1 1 2 2 4 4 1
4  6    -0.690000000000D 02      2     60
 1 2 2 1 3 4 4 3 3 4 4 3
4  6     0.360000000000D 02      2     84
 1 2 2 1 1 3 3 2 2 4 4 1
4  6     0.330000000000D 02      8     60
 1 2 2 1 1 2 2 3 3 4 4 1
5  6     0.204000000000D 03      4    240
 1 2 2 3 3 1 1 4 4 5 5 1
5  6    -0.222000000000D 04      1    240
 1 2 2 1 3 4 4 3 3 5 5 3
5  6     0.124800000000D 04      2    240
 1 2 2 1 1 3 3 4 4 5 5 1
6  6     0.970000000000D 03      2    720
 1 2 2 3 3 4 4 5 5 6 6 1
6  6    -0.244000000000D 03      4    720
 1 2 2 3 3 1 4 5 5 6 6 4
```

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 6  6  -0.141600000000D 04          2        720
  1 2 2 1 3 4 4 5 5 6 6 3
 6  6   0.129200000000D 04          1        720
  1 2 2 1 3 4 4 3 5 6 6 5
 3  7   0.800000000000D 01          6         14
  1 2 2 1 1 2 2 1 1 2 2 3 3 1
 3  7   0.800000000000D 01          6         28
  1 2 2 1 1 3 3 1 1 2 2 3 3 1
 4  7   0.240000000000D 03          2        154
  1 2 2 1 1 2 2 3 3 4 4 3 3 1
 4  7   0.240000000000D 03          4        112
  1 2 2 1 1 3 3 1 1 2 2 4 4 1
 4  7   0.240000000000D 03          2         84
  1 2 2 1 1 2 2 1 1 3 3 4 4 1
 4  7   0.360000000000D 02          4         70
  1 2 2 3 3 1 1 2 2 3 3 4 4 1
 4  7   0.360000000000D 02          4        238
  1 2 2 1 1 3 3 2 2 3 3 4 4 1
 5  7   0.240000000000D 02          6        560
  1 2 2 3 3 1 1 4 4 2 2 5 5 1
 5  7   0.108000000000D 04          2        504
  1 2 2 1 1 3 3 1 1 4 4 5 5 1
 5  7   0.168000000000D 03         10        420
  1 2 2 1 1 2 2 3 3 4 4 5 5 1
 5  7   0.232800000000D 04          2        560
  1 2 2 1 1 3 3 4 4 3 3 5 5 1
 5  7   0.249600000000D 04          2        588
  1 2 2 1 1 3 3 4 4 5 5 3 3 1
 5  7   0.384000000000D 03          2        336
  1 2 2 3 3 1 1 2 2 4 4 5 5 1
 5  7   0.384000000000D 03          2        588
  1 2 2 1 1 3 3 2 2 4 4 5 5 1
 5  7  -0.264000000000D 03          2        420
  1 2 2 3 3 1 4 5 5 4 4 5 5 4
 5  7  -0.264000000000D 03          6        420
  1 2 2 1 3 4 4 3 3 4 4 5 5 3
 6  7   0.204000000000D 04          4       1680
  1 2 2 3 3 1 1 4 4 5 5 6 6 1
 6  7   0.763200000000D 04          2       1680
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 6  7  -0.104160000000D 05          2       1680
  1 2 2 1 3 4 4 3 3 5 5 6 6 3
 6  7  -0.415200000000D 04          2       1680
  1 2 2 3 3 1 4 5 5 4 4 6 6 4
 7  7   0.616800000000D 04          2       5040
  1 2 2 3 3 4 4 5 5 6 6 7 7 1
 7  7  -0.256800000000D 04          4       5040
  1 2 2 3 3 1 4 5 5 6 6 7 7 4
 7  7  -0.885600000000D 04          2       5040
  1 2 2 1 3 4 4 5 5 6 6 7 7 3
```

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 7  7    0.864000000000D 04       2      5040
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 2  8    0.600000000000D 01       1         2
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 3  8    0.800000000000D 01       3        80
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 3  8    0.660000000000D 02       2        16
  1  2  2 1 1 2 2 1 1 2 2 1 1 3 3 1
 3  8    0.660000000000D 02       1        24
  1  2  2 1 1 2 2 1 1 3 3 1 1 3 3 1
 3  8    0.800000000000D 01       6        16
  1  2  2 1 1 2 2 3 3 1 1 2 2 3 3 1
 4  8   -0.690000000000D 02       1       280
  1  2  2 1 1 2 2 1 3 4 4 3 3 4 4 3
 4  8    0.702000000000D 03       1       176
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 4  8   -0.690000000000D 02       2       112
  1  2  2 1 3 4 4 3 3 4 4 3 3 4 4 3
 4  8    0.200000000000D 01      12       400
  1  2  2 1 1 3 3 4 4 2 2 3 3 4 4 1
 4  8    0.330000000000D 02       2        72
  1  2  2 3 3 4 4 1 1 2 2 3 3 4 4 1
 4  8    0.330000000000D 02       1       800
  1  2  2 1 1 3 3 4 4 2 2 4 4 3 3 1
 4  8    0.330000000000D 02       4       336
  1  2  2 1 1 2 2 3 3 4 4 3 3 4 4 1
 4  8    0.702000000000D 03       2       256
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 4  8    0.220000000000D 03       3       160
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 4  8    0.360000000000D 02       8       192
  1  2  2 1 1 2 2 3 3 1 1 4 4 3 3 1
 4  8    0.360000000000D 02       2       128
  1  2  2 1 1 2 2 3 3 1 1 2 2 4 4 1
 4  8    0.240000000000D 03       2        96
  1  2  2 1 1 3 3 4 4 1 1 3 3 4 4 1
 4  8    0.240000000000D 03       1       608
  1  2  2 1 1 3 3 1 1 4 4 2 2 4 4 1
 4  8    0.330000000000D 02       8       224
  1  2  2 1 1 3 3 1 1 2 2 4 4 3 3 1
 4  8    0.330000000000D 02       8       112
  1  2  2 1 1 2 2 1 1 2 2 3 3 4 4 1
 4  8    0.200000000000D 01       6       720
  1  2  2 1 1 3 3 2 2 4 4 3 3 4 4 1
 4  8    0.360000000000D 02       2       176
  1  2  2 1 1 2 2 1 1 3 3 2 2 4 4 1
 4  8    0.360000000000D 02       8       352
  1  2  2 1 1 3 3 1 1 2 2 3 3 4 4 1
 5  8    0.696000000000D 03       2       912
  1  2  2 1 1 3 3 4 4 5 5 3 3 4 4 1
```

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 5  8   0.360000000000D 02    6    1632
  1 2 2 1 1 3 3 4 4 2 2 5 5 3 3 1
 5  8   0.124800000000D 04    4    1120
  1 2 2 1 1 2 2 3 3 4 4 3 3 5 5 1
 5  8   0.124800000000D 04    4     896
  1 2 2 1 1 3 3 1 1 2 2 4 4 5 5 1
 5  8  -0.264000000000D 03    2     336
  1 2 2 1 3 4 4 5 5 3 3 4 4 5 5 3
 5  8  -0.222000000000D 04    1    1120
  1 2 2 1 1 2 2 1 3 4 4 3 3 5 5 3
 5  8  -0.222000000000D 04    2     672
  1 2 2 1 3 4 4 3 3 4 4 3 3 5 5 3
 5  8   0.648000000000D 03    2    1408
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 5  8  -0.264000000000D 03    1    2016
  1 2 2 1 3 4 4 3 3 5 5 4 4 5 5 3
 5  8   0.696000000000D 03    2    1648
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 5  8   0.384000000000D 03    2    1904
  1 2 2 1 1 3 3 2 2 3 3 4 4 5 5 1
 5  8   0.204000000000D 03    8    1232
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 5  8   0.648000000000D 03    2     768
  1 2 2 1 1 3 3 4 4 1 1 3 3 5 5 1
 5  8   0.204000000000D 03   16     896
  1 2 2 1 1 2 2 3 3 1 1 4 4 5 5 1
 5  8   0.384000000000D 03    2     560
  1 2 2 3 3 1 1 2 2 3 3 4 4 5 5 1
 5  8   0.360000000000D 02    6     544
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 5  8   0.495000000000D 03    1    1152
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 5  8   0.678000000000D 04    1    1408
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 5  8   0.735000000000D 04    1    1632
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 5  8   0.124800000000D 04    2     672
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 5  8   0.192000000000D 03    2    1696
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 5  8   0.192000000000D 03    2    1648
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 5  8   0.192000000000D 03    2     912
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 6  8   0.384000000000D 03    4    4480
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 6  8   0.384000000000D 03    2    4480
  1 2 2 3 3 1 1 4 4 5 5 2 2 6 6 1
 6  8   0.900000000000D 01    6    4480
  1 2 2 3 3 4 4 1 1 5 5 3 3 6 6 1
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 6  8   0.529200000000D 04    2    4032
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 6  8   0.580800000000D 04    2    4480
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 6  8   0.127440000000D 05    2    4704
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 6  8   0.114000000000D 05    2    4480
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 6  8  -0.309780000000D 05    1    4704
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 6  8  -0.153600000000D 04    2    4704
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 6  8  -0.141600000000D 04    2    3360
  1 2 2 1 1 2 2 1 3 4 4 5 5 6 6 3
 6  8  -0.141600000000D 04    8    3360
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 6  8  -0.175800000000D 05    1    4480
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 6  8   0.966000000000D 03    2    2688
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 6  8  -0.966000000000D 04    1    4032
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 6  8   0.777600000000D 04    4    4480
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 6  8   0.240000000000D 04    2    2688
  1 2 2 3 3 1 1 2 2 4 4 5 5 6 6 1
 6  8   0.219600000000D 04    4    4704
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 6  8   0.966000000000D 03    2    4704
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 6  8   0.240000000000D 04    2    4704
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 6  8  -0.153600000000D 04    2    2688
  1 2 2 1 3 4 4 5 5 3 3 4 4 6 6 3
 6  8  -0.244000000000D 03   24    3360
  1 2 2 3 3 1 4 5 5 4 4 5 5 6 6 4
 6  8   0.163200000000D 04    4    4032
  1 2 2 1 1 3 3 4 4 1 1 5 5 6 6 1
 6  8   0.129200000000D 04    3    3360
  1 2 2 1 3 4 4 3 5 6 6 5 5 6 6 5
 6  8   0.970000000000D 03   12    3360
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 7  8   0.120960000000D 05    4   13440
  1 2 2 3 3 1 1 4 4 5 5 6 6 7 7 1
 7  8   0.496800000000D 04    4   13440
  1 2 2 3 3 4 4 1 1 5 5 6 6 7 7 1
 7  8  -0.108240000000D 05    4   13440
  1 2 2 1 3 4 4 5 5 3 3 6 6 7 7 3
 7  8   0.514680000000D 05    2   13440
  1 2 2 1 1 3 3 4 4 5 5 6 6 7 7 1
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7  8  -0.190320000000D 05     4   13440
 1 2 2 3 3 1 4 5 5 4 4 6 6 7 7 4
7  8  -0.219480000000D 05     2   13440
 1 2 2 1 1 3 3 1 4 5 5 6 6 7 7 4
7  8  -0.663120000000D 05     2   13440
 1 2 2 1 3 4 4 3 3 5 5 6 6 7 7 3
7  8   0.736140000000D 05     1   13440
 1 2 2 1 3 4 4 3 5 6 6 5 5 7 7 5
8  8   0.530400000000D 05     2   40320
 1 2 2 1 3 4 4 3 5 6 6 7 7 8 8 5
8  8  -0.158400000000D 05     4   40320
 1 2 2 3 3 1 4 5 5 6 6 7 7 8 8 4
8  8   0.420690000000D 05     2   40320
 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 1
8  8  -0.606540000000D 05     2   40320
 1 2 2 1 3 4 4 5 5 6 6 7 7 8 8 3
8  8  -0.300315000000D 05     1   40320
 1 2 2 1 3 4 4 3 5 6 6 5 7 8 8 7
8  8   0.183000000000D 05     4   40320
 1 2 2 1 3 4 4 5 5 3 6 7 7 8 8 6
8  8  -0.666750000000D 04     4   40320
 1 2 2 3 3 4 4 1 5 6 6 7 7 8 8 5
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