Names of Minor Planets and the Graphical Law

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(Dated: September 22, 2025)

Abstract

We study the Dictionary of Minor Planet Names of L. D. Schmadel. We draw the natural logarithm of the number of names, normalised, starting with a letter vs the natural logarithm of the rank of the letter, normalised. We conclude that the names of the minor planets discovered up to 1900 and 1910 can be characterised by BP(4,$\beta H = 0$) and the minor planets discovered up to 1920, 1930 and 1940 can be characterised by BP(4,$\beta H = 0.02$) i.e. a magnetisation curve for the Bethe-Peierls approximation of the Ising model with four nearest neighbours with $\beta H = 0.02$. β is $\frac{1}{k_B T}$ where, T is temperature, H is external magnetic field and k_B is the Boltzmann constant.

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I. INTRODUCTION

Ceres is the first minor planet to be discovered in 1801 January 1 by G. Piazzi at Palermo, capital of Sicily. This gets followed by enormous number of minor planets to be discovered and named. The Dictionary of Minor Planet Names by L. D. Schmadel, [1], is an important compilation along this direction.

In this article, we study magnetic field pattern behind this dictionary of the minor planets,[1]. We have started considering magnetic field pattern in [2], in the languages we converse with. We have studied there, a set of natural languages, [2] and have found existence of a magnetisation curve under each language. We have termed this phenomenon as graphical law.

Then, we moved on to investigate into, [3], dictionaries of five disciplines of knowledge and found existence of a curve magnetisation under each discipline. This was followed by finding of the graphical law behind the bengali language,[4] and the basque language[5]. This was pursued by finding of the graphical law behind the Romanian language, [6], five more disciplines of knowledge, [7], Onsager core of Abor-Miri, Mising languages,[8], Onsager Core of Romanised Bengali language,[9], the graphical law behind the Little Oxford English Dictionary, [10], the Oxford Dictionary of Social Work and Social Care, [11], the Visayan-English Dictionary, [12], Garo to English School Dictionary, [13] and Mursi-English-Amharic Dicionary, [14], respectively.

The planning of the paper is as follows. We give an introduction to the standard curves of magnetisation of Ising model in the section II. In the section III, we describe our method of study. The subsequent sections, IV-VIII, are analysis of the names of the minor planets, [1] discovered upto cut-off years 1900, 1910, 1920, 1930 and 1940 respectively. Sections IX, X are Acknowledgement and Bibliography respectively.

II. MAGNETISATION

A. Bragg-Williams approximation

Let us consider a coin. Let us toss it many times. Probability of getting head or, tale is half i.e. we will get head and tale equal number of times. If we attach value one to head, minus one to tale, the average value we obtain, after many tossing is zero. Instead let us consider a one-sided loaded coin, say on the head side. The probability of getting head is more than one half, getting tale is less than one-half. Average value, in this case, after many tossing we obtain is non-zero, the precise number depends on the loading. The loaded coin is like ferromagnet, the unloaded coin is like paramagnet, at zero external magnetic field. Average value we obtain is like magnetisation, loading is like coupling among the spins of the ferromagnetic units. Outcome of single coin toss is random, but average value we get after long sequence of tossing is fixed. This is long-range order. But if we take a small sequence of tossing, say, three consecutive tossing, the average value we obtain is not fixed, can be anything. There is no short-range order.

Let us consider a row of spins, one can imagine them as spears which can be vertically up or, down. Assume there is a long-range order with probability to get a spin up is two third. That would mean when we consider a long sequence of spins, two third of those are with spin up. Moreover, assign with each up spin a value one and a down spin a value minus one. Then total spin we obtain is one third. This value is referred to as the value of long-range order parameter. Now consider a short-range order existing which is identical with the long-range order. That would mean if we pick up any three consecutive spins, two will be up, one down. Bragg-Williams approximation means short-range order is identical with long-range order, applied to a lattice of spins, in general. Row of spins is a lattice of one dimension.

Now let us imagine an arbitrary lattice, with each up spin assigned a value one and a down spin a value minus one, with an unspecified long-range order parameter defined as above by $L = \frac{1}{N}\Sigma_i \sigma_i$, where σ_i is i-th spin, N being total number of spins. L can vary from minus one to one. $N = N_+ + N_-$, where N_+ is the number of up spins, N_- is the number of down spins. $L = \frac{1}{N}(N_+ - N_-)$. As a result, $N_+ = \frac{N}{2}(1+L)$ and $N_- = \frac{N}{2}(1-L)$. Magnetisation or, net magnetic moment , M is $\mu\Sigma_i\sigma_i$ or, $\mu(N_+ - N_-)$ or, μNL, $M_{max} = \mu N$. $\frac{M}{M_{max}} = L$. $\frac{M}{M_{max}}$ is referred to as reduced magnetisation. Moreover, the Ising Hamiltonian,[15], for the lattice of spins, setting μ to one, is $-\epsilon\Sigma_{n.n}\sigma_i\sigma_j - H\Sigma_i\sigma_i$, where n.n refers to nearest neighbour pairs.

The difference $\triangle E$ of energy if we flip an up spin to down spin is, [16], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_B T})$, [17]. In the Bragg-Williams approximation,[18], $\bar{\sigma} = L$, considered in the thermal average sense. Consequently,

$$ln\frac{1+L}{1-L} = 2\frac{\gamma\epsilon L + H}{k_B T} = 2\frac{L + \frac{H}{\gamma\epsilon}}{\frac{T}{\gamma\epsilon/k_B}} = 2\frac{L+c}{\frac{T}{T_c}} \tag{1}$$

where, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [19]. $\frac{T}{T_c}$ is referred to as reduced temperature.
Plot of L vs $\frac{T}{T_c}$ or, reduced magentisation vs. reduced temperature is used as reference curve. In the presence of magnetic field, $c \neq 0$, the curve bulges outward. Bragg-Williams is a Mean Field approximation. This approximation holds when number of neighbours interacting with a site is very large, reducing the importance of local fluctuation or, local order, making the long-range order or, average degree of freedom as the only degree of freedom of the lattice. To have a feeling how this approximation leads to matching between experimental and Ising model prediction one can refer to FIG.12.12 of [16]. W. L. Bragg was a professor of Hans Bethe. Rudlof Peierls was a friend of Hans Bethe. At the suggestion of W. L. Bragg, Rudlof Peierls following Hans Bethe improved the approximation scheme, applying quasi-chemical method.

B. Bethe-peierls approximation in presence of four nearest neighbours, in absence of external magnetic field

In the approximation scheme which is improvement over the Bragg-Williams, [15],[16],[17],[18],[19], due to Bethe-Peierls, [20], reduced magnetisation varies with reduced temperature, for γ neighbours, in absence of external magnetic field, as

$$\frac{ln\frac{\gamma}{\gamma-2}}{ln\frac{factor-1}{factor^{\frac{\gamma-1}{\gamma}} - factor^{\frac{1}{\gamma}}}} = \frac{T}{T_c}; factor = \frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \tag{2}$$

$ln\frac{\gamma}{\gamma-2}$ for four nearest neighbours i.e. for $\gamma = 4$ is 0.693. For a snapshot of different kind of magnetisation curves for magnetic materials the reader is urged to give a google search "reduced magnetisation vs reduced temperature curve". In the following, we describe datas generated from the equation(1) and the equation(2) in the table, I, and curves of magnetisation plotted on the basis of those datas. BW stands for reduced temperature in Bragg-Williams approximation, calculated from the equation(1). BP(4) represents reduced temperature in the Bethe-Peierls approximation, for four nearest neighbours, computed from the equation(2). The data set is used to plot fig.1. Empty spaces in the table, I, mean corresponding point pairs were not used for plotting a line.

reduced temperature, $\frac{T}{T_c}$				$\frac{M}{M_{max}}$,
BW(c=0)	BW(c=0.005)	BW(c=0.01)	BP(4,βH = 0)	reduced magnetisation
0	0	0	0	1
0.435	0.437	0.439	0.563	0.978
0.439	0.441	0.443	0.568	0.977
0.491	0.493	0.495	0.624	0.961
0.501	0.504	0.507	0.630	0.957
0.514	0.517	0.519	0.648	0.952
0.559	0.562	0.565	0.654	0.931
0.566	0.569	0.573	0.7	0.927
0.584	0.587	0.590	0.7	0.917
0.601	0.604	0.607	0.722	0.907
0.607	0.610	0.613	0.729	0.903
0.653	0.658	0.661	0.770	0.869
0.659	0.663	0.666	0.773	0.865
0.669	0.674	0.678	0.784	0.856
0.679	0.684	0.688	0.792	0.847
0.701	0.705	0.709	0.807	0.828
0.723	0.728	0.732	0.828	0.805
0.732	0.736	0.743	0.832	0.796
0.753	0.758	0.766	0.845	0.772
0.779	0.784	0.788	0.864	0.740
0.838	0.844	0.853	0.911	0.651
0.850	0.858	0.864	0.911	0.628
0.870	0.877	0.885	0.923	0.592
0.883	0.891	0.899	0.928	0.564
0.899	0.908	0.918		0.527
0.905	0.914	0.926	0.941	0.513
0.944	0.956	0.968	0.965	0.400
		0.985		0.350
		0.998		0.310
0.969	0.985		0.965	0.300
	0.998			0.250
0.987			1	0.200
0.997			1	0.100
1			1	0

TABLE I. Datas for Reduced temperature[for the Bragg-Williams approximation, in the absence (BW(c=0)) and in the presence (BW(c=0.005), BW(c=0.01)) of magnetic field, $c = 0$, $c = \frac{H}{\gamma\epsilon} = 0.005$, $c = \frac{H}{\gamma\epsilon} = 0.01$ respectively and in the Bethe-Peierls approximation, BP(4,βH=0), in the absence of magnetic field, for four nearest neighbours] vs reduced magnetisation. Reduced temperature data set(say, data set BW(c=0)) is drawn along the x-axis and the corresponding Reduced magnetisation data set is drawn along the y-axis. In gnuplot the command is plot ".dat" using 1:2 with line; 1 standing for x-axis and 2 standing for y-axis datas.[For example, for drawing BW(c=0), ".dat" file, say denoted as "0.dat", contains BW(c=0) data set in first column and reduced magnetisation data set in second column. Moreover, after (0.944,0.400), next pair of points will be (0.969,0.300), then (0.987,0.200), ...and so on in the "0.dat" file.]

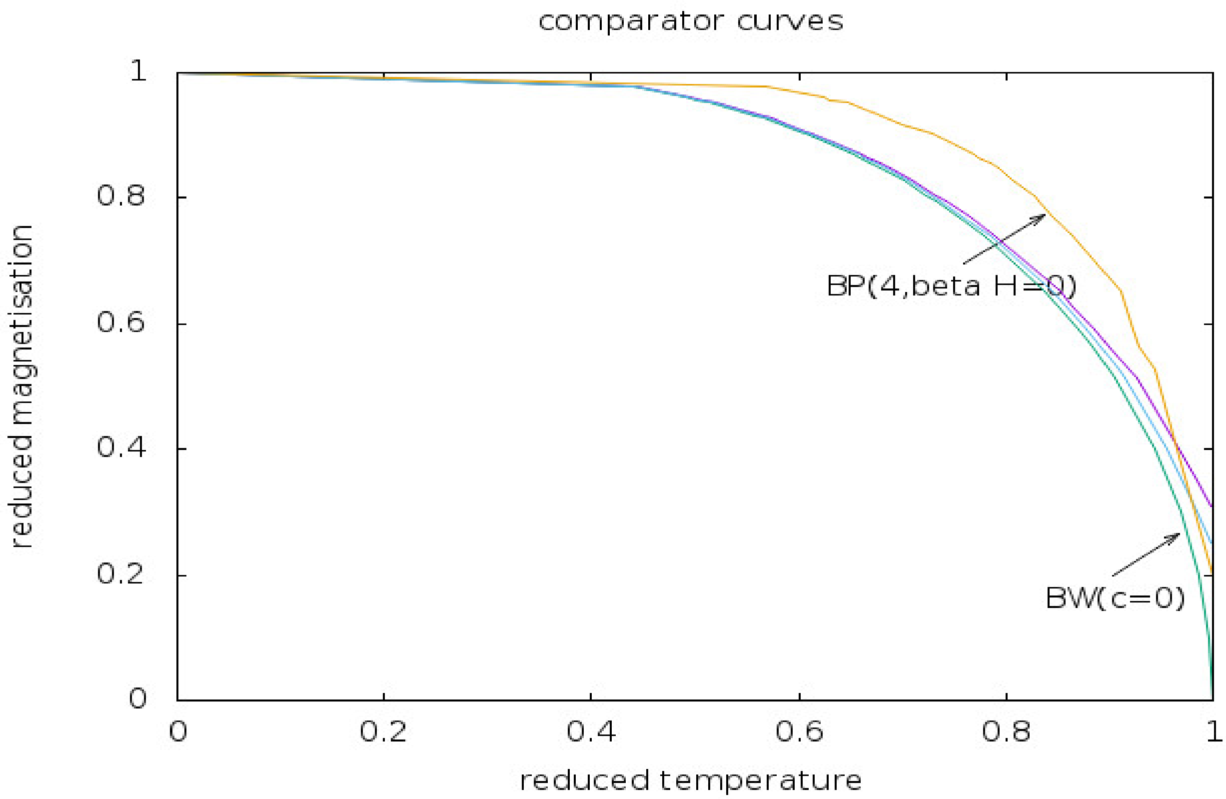

FIG. 1. Reduced magnetisation vs reduced temperature curves, for the Bragg-Williams approximation, in the absence (BW(c=0)) and in the presence (BW(c=0.005), BW(c=0.01)) of magnetic field, $c = 0$, $c = \frac{H}{\gamma\epsilon} = 0.005$, $c = \frac{H}{\gamma\epsilon} = 0.01$, outwards; and in the Bethe-Peierls approximation, BP(4,βH=0), in the absence of magnetic field, for four nearest neighbours (outer in the top).

C. Bethe-peierls approximation in presence of four nearest neighbours, in presence of external magnetic field

In the Bethe-Peierls approximation scheme, [20], reduced magnetisation varies with reduced temperature, for γ neighbours, in presence of external magnetic field, as

$$\frac{ln\frac{\gamma}{\gamma-2}}{ln\frac{factor-1}{e^{\frac{2\beta H}{\gamma}}factor^{\frac{\gamma-1}{\gamma}}-e^{-\frac{2\beta H}{\gamma}}factor^{\frac{1}{\gamma}}}}=\frac{T}{T_c};factor=\frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \tag{3}$$

Derivation of this formula ala [20] is given in the appendix of [7].

$ln\frac{\gamma}{\gamma-2}$ for four nearest neighbours i.e. for $\gamma=4$ is 0.693. For four neighbours,

$$\frac{0.693}{ln\frac{factor-1}{e^{\frac{2\beta H}{\gamma}}factor^{\frac{\gamma-1}{\gamma}}-e^{-\frac{2\beta H}{\gamma}}factor^{\frac{1}{\gamma}}}}=\frac{T}{T_c};factor=\frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \tag{4}$$

In the following, we describe datas in the table, II, generated from the equation(4) and curves of magnetisation plotted on the basis of those datas. BP(m=0.03) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H=0.06$. calculated from the equation(4). BP(m=0.025) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H=0.05$. calculated from the equation(4). BP(m=0.02) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H=0.04$. calculated from the equation(4). BP(m=0.01) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H=0.02$. calculated from the equation(4). BP(m=0.005) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H=0.01$. calculated from the equation(4). The data set is used to plot fig.2. Empty spaces in the table, II, mean corresponding point pairs were not used for plotting a line.

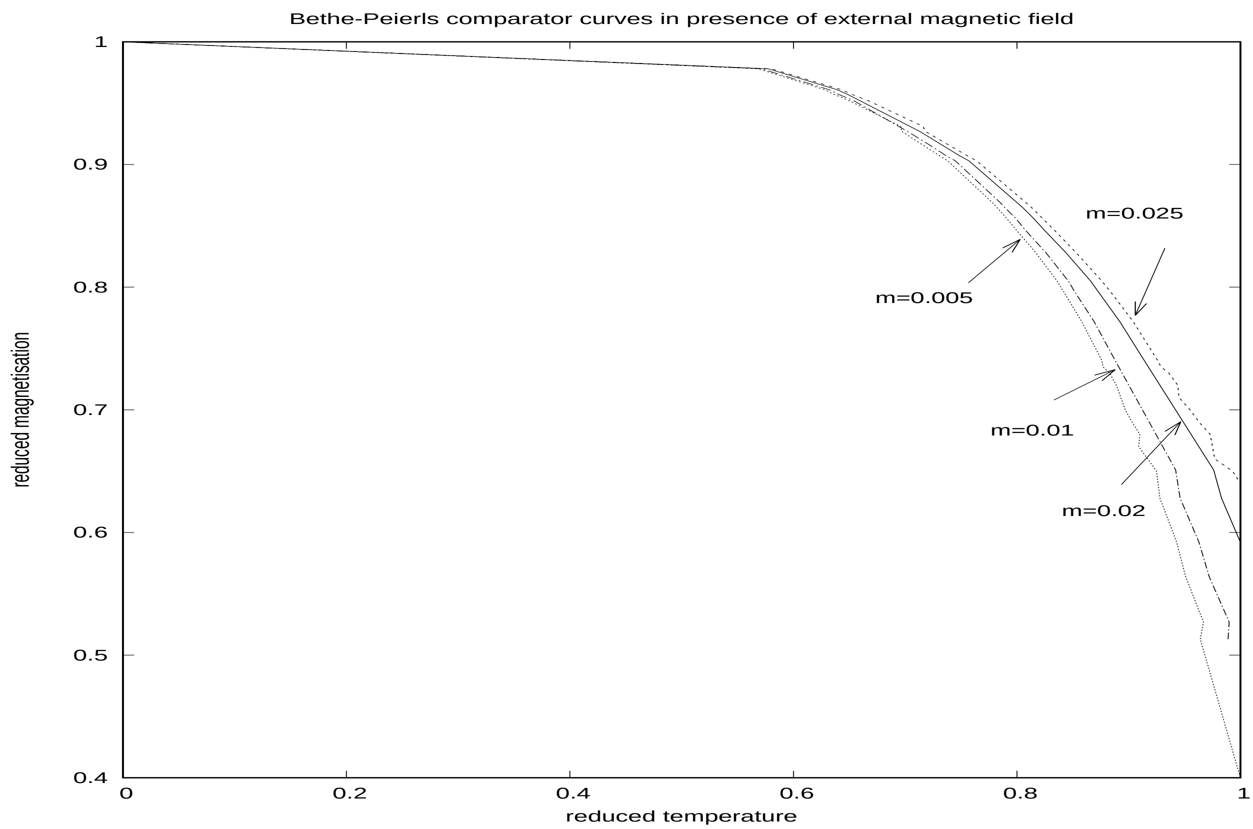

FIG. 2. Reduced magnetisation vs reduced temperature curves for Bethe-Peierls approximation in presence of little external magnetic fields, for four nearest neighbours, with $\beta H = 2m$.

reduced temperature, $\frac{T}{T_c}$					$\frac{M}{M_{max}}$,
BP(m=0.03)	BP(m=0.025)	BP(m=0.02)	BP(m=0.01)	BP(m=0.005)	reduced magnetisation
0	0	0	0	0	1
0.583	0.580	0.577	0.572	0.569	0.978
0.587	0.584	0.581	0.575	0.572	0.977
0.647	0.643	0.639	0.632	0.628	0.961
0.657	0.653	0.649	0.641	0.637	0.957
0.671	0.667		0.654	0.650	0.952
	0.716			0.696	0.931
0.723	0.718	0.713	0.702	0.697	0.927
0.743	0.737	0.731	0.720	0.714	0.917
0.762	0.756	0.749	0.737	0.731	0.907
0.770	0.764	0.757	0.745	0.738	0.903
0.816	0.808	0.800	0.785	0.778	0.869
0.821	0.813	0.805	0.789	0.782	0.865
0.832	0.823	0.815	0.799	0.791	0.856
0.841	0.833	0.824	0.807	0.799	0.847
0.863	0.853	0.844	0.826	0.817	0.828
0.887	0.876	0.866	0.846	0.836	0.805
0.895	0.884	0.873	0.852	0.842	0.796
0.916	0.904	0.892	0.869	0.858	0.772
0.940	0.926	0.914	0.888	0.876	0.740
	0.929			0.877	0.735
	0.936			0.883	0.730
	0.944			0.889	0.720
	0.945				0.710
	0.955			0.897	0.700
	0.963			0.903	0.690
	0.973			0.910	0.680
				0.909	0.670
	0.993			0.925	0.650
		0.976	0.942		0.651
	1.00				0.640
		0.983	0.946	0.928	0.628
		1.00	0.963	0.943	0.592
			0.972	0.951	0.564
			0.990	0.967	0.527
				0.964	0.513
			1.00		0.500
				1.00	0.400
					0.300
					0.200
					0.100
					0

TABLE II. Bethe-Peierls approx. in presence of little external magnetic fields

D. Onsager solution

At a temperature T, below a certain temperature called phase transition temperature, T_c, for the two dimensional Ising model in absence of external magnetic field i.e. for H equal to zero, the exact, unapproximated, Onsager solution gives reduced magnetisation as a function of reduced temperature as, [21], [22], [23], [20],

$$\frac{M}{M_{max}} = [1 - (sinh\frac{0.8813736}{\frac{T}{T_c}})^{-4}]^{1/8}.$$

Graphically, the Onsager solution appears as in fig.3.

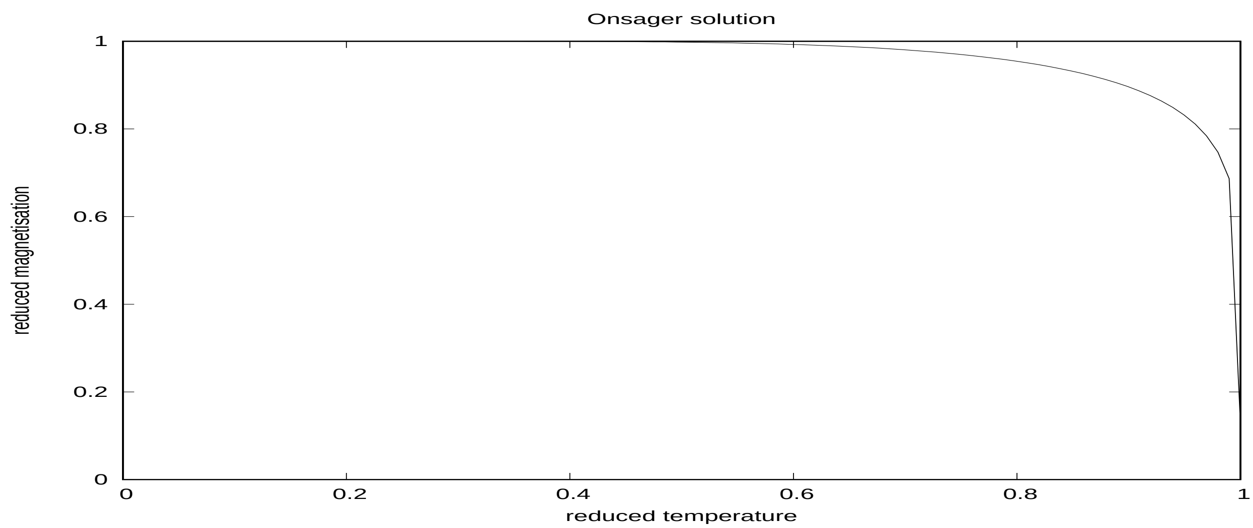

FIG. 3. Reduced magnetisation vs reduced temperature curves for exact solution of two dimensional Ising model, due to Onsager, in absence of external magnetic field

III. METHOD OF STUDY

We count all the names of the minor planets, discovered upto 1939 end, in the dictionary, [1], one by one from the beginning to the end and arrange according to the initial letter of a name. We arrange with cut-off years 1900,1910, 1920, 1930 and 1940 respectively. The result is the tables, III, V, VII, IX and XI respectively.

We have not counted the following minor planets: (3177)1934AK(discovered in 1934 January8), (3229)A916PC(discovered in 1916 August 9), (3427)1938AD(discovered in 1938 January 6), (3567)1930VD(discovered in 1930 November 15), (3761)1936OH(discovered in 1936 July 25), (3768)1937RB(discovered in 1937 September 5), (4297)1938HE(discovered in 1938 April 19), (4420)1936PB(discovered in 1936 August 15), (4509)A917SG(discovered in 1917 September 23), (4588)1931EE(discovered in 1913 March 13), (4647)1931TU_1(discovered in 1931 October 9), (4775)1927TC(discovered in 1927 October 3), (4808)1925BA(discovered in 1925 January 21), (4809)1928RB(discovered in 1928 September 5), (4849)1936QV(discovered in 1936 August 17), (5152)1931UD(discovered in 1931 October 18), (5452)1937NN(discovered in 1937 July 5), (5494)1933UM_1(discovered in 1933 October 19), (5532)1932CY(discovered in 1932 February 14), (5533)1935SC(discovered in 1935 September 21) respectively. These are without proper names.

To visualise we plot the tables, in the figure, 4. For the purpose of exploring graphical law, we assort the letters according to the number of names, in the descending order, denoted by f and the respective rank, [24], denoted by k. k is a positive integer starting from one. Moreover, we attach a limiting rank, k_{lim}, and a limiting number of names, if the least number of names is not one. The limiting rank is maximum rank plus one. the limiting number of names is one. As a result both $\frac{lnf}{lnf_{max}}$ and $\frac{lnk}{lnk_{lim}}$ varies from zero to one. We do this for five cut-off years. Then we tabulate in the respective table and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the respective figure.

We then ignore the letter with the highest number of names to start with, tabulate in the respective table, and redo the plot, normalising the lnfs with next-to-maximum $lnf_{nextmax}$, and starting from $k = 2$ in the respective figure. Normalising the lnfs with next-to-next-to-maximum $lnf_{nextnextmax}$, we tabulate in the respective table, and starting from $k = 3$ we draw in the respective figure. Normalising the lnfs with next-to-next-to-next-to-maximum $lnf_{nextnextnextmax}$ we record in the respective table and plot starting from $k = 4$ in the

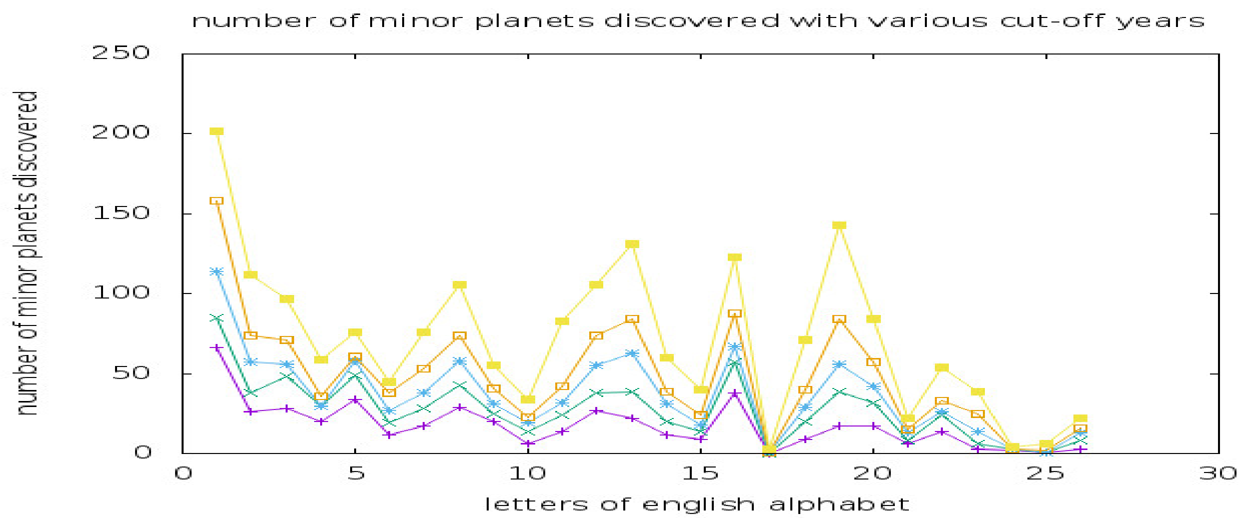

FIG. 4. Vertical axis is number of planets discovered up to a cut-off year. Cut-off years are 1900, 1909, 1919, 1929 and 1939 respectively. Horizontal axis is the letters of the English alphabet. Letters are represented by the sequence number in the English alphabet.

respective figure.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
66	26	28	20	34	12	17	29	20	6	14	27	22	12	9	38	0	9	17	17	6	14	3	2	1	3

TABLE III. names of minor planets discovered up to 1899 end

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/lnf_{n-max}	lnf/lnf_{2n-max}	lnf/lnf_{3n-max}
1	0	0	66	4.190	1	Blank	Blank	Blank
2	0.69	0.244	38	3.638	0.868	1	Blank	Blank
3	1.10	0.389	34	3.526	0.842	0.969	1	Blank
4	1.39	0.491	29	3.367	0.804	0.926	0.955	1
5	1.61	0.569	28	3.332	0.795	0.916	0.945	0.989
6	1.79	0.633	27	3.296	0.787	0.906	0.935	0.979
7	1.95	0.689	26	3.258	0.778	0.896	0.924	0.968
8	2.08	0.735	22	3.091	0.738	0.850	0.877	0.918
9	2.20	0.777	20	2.996	0.715	0.824	0.850	0.889
10	2.30	0.813	17	2.833	0.676	0.779	0.803	0.841
11	2.40	0.848	14	2.639	0.630	0.725	0.748	0.784
12	2.48	0.876	12	2.485	0.593	0.683	0.705	0.738
13	2.56	0.905	9	2.197	0.524	0.604	0.623	0.652
14	2.64	0.933	6	1.792	0.428	0.493	0.508	0.532
15	2.71	0.958	3	1.099	0.262	0.302	0.312	0.326
16	2.77	0.979	2	0.693	0.165	0.190	0.197	0.205
17	2.83	1	1	0	0	0	0	0

TABLE IV. names of minor planets discovered up to 1899 end: ranking, natural logarithm, normalisations

IV. DISCOVERED UP TO 1899 END

In this section we tabulate and analyse the names of the minor planets discovered upto 1899 end. The number of planets along the letters to start with is as in the table, III. The table for the graphical law analysis is IV. The corresponding plots are fig.5-fig.8.

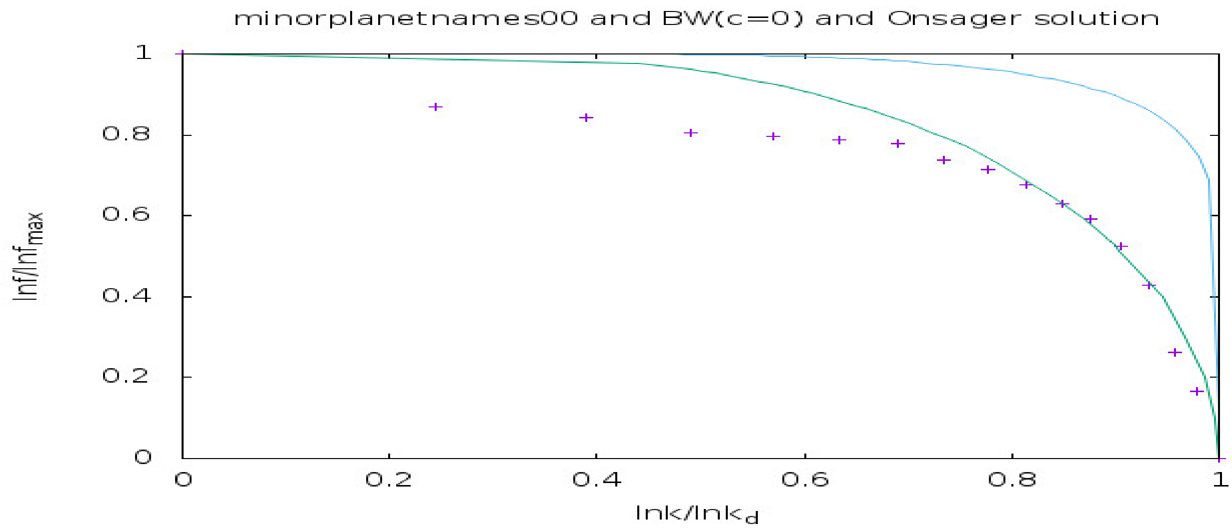

FIG. 5. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1899 end, with the fit curve being the Bragg-Williams curve in absence of external magnetic field, BW(c=0). The uppermost curve is the Onsager solution.

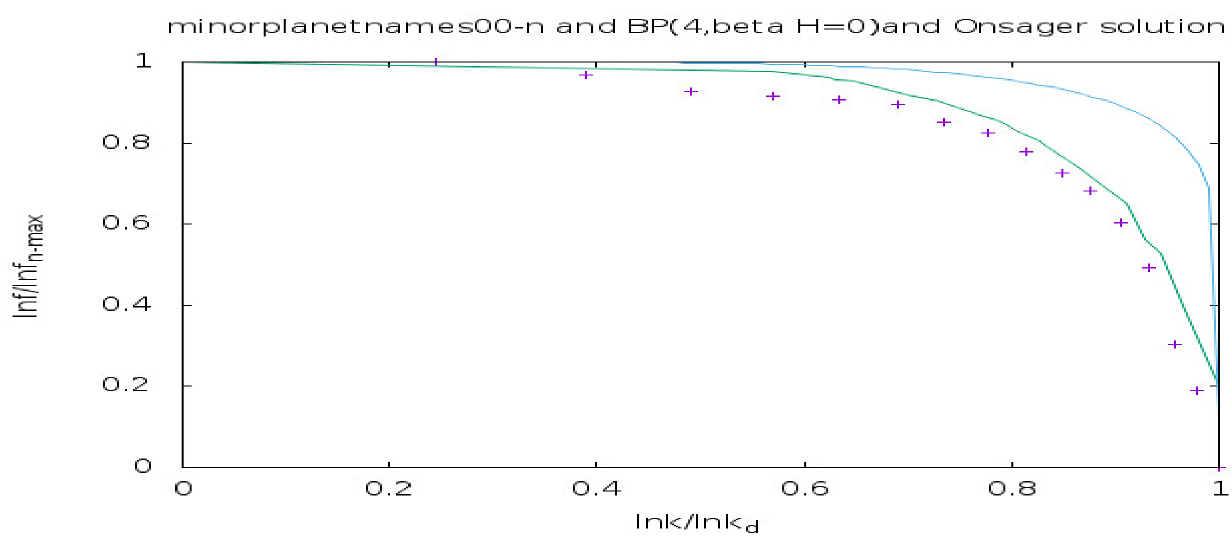

FIG. 6. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1899 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

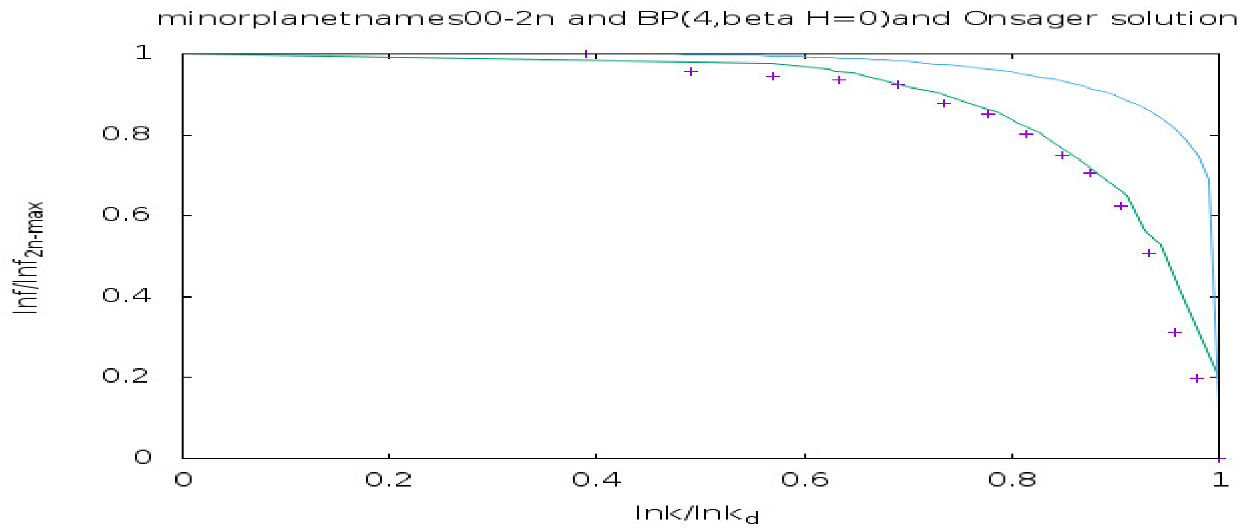

FIG. 7. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1899 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

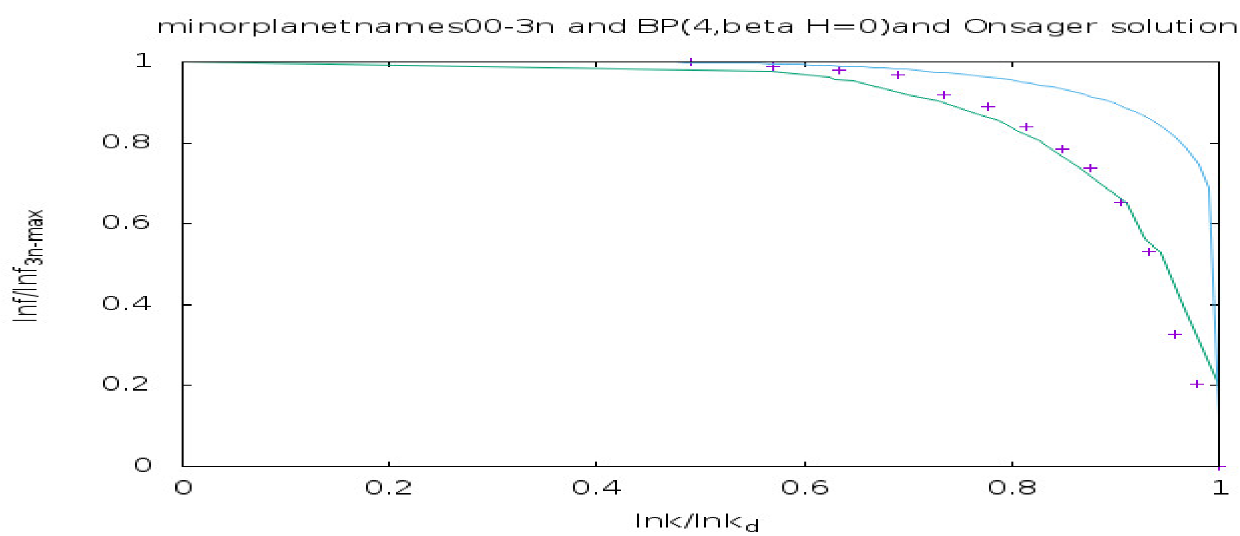

FIG. 8. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1899 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

1. conclusion

From the figures (fig.5-fig.8), we observe that behind the names of the minor planets discovered upto 1900, [1], there is a magnetisation curve, BP(4,$\beta H = 0$), in the Bethe-Peierls approximation with four nearest neighbours, in absence of external magnetic field, $H = 0$. Moreover, the associated correspondence with the Ising model is,

$$\frac{lnf}{lnf_{2n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [25]. As temperature decreases, i.e. lnk decreases, f increases. The letters which are recording higher entries compared to those which have lesser entries are at lower temperature.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
85	38	48	30	49	19	28	43	25	14	24	38	39	20	14	57	0	20	39	32	8	24	6	3	1	8

TABLE V. names of minor planets discovered up to 1909 end

V. DISCOVERED UP TO 1909 END

In this section we tabulate and analyse the names of the minor planets discovered up to 1909 end. The number of planets along the letters to start with is as in the table, V. The table for the graphical law analysis is VI. The corresponding plots are fig.9-fig.12.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/lnf_{nmax}	lnf/lnf_{nnmax}	lnf/lnf_{nnnmax}
1	0	0	85	4.443	1	Blank	Blank	Blank
2	0.69	0.235	57	4.043	0.910	1	Blank	Blank
3	1.10	0.373	49	3.892	0.876	0.963	1	Blank
4	1.39	0.471	48	3.871	0.871	0.957	0.995	1
5	1.61	0.547	43	3.761	0.847	0.930	0.966	0.972
6	1.79	0.609	39	3.664	0.825	0.906	0.941	0.947
7	1.95	0.661	38	3.638	0.819	0.900	0.935	0.940
8	2.08	0.706	32	3.466	0.780	0.857	0.891	0.895
9	2.20	0.746	30	3.401	0.765	0.841	0.874	0.879
10	2.30	0.782	28	3.332	0.750	0.824	0.856	0.861
11	2.40	0.815	25	3.219	0.725	0.796	0.827	0.832
12	2.48	0.844	24	3.178	0.715	0.786	0.817	0.821
13	2.56	0.871	20	2.996	0.674	0.741	0.770	0.774
14	2.64	0.896	19	2.944	0.663	0.728	0.756	0.761
15	2.71	0.920	14	2.639	0.594	0.653	0.678	0.682
16	2.77	0.942	8	2.079	0.468	0.514	0.534	0.537
17	2.83	0.962	6	1.792	0.403	0.443	0.460	0.463
18	2.89	0.982	3	1.099	0.247	0.272	0.282	0.284
19	2.94	1	1	0	0	0	0	0

TABLE VI. names of minor planets discovered up to 1909 end: ranking, natural logarithm, normalisations

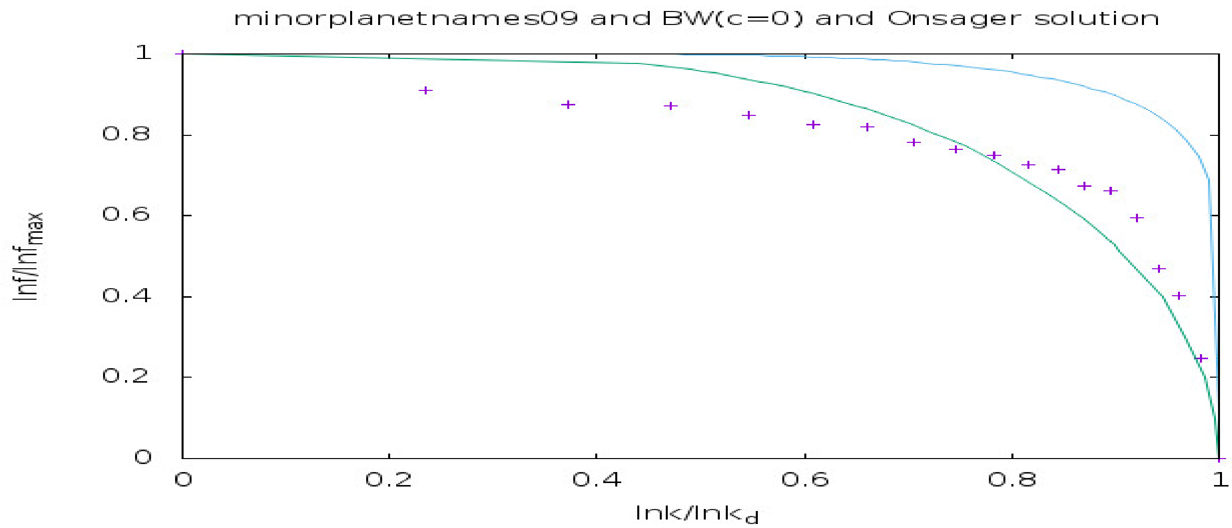

FIG. 9. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1909 end, with the fit curve being the Bragg-Williams curve in absence of external magnetic field, BW(c=0). The uppermost curve is the Onsager solution.

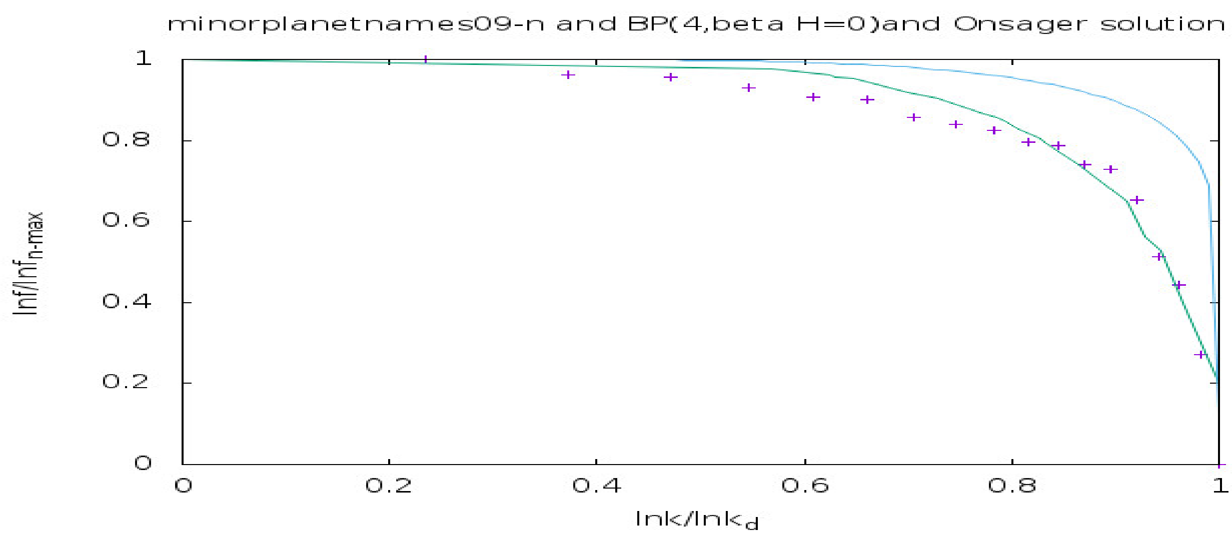

FIG. 10. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1909 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

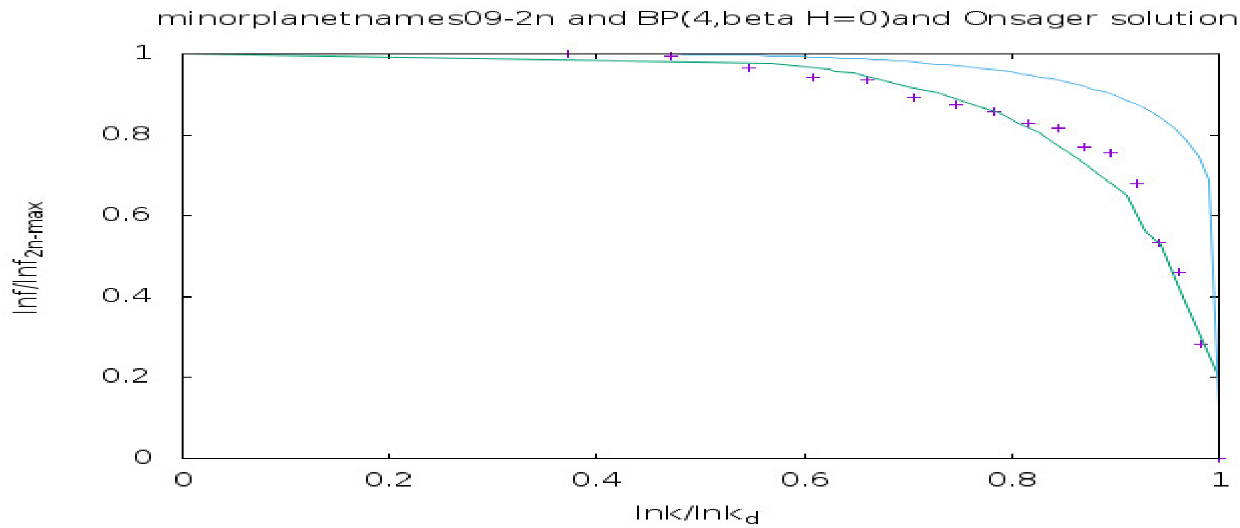

FIG. 11. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1909 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

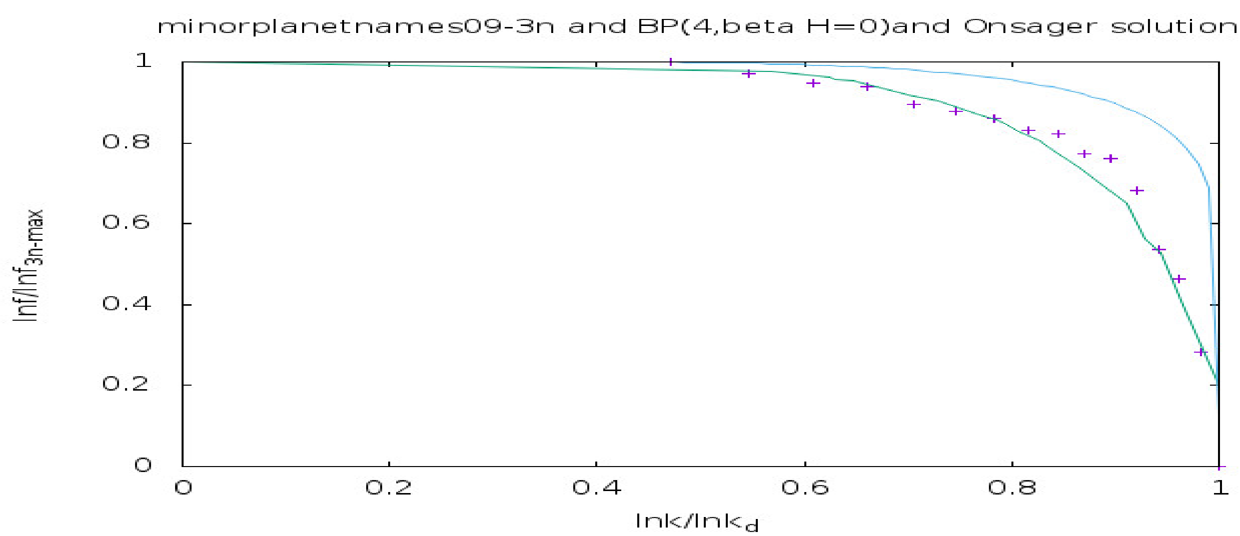

FIG. 12. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1909 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

1. conclusion

From the figures (fig.9-fig.12), we observe that behind the names of the minor planets discovered upto 1909, [1], there is a magnetisation curve, BP(4,$\beta H = 0$), in the Bethe-Peierls approximation with four nearest neighbours, in absence of external magnetic field, $H = 0$. Moreover, the associated correspondance with the Ising model is,

$$\frac{lnf}{lnf_{2n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [25]. As temperature decreases, i.e. lnk decreases, f increases.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
114	57	56	30	58	27	38	58	31	19	32	55	63	31	18	67	1	29	56	42	13	26	14	3	1	13

TABLE VII. names of minor planets discovered up to 1919 end

VI. DISCOVERED UP TO 1919 END

In this section we tabulate and analyse the names of the minor planets discovered upto 1919 end. The number of planets along the letters to start with is as in the table, VII. The table for the graphical law analysis is VIII. The corresponding plots are fig.13-fig.16.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/lnf_{nmax}	lnf/lnf_{nnmax}	lnf/lnf_{nnnmax}
1	0	0	114	4.736	1	Blank	Blank	Blank
2	0.69	0.228	67	4.205	0.888	1	Blank	Blank
3	1.10	0.361	63	4.143	0.875	0.985	1	Blank
4	1.39	0.455	58	4.060	0.857	0.966	0.980	1
5	1.61	0.528	57	4.043	0.854	0.961	0.976	0.996
6	1.79	0.589	56	4.025	0.850	0.957	0.972	0.991
7	1.95	0.639	55	4.007	0.846	0.953	0.967	0.987
8	2.08	0.683	42	3.738	0.789	0.889	0.902	0.921
9	2.20	0.722	38	3.638	0.768	0.865	0.878	0.896
10	2.30	0.756	32	3.466	0.732	0.824	0.837	0.854
11	2.40	0.788	31	3.434	0.725	0.817	0.829	0.846
12	2.48	0.816	30	3.401	0.718	0.809	0.821	0.838
13	2.56	0.842	29	3.367	0.711	0.801	0.813	0.829
14	2.64	0.867	27	3.296	0.696	0.784	0.796	0.812
15	2.71	0.889	26	3.258	0.688	0.775	0.786	0.802
16	2.77	0.911	19	2.944	0.622	0.700	0.711	0.725
17	2.83	0.930	18	2.890	0.610	0.687	0.698	0.712
18	2.89	0.949	14	2.639	0.557	0.628	0.637	0.650
19	2.94	0.967	13	2.565	0.542	0.610	0.619	0.632
20	3.00	0.984	3	1.099	0.232	0.261	0.265	0.271
21	3.05	1	1	0	0	0	0	0

TABLE VIII. names of minor planets discovered up to 1919 end: ranking, natural logarithm, normalisations

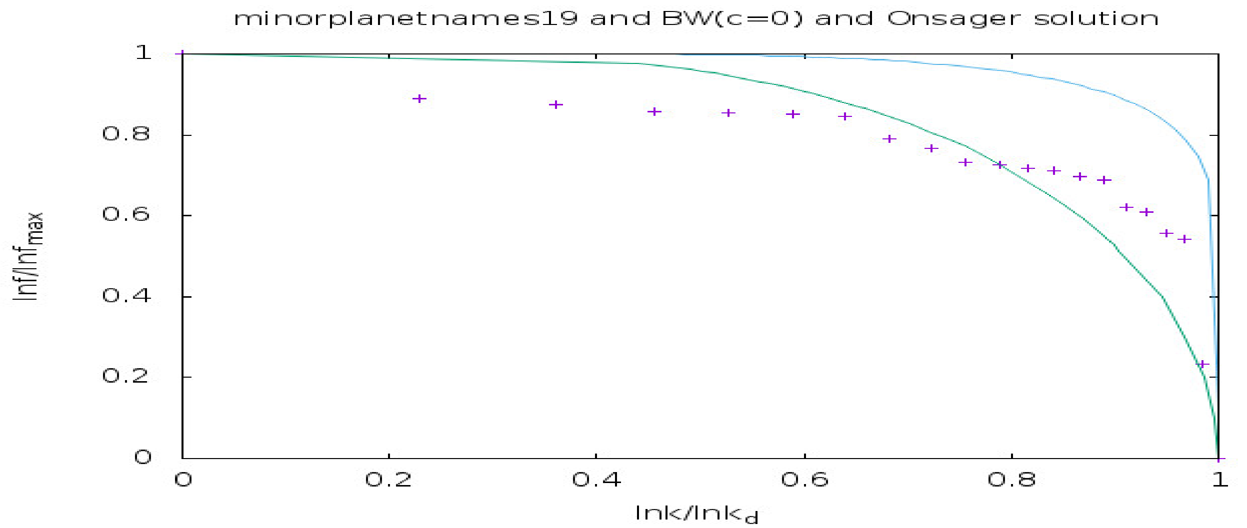

FIG. 13. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1919 end, with the fit curve being the Bragg-Williams curve in absence of external magnetic field, BW(c=0). The uppermost curve is the Onsager solution.

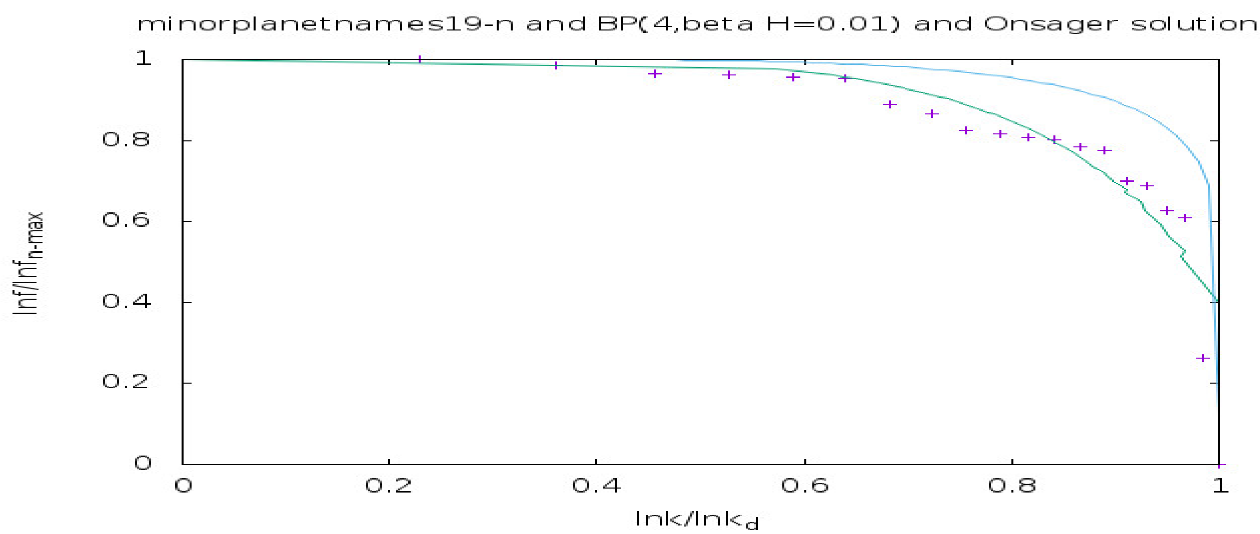

FIG. 14. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1919 end, with the fit curve being Bethe-Peierls curve, BP(4, $\beta H = 0.01$), in presence of four nearest neighbours and little external magnetic field, $m = 0.005$ or, $\beta H = 0.01$. The uppermost curve is the Onsager solution.

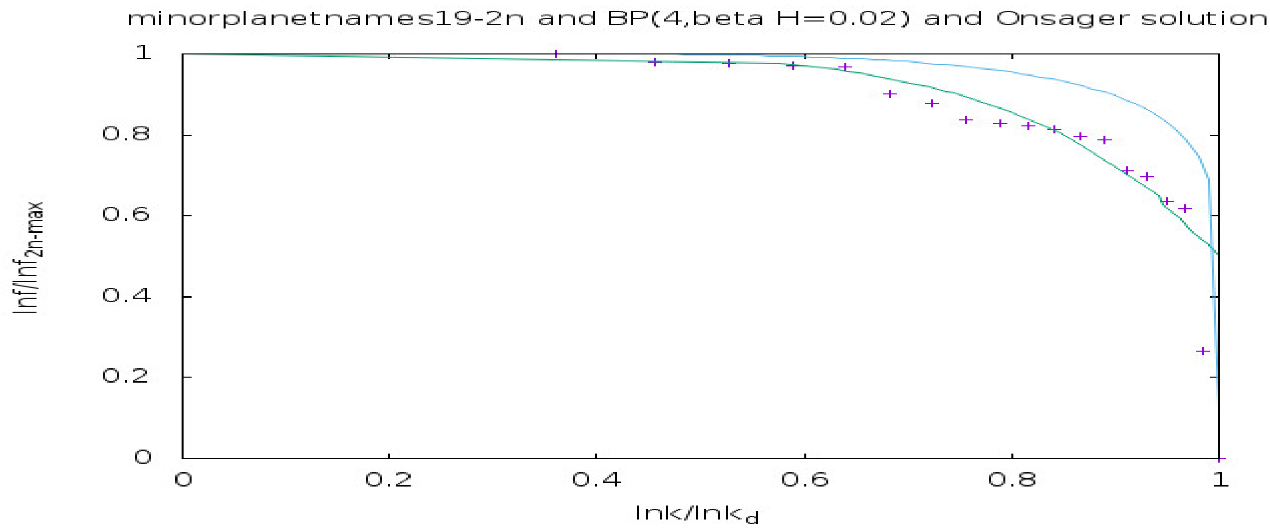

FIG. 15. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1919 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

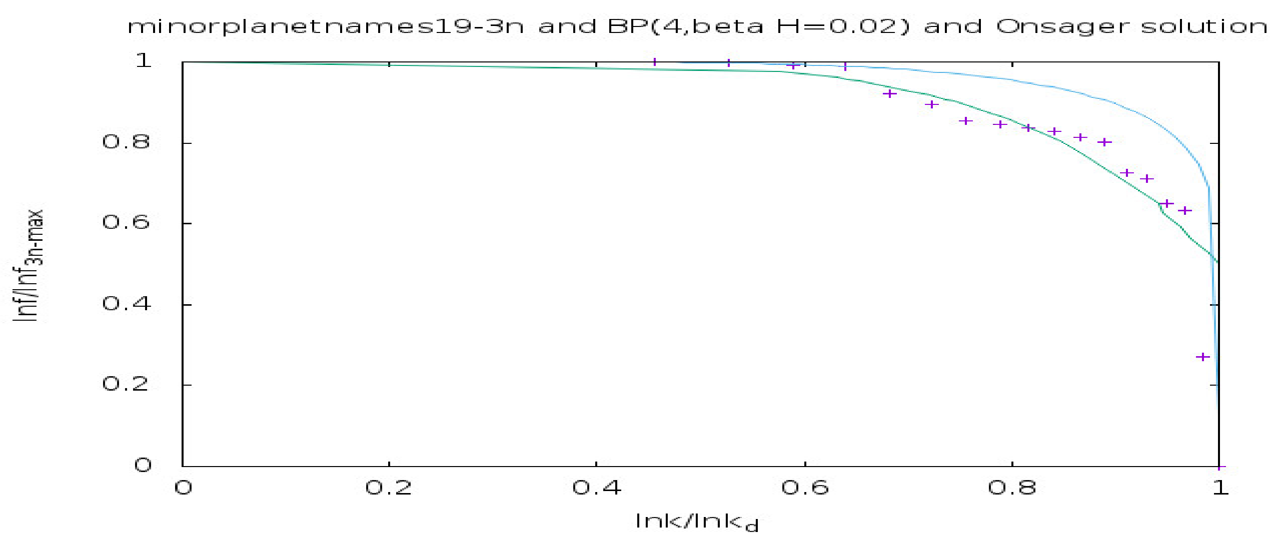

FIG. 16. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1919 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

1. conclusion

From the figures (fig.13-fig.16), we observe that behind the names of the minor planets discovered up to 1919, [1], there is a magnetisation curve, BP(4,$\beta H = 0.02$), in the Bethe-Peierls approximation with four nearest neighbours, in presence of little magnetic field, $\beta H = 0.02$.

Moreover, the associated correspondence with the Ising model is,

$$\frac{lnf}{lnf_{2n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [25]. As temperature decreases, i.e. lnk decreases, f increases. The letters which are recording higher entries compared to those which have lesser entries are at lower temperature.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
158	74	71	36	61	38	53	74	41	23	42	74	84	39	24	88	1	40	84	57	15	33	25	3	2	16

TABLE IX. names of minor planets discovered up to 1929 end

VII. DISCOVERED UP TO 1929 END

In this section we tabulate and analyse the names of the minor planets discovered upto 1929 end. The number of planets along the letters to start with is as in the table, IX. The table for the graphical law analysis is X. The corresponding plots are fig.17-fig.20.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/$lnf_{next-max}$	lnf/lnf_{nnmax}	lnf/lnf_{nnnmax}
1	0	0	158	5.063	1	Blank	Blank	Blank
2	0.69	0.220	88	4.477	0.884	1	Blank	Blank
3	1.10	0.350	84	4.431	0.875	0.990	1	Blank
4	1.39	0.443	74	4.304	0.850	0.961	.971	1
5	1.61	0.513	71	4.263	0.842	0.952	.962	.990
6	1.79	0.570	61	4.111	0.812	0.918	.928	.955
7	1.95	0.621	57	4.043	0.799	0.903	.912	.939
8	2.08	0.662	53	3.970	0.784	0.887	.896	.922
9	2.20	0.701	42	3.738	0.738	0.835	.844	.868
10	2.30	0.732	41	3.714	0.734	0.830	.838	.863
11	2.40	0.764	40	3.680	0.729	0.824	.833	.857
12	2.48	0.790	39	3.664	0.724	0.818	.827	.851
13	2.56	0.815	38	3.638	0.719	0.813	.821	.845
14	2.64	0.841	36	3.584	0.708	0.801	.809	.833
15	2.71	0.863	33	3.497	0.691	0.781	.789	.813
16	2.77	0.882	25	3.219	0.636	0.719	.726	.748
17	2.83	0.901	24	3.178	0.628	0.710	.717	.738
18	2.89	0.920	23	3.135	0.619	0.700	.708	.728
19	2.94	0.936	16	2.773	0.548	0.619	.626	.644
20	3.00	0.955	15	2.708	0.535	0.605	.611	.629
21	3.04	0.968	3	1.099	0.217	0.245	.248	.255
22	3.09	0.984	2	0.693	0.137	0.155	.156	.161
23	3.14	1	1	0	0	0	0	0

TABLE X. names of minor planets discovered up to 1929 end: ranking, natural logarithm, normalisations

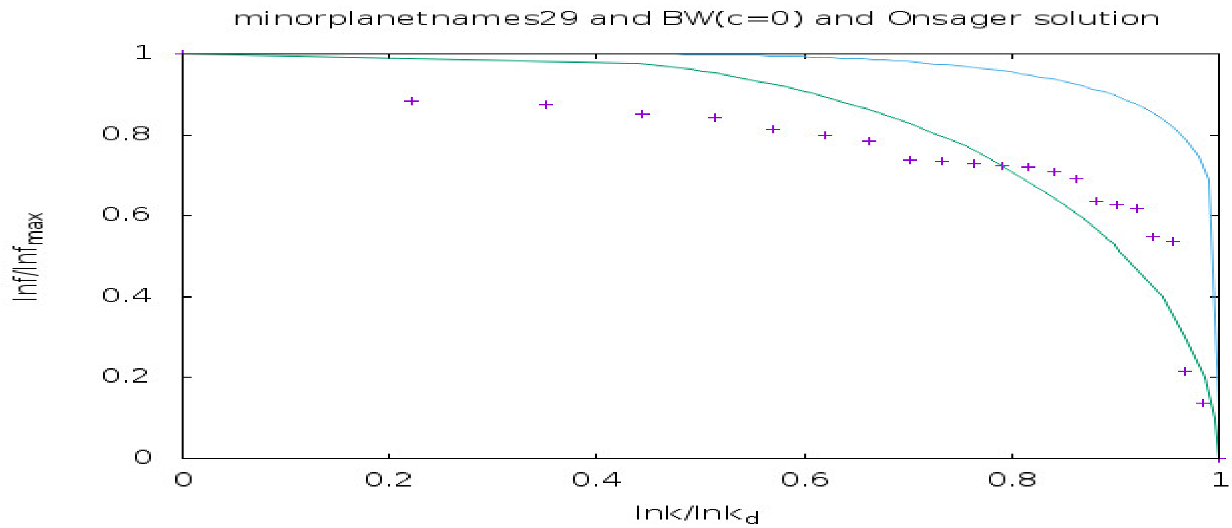

FIG. 17. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1929 end, with the fit curve being the Bragg-Williams curve in absence of external magnetic field, BW(c=0). The uppermost curve is the Onsager solution.

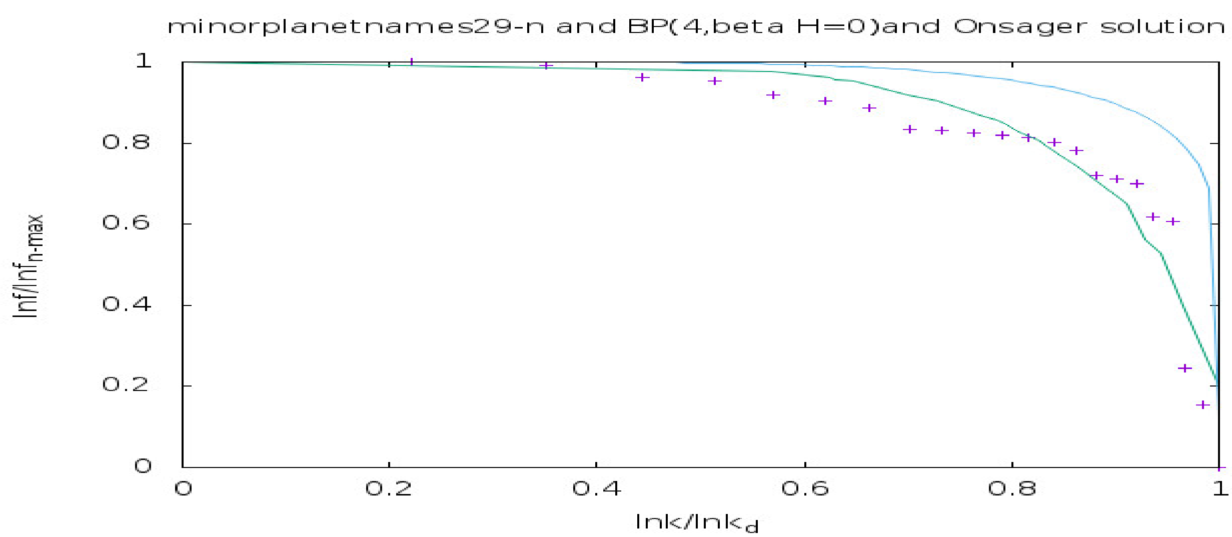

FIG. 18. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1929 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

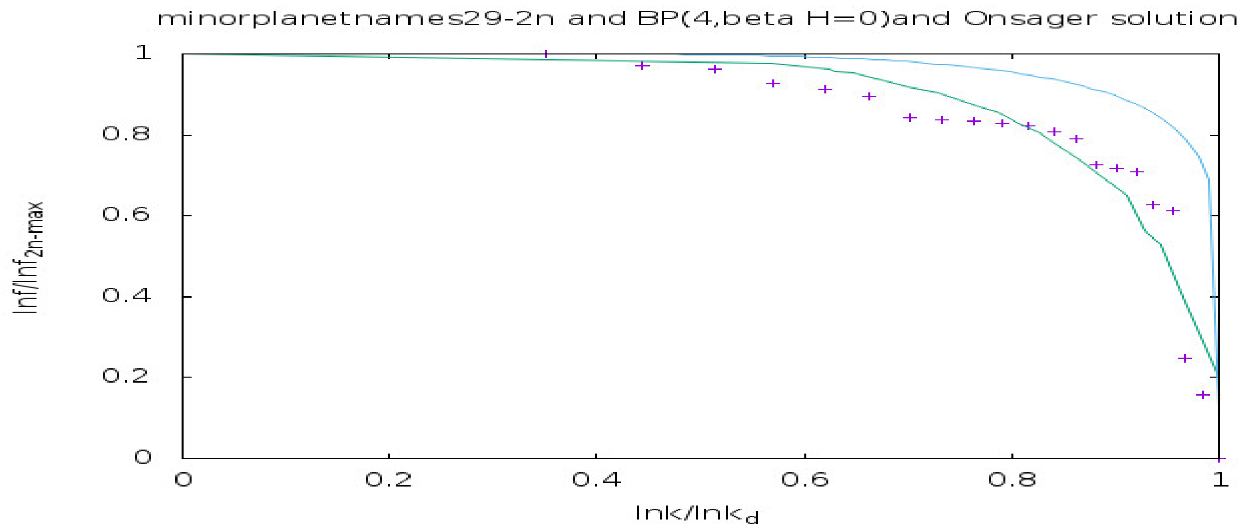

FIG. 19. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1929 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

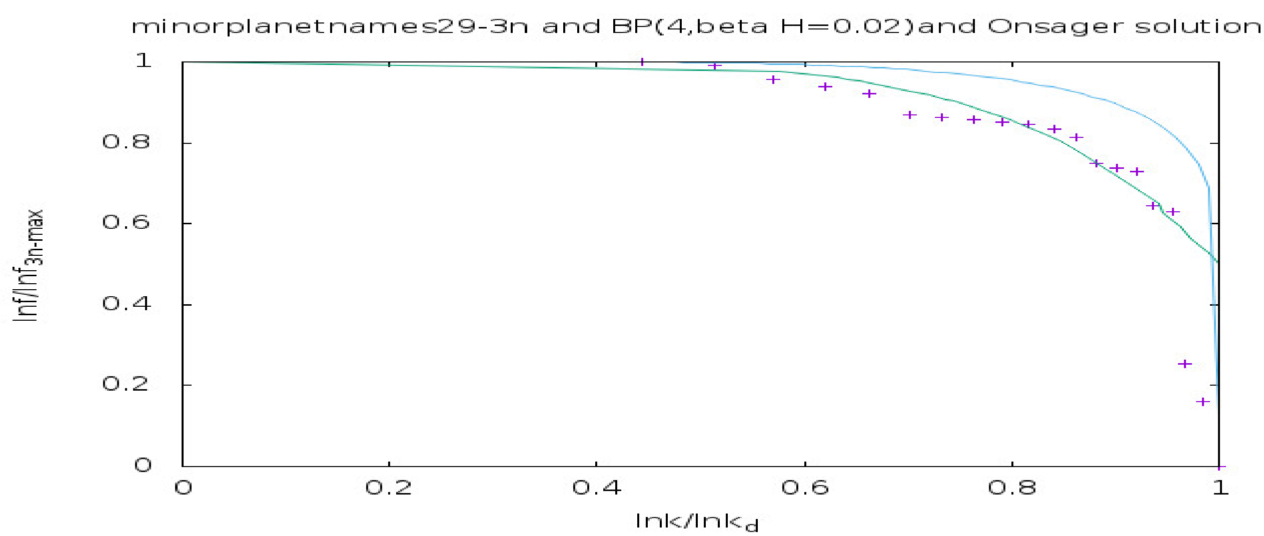

FIG. 20. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1929 end, with the fit curve being Bethe-Peierls curve, BP(4, $\beta H = 0.02$), in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

1. conclusion

From the figures (fig.17-fig.20), we observe that behind the names of the minor planets discovered up to 1929, [1], there is a magnetisation curve, BP(4,$\beta H = 0.02$), in the Bethe-Peierls approximation with four nearest neighbours, in presence of little magnetic field, $\beta H = 0.02$.

Moreover, the associated correspondence with the Ising model is,

$$\frac{lnf}{lnf_{3n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [25]. As temperature decreases, i.e. lnk decreases, f increases. The letters which are recording higher entries compared to those which have lesser entries are at lower temperature.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
202	112	97	59	76	45	76	106	55	34	83	106	131	60	40	123	3	71	143	84	22	54	39	4	6	22

TABLE XI. names of minor planets discovered up to 1939 end

VIII. DISCOVERED UP TO 1939 END

In this section we tabulate and analyse the names of the minor planets discovered upto 1939 end. The number of planets along the letters to start with is as in the table, XI. The table for the graphical law analysis is XII. The corresponding plots are fig.21-fig.24.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/$lnf_{next-max}$	lnf/lnf_{nnmax}	lnf/lnf_{nnnmax}
1	0	0	202	5.308	1	Blank	Blank	Blank
2	0.69	0.217	143	4.963	0.935	1	Blank	Blank
3	1.10	0.346	131	4.875	0.918	0.982	1	Blank
4	1.39	0.437	123	4.812	0.907	0.970	.987	1
5	1.61	0.506	112	4.718	0.889	0.951	.968	.980
6	1.79	0.563	106	4.663	0.878	0.940	.957	.969
7	1.95	0.613	97	4.575	0.862	0.922	.938	.951
8	2.08	0.654	84	4.431	0.835	0.893	.909	.921
9	2.20	0.692	83	4.419	0.833	0.890	.906	.918
10	2.30	0.723	76	4.331	0.816	0.873	.888	.900
11	2.40	0.755	71	4.263	0.803	0.859	.874	.886
12	2.48	0.780	60	4.094	0.771	0.825	.840	.851
13	2.56	0.805	59	4.078	0.768	0.822	.837	.847
14	2.64	0.830	55	4.007	0.755	0.807	.822	.833
15	2.71	0.852	54	3.989	0.752	0.804	.818	.829
16	2.77	0.871	45	3.807	0.717	0.767	.781	.791
17	2.83	0.890	40	3.689	0.695	0.743	.757	.767
18	2.89	0.909	39	3.664	0.690	0.738	.752	.761
19	2.94	0.925	34	3.526	0.664	0.710	.723	.733
20	3.00	0.943	22	3.091	0.582	0.623	.634	.642
21	3.04	0.956	6	1.792	0.338	0.361	.368	.372
22	3.09	0.972	4	1.386	0.261	0.279	.284	.288
23	3.14	0.987	3	1.099	0.207	0.221	.225	.228
24	3.18	1	1	0	0	0	0	0

TABLE XII. names of minor planets discovered up to 1939 end: ranking, natural logarithm, normalisations

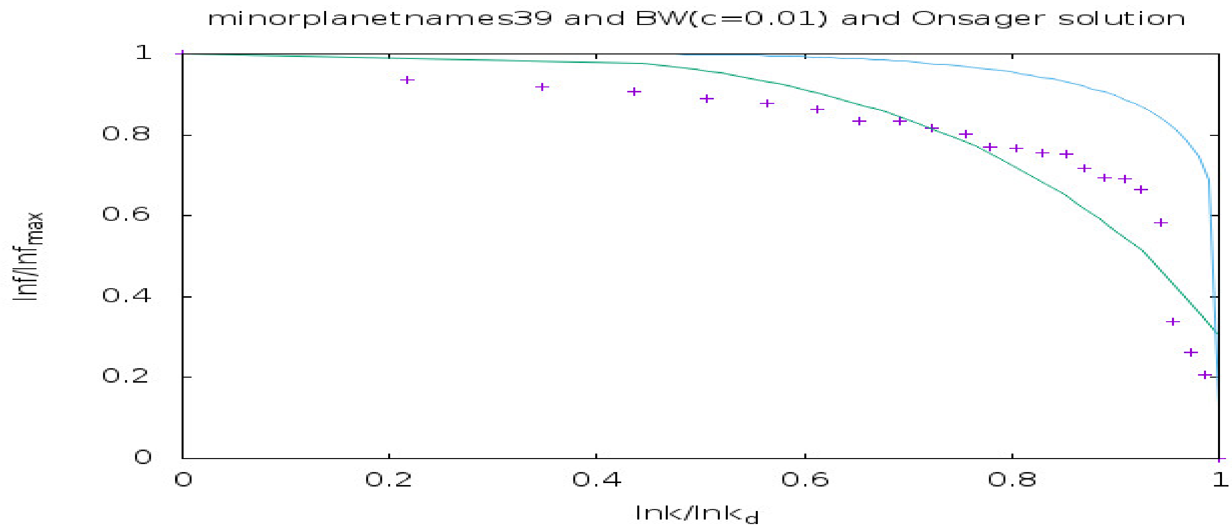

FIG. 21. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1939 end, with the fit curve being the Bragg-Williams curve in presence of external magnetic field, BW(c=0.01). The uppermost curve is the Onsager solution.

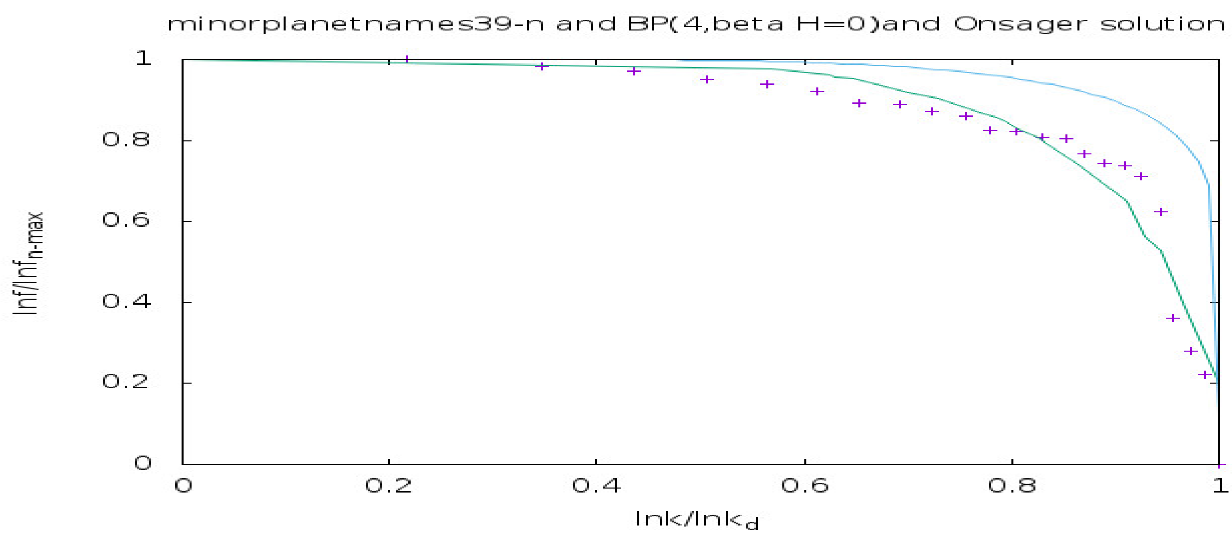

FIG. 22. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1939 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

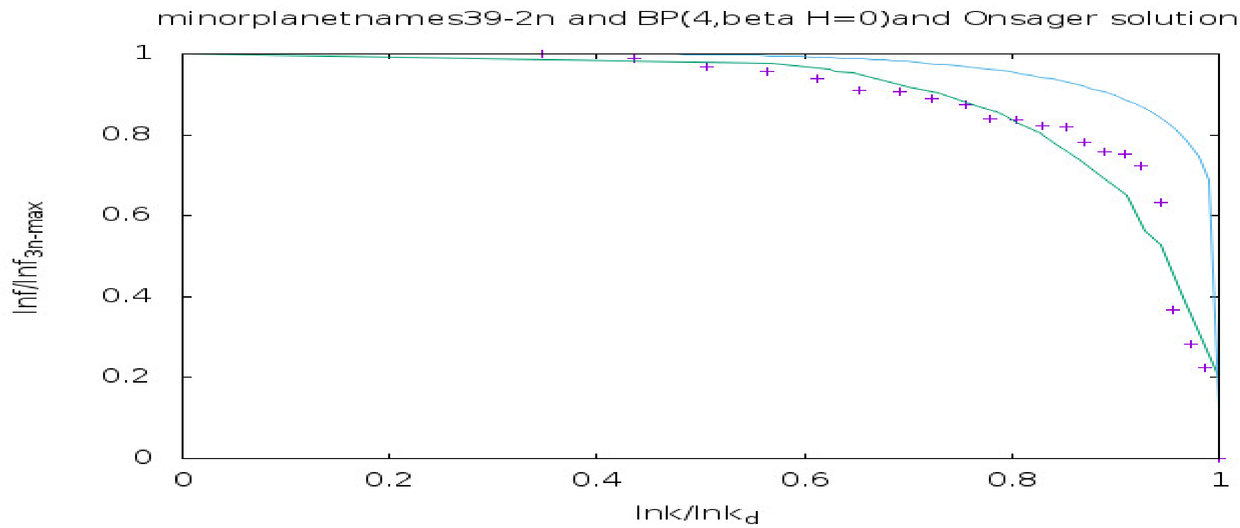

FIG. 23. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1939 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H = 0$). The uppermost curve is the Onsager solution.

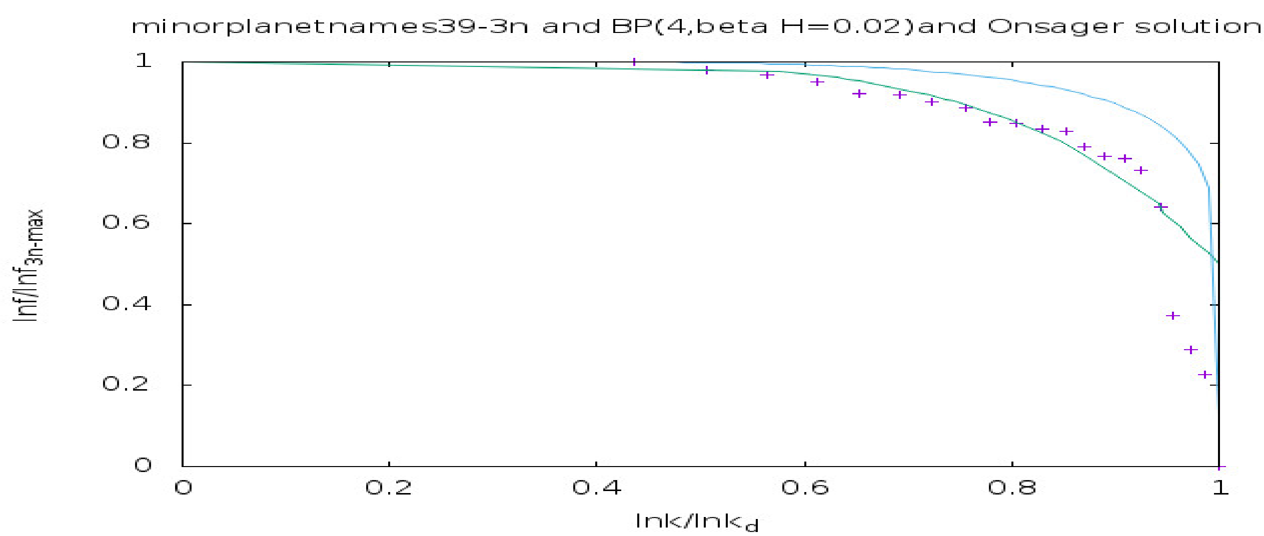

FIG. 24. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the names of the minor planets discovered up to 1939 end, with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

1. conclusion

From the figures (fig.21-fig.24), we observe that behind the names of the minor planets discovered up to 1939, [1], there is a magnetisation curve, BP(4,$\beta H = 0.02$), in the Bethe-Peierls approximation with four nearest neighbours, in presence of little magnetic field, $\beta H = 0.02$.
Moreover, the associated correspondence with the Ising model is,

$$\frac{lnf}{lnf_{3n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [25]. As temperature decreases, i.e. lnk decreases, f increases. The letters which are recording higher entries compared to those which have lesser entries are at lower temperature.

IX. ACKNOWLEDGEMENT

We have used gnuplot for drawing the figures. We would like to thank nehu library for allowing us to use the dictionary of Minor Planet Names,[1]. While writing this paper, the author lost one of his closest and longest friend by the name Biswajit Sengupta, nicknamed Chaitanya. He got drowned while performing the last rite of his father who expired two weeks back. The author would like to dedicate the paper to him and his father.

X. BIBLIOGRAPHY

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