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Dictionary of Mong Njua and the Graphical Law

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Abstract

We study the head entries of Dictionary of Mong Njua by Thomas Amis Lyman. We draw the natural logarithm of the number of head entries, normalised, starting with a letter vs the natural logarithm of the rank of the letter, normalised. We conclude that the Dictionary can be characterised by BP(4, βH=0), i.e. the magnetisation curve in the Bethe-Peierls approximation of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H, with βH= 0. β is $\frac{1}{k_B T}$ where, T is temperature and k_B is the tiny Boltzmann constant.

Keywords: Mong Njua, Dictionary, Ranking, Magnetisation, Ising Model, Bethe-Peierls approximation.

Introduction

"The Mong Njua tribe is also known as 'Green Miao' or 'Green Meo'. The tribe itself, however, uses the ethnic name Mong to which a descriptive term is added to designate the particular branch of the Mong group. In reference to themselves, the tribesmen used the designator nju'a, 'to be green, be azure'. The Mong constitute a sub-division of the ethnic group known as Miao who inhabits the mountainous regions of Southwestern China, North Vietnam, Laos and the Shan states of Burma and northern Thailand. The Miao are divided by linguistic and cultural differences into a number of tribes whose names often derive from the color or pattern of their women's garments (White Miao, Black Miao, Striped Miao etc). The Mong Njua or 'Green Miao' with 'White Miao' and 'Banded-Sleeve Miao' are the three sub-groups of Miao to be found in Thailand....."....Dictionary of Mong Njua, [1].

In this paper, we turn to Dictionary of Mong Njua, [1]. We go through the head entries. We count all the head entries of the dictionary, [1], one by one from the beginning to the end. The result is the table, Table 1. To visualise we plot the number of head entries against the respective letters in the dictionary sequence, [1], in the adjoining figure, Figure1.

Table 1: The head entries of Dictionary of Mong Njua against Mong Njua alphabet, [1].

?	**c**	**ch**	**č**	**čh**	**¢**	**¢h**	**f**	**h**	**hl**	**hs**
61	81	48	44	16	46	57	43	39	26	1
hy	k	kh	khl	kl	l	m	mb	mbl	ml	mph
19	97	42	5	53	98	57	30	18	5	5
mphl	n	n ¢h	nd	nth	nz	n̂	n̂ch	n̂dj	n̂j	n̂t_jh
1	53	15	40	5	25	42	10	23	42	4
ňčh	ňǰ	ng	ng g	ng gl	ngγ	ng kh	ng khl	ng qh	p	ph
6	33	5	20	9	19	2	0	2	92	37
phl	pl	q	qh	s	š	t	th	t_j	t_jh	v
10	23	56	23	62	58	98	48	69	30	31
									y	ž
									63	39

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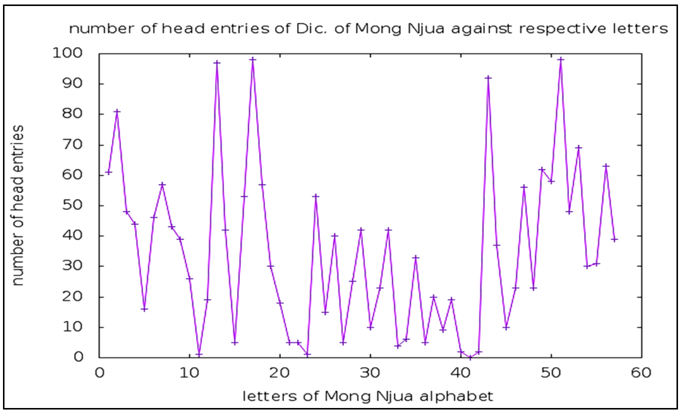

Fig 1: The vertical axis is the number of the head entries of Dictionary of Mong Njua [1]. The horizontal axis is the letters of the Mong alphabet. Letters are represented by the sequence number in the alphabet as it appears in the dictionary, [1].

Next we look for the graphical law. 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 the Graphical Law. Then, we moved on to investigate, [3], into dictionaries of five disciplines of knowledge and found the existence of a curve of magnetisation under each discipline. This was followed by finding of the graphical law in the references from [4] to [103].

The planning of the paper is as follows. In the next section, we describe the Graphical Law analysis of the head entries of Dictionary of Mong Njua, [1]. In the section III, we give an introduction to the standard curves of magnetisation of Ising model. The section IV is Acknowledgment. The last section is Bibliography.

The Graphical Law Analysis

For the purpose of exploring graphical law, we assort the letters according to the number of head entries, in the descending order, denoted by f and the respective rank, denoted by k. k is a positive integer starting from one. The lowest value of f is one. The corresponding rank, k, denoted as k_{lim} is thirty eight. As a result both $\frac{lnf}{lnf_{max}}$ and $\frac{lnk}{lnk_{lim}}$ varies from zero to one. Then we tabulate in the adjoining table, Table-2, and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure, Figure 2. We then ignore the letter with the highest number of head entries starting with, tabulate in the adjoining table, Table-2, and redo the plot, normalising the lnf s with next-to-maximum $lnf_{n\text{-}max}$, and starting from k=2 in the figure, Figure 3. This program then we repeat up to k=5, resulting in the figures up to Figure 7.

Table 2: The head entries of Dictionary of Mong Njua: ranking, natural logarithm, normalisations

k	lnk	$\frac{lnk}{lnk_{lim}}$	f	lnf	$\frac{lnf}{lnf_{max}}$	$\frac{lnf}{lnf_{nmax}}$	$\frac{lnf}{lnf_{2nmax}}$	$\frac{lnf}{lnf_{3nmax}}$	$\frac{lnf}{lnf_{4nmax}}$	$\frac{lnf}{lnf_{5nmax}}$
1	0	0	98	4.585	1	Blank	Blank	Blank	Blank	Blank
2	0.69	0.190	97	4.575	0.998	1	Blank	Blank	Blank	Blank
3	1.10	0.302	92	4.522	0.986	0.988	1	Blank	Blank	Blank
4	1.39	0.382	81	4.394	0.958	0.960	0.972	1	Blank	Blank
5	1.61	0.442	69	4.234	0.923	0.925	0.936	0.964	1	Blank
6	1.79	0.492	63	4.143	0.904	0.906	0.916	0.943	0.979	1
7	1.95	0.536	62	4.127	0.900	0.902	0.913	0.939	0.975	0.996
8	2.08	0.571	61	4.111	0.897	0.899	0.909	0.936	0.971	0.992
9	2.20	0.604	58	4.060	0.885	0.887	0.898	0.924	0.959	0.980
10	2.30	0.632	57	4.043	0.882	0.884	0.894	0.920	0.955	0.976
11	2.40	0.659	56	4.025	0.878	0.880	0.890	0.916	0.951	0.972
12	2.48	0.681	53	3.970	0.866	0.868	0.878	0.904	0.938	0.958
13	2.56	0.703	48	3.871	0.844	0.846	0.856	0.881	0.914	0.934
14	2.64	0.725	46	3.829	0.835	0.837	0.847	0.871	0.904	0.924
15	2.71	0.745	44	3.784	0.825	0.827	0.837	0.861	0.894	0.913
16	2.77	0.761	43	3.761	0.820	0.822	0.832	0.856	0.888	0.908
17	2.83	0.777	42	3.738	0.815	0.817	0.827	0.851	0.883	0.902
18	2.89	0.794	40	3.689	0.805	0.806	0.816	0.840	0.871	0.890
19	2.94	0.808	39	3.664	0.799	0.801	0.810	0.834	0.865	0.884
20	3.00	0.824	37	3.611	0.788	0.789	0.799	0.822	0.853	0.872

21	3.04	0.835	33	3.497	0.763	0.764	0.773	0.796	0.826	0.844
22	3.09	0.849	31	3.434	0.749	0.751	0.759	0.782	0.811	0.829
23	3.14	0.863	30	3.401	0.742	0.743	0.752	0.774	0.803	0.821
24	3.18	0.874	26	3.258	0.711	0.712	0.720	0.741	0.769	0.786
25	3.22	0.885	25	3.219	0.702	0.704	0.712	0.733	0.760	0.777
26	3.26	0.896	23	3.135	0.684	0.685	0.693	0.713	0.740	0.757
27	3.30	0.907	20	2.996	0.653	0.655	0.663	0.682	0.708	0.723
28	3.33	0.915	19	2.944	0.642	0.643	0.651	0.670	0.695	0.711
29	3.37	0.926	18	2.890	0.630	0.632	0.639	0.658	0.683	0.698
30	3.40	0.934	16	2.773	0.605	0.606	0.613	0.631	0.655	0.669
31	3.43	0.942	15	2.708	0.591	0.592	0.599	0.616	0.640	0.654
32	3.47	0.953	10	2.303	0.502	0.503	0.509	0.524	0.544	0.556
33	3.50	0.962	9	2.197	0.479	0.480	0.486	0.5	0.519	0.530
34	3.53	0.970	6	1.792	0.391	0.392	0.396	0.408	0.423	0.433
35	3.56	0.978	5	1.609	0.351	0.352	0.356	0.366	0.380	0.388
36	3.58	0.984	4	1.386	0.302	0.303	0.307	0.315	0.327	0.335
37	3.61	0.992	2	0.693	0.151	0.151	0.153	0.158	0.164	0.167
38	3.64	1	1	0	0	0	0	0	0	0

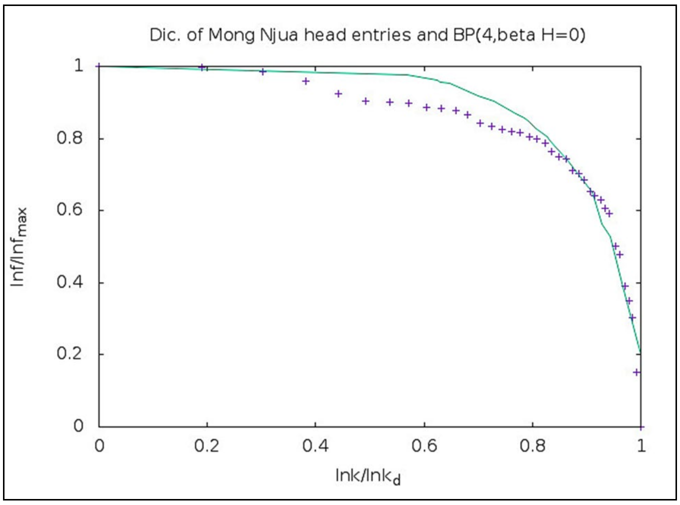

Fig 2: The vertical axis is $\frac{lnf}{ln f_{max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0), of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H= 0.

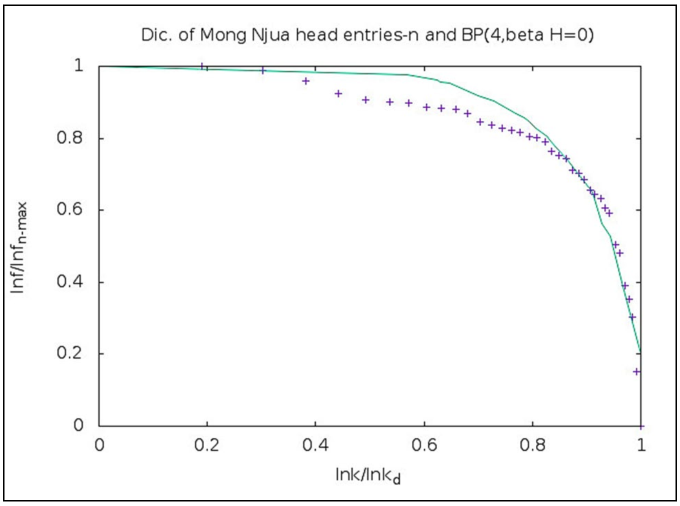

Fig 3: The vertical axis is $\frac{lnf}{ln f_{nmax}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0), of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H= 0.

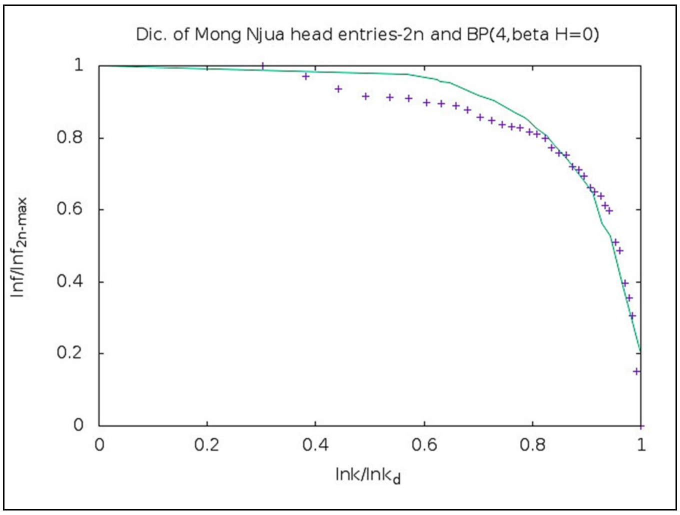

Fig 4: The vertical axis is $\frac{lnf}{ln f_{2nmax}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0), of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H= 0.

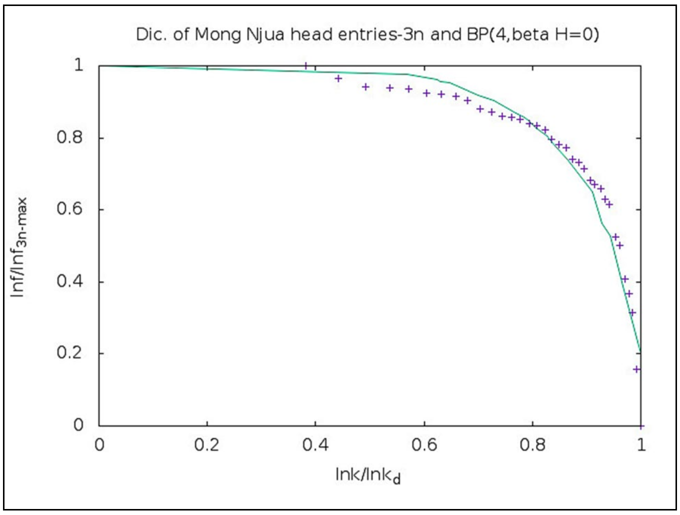

Fig 5: The vertical axis is $\frac{lnf}{ln f_{3nmax}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0), of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H= 0.

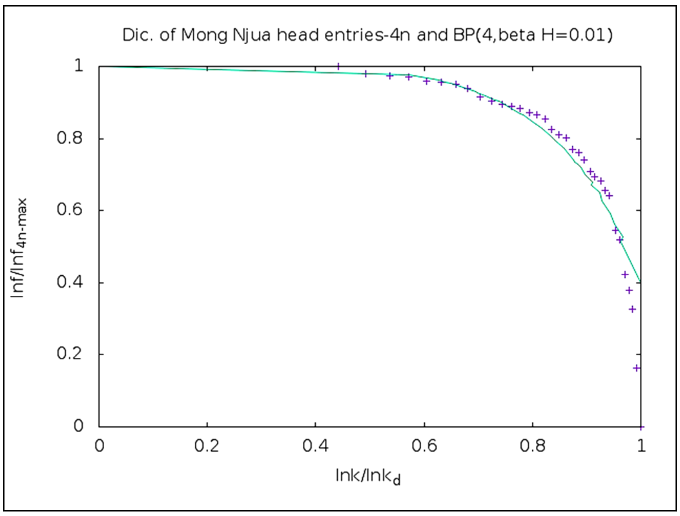

Fig 6: The vertical axis is $\frac{lnf}{ln f_{4nmax}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0.01), of the Ising Model, in the presence of four nearest neighbours and in the presence of external magnetic field, H, with βH=0.01.

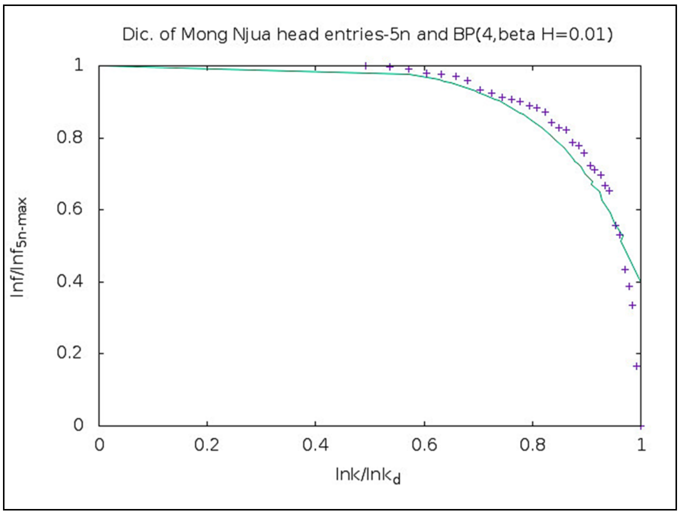

Fig 7: The vertical axis is $\frac{lnf}{ln f_{5nmax}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Mong Njua, with the fit curve being the Bethe-Peierls curve, BP(4, βH=0.01), of the Ising Model, in the presence of four nearest neighbours and in the presence of external magnetic field, H, with βH=0.01.

Conclusion

From the figures, Figure 2-Figure 7, we observe that there is a curve of magnetisation, behind the entries of Dictionary of Mong Njua [1]. This is the magnetisation curve BP(4, βH=0), in the Bethe-Peierls approximation of the Ising Model, in the presence of four nearest neighbours and in the absence of external magnetic field, H, with βH=0.

Moreover, the associated correspondence is,

$$\frac{lnf}{ln f_{3nmax}} \leftrightarrow \frac{M}{M_{max}} \text{ and lnk} \leftrightarrow \text{T},$$

k corresponds to temperature in an exponential scale, [111].

Magnetisation

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 = 1/N $\sum_i \sigma_i$ 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 μ$\sum_i \sigma_i$ or, μ(N_+ - N_-) or, μNL, M_{max} = μN. $\frac{M}{M_{max}}$= L. $\frac{M}{M_{max}}$ is referred to as reduced magnetisation. Moreover, the Ising Hamiltonian, [105], for the lattice of spins, setting μ to one, is $-\varepsilon\sum_{n.n} \sigma_i \sigma_j - H\sum_i \sigma_i$, where n.n refers to nearest neighbour pairs. The difference of energy, ΔE, if we flip an up spin to down spin is, [106], 2εγ$\bar{\sigma}$+ 2H, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle $\frac{N_-}{N_+}$equals exp(− ΔE/k_B T), [107]. In the Bragg-Williams approximation, [108], $\bar{\sigma}$=L, considered in the thermal average sense. Consequently,

$$\ln\frac{1+L}{1-L} = 2\ (\gamma\varepsilon L+H)/(k_B\ T) = 2\ (L+H/\gamma\varepsilon)/(T/(\gamma\varepsilon/k_B))$$
$$=2(L+c)/(T/T_c)\ (1)$$

Where, c = H/εγ. T_c = εγ/k_B, [109]. T/T_c is referred to as reduced temperature. Plot of L vs 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 Figure 12.12 of the book, [106]. 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.

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, [105], [106], [107], [108], [109], due to Bethe-Peierls, [110], reduced magnetisation varies with reduced temperature, for γ neighbours, in absence of external magnetic field.

$$(\ln \gamma/(\gamma-2))/(\ln (\text{factor}-1)/D) = T/T_c \quad (2)$$

Where, $D=factor^{((\gamma-1)/\gamma)}-factor^{(1/\gamma)}$ and factor $= (1+\frac{M}{M_{max}})/(1-\frac{M}{M_{max}})$. For γ=4 i.e. for four nearest neighbours, $\ln\frac{\gamma}{\gamma-2}$ is 0.693.

In the following, we describe datas generated from the Equation 1 and the Equation 2 in the table, Table-3, 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, βH=0) represents reduced temperature in the Bethe-Peierls approximation, for four nearest neighbours, computed from the Equation 2. The data set is used to plot Figure 8. Empty spaces in the table, Table-3, mean corresponding point pairs were not used for plotting a line.

Table 3: 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 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.

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

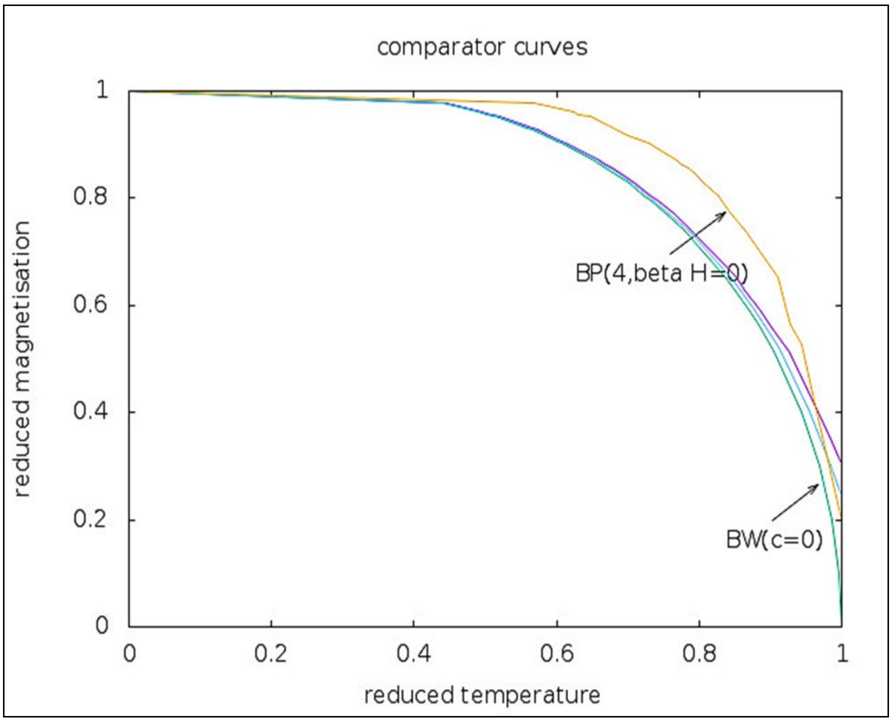

Fig 8: Reduced magnetisation vs reduced temperature curves, for the Bragg-Williams approximation, in the absence (BW(c=0)) and in the presence (BW(c=0.005), BW(c=0.01)) of magnetic field, c=$\frac{H}{\gamma\varepsilon}$=0, c=$\frac{H}{\gamma\varepsilon}$=0.005, c=$\frac{H}{\gamma\varepsilon}$=0.01, outwards; and in the Bethe-Peierls approximation, BP(4, βH=0), in the absence of magnetic field, for four nearest neighbours (outer in the top).

Bethe-peierls approximation in presence of four nearest neighbours, in the presence of external magnetic field:

In the Bethe-Peierls approximation scheme, [110], reduced magnetisation varies with reduced temperature, for γ neighbours, in presence of external magnetic field, as

$$(\ln \gamma/(\gamma\text{-}2))/(\ln (\text{factor-}1)/D) = T/T_c \quad (3)$$

Where, D=$e^{\frac{2\beta H}{\gamma}} factor^{((\gamma-1)/\gamma)}$ -$e^{\frac{-2\beta H}{\gamma}}$ $factor^{(1/\gamma)}$ and factor=$(1+\frac{M}{M_{max}})/(1-\frac{M}{M_{max}})$. For γ=4 i.e. for four nearest neighbours, ln$\frac{\gamma}{\gamma-2}$ is 0.693. Derivation of this formula ala [110] is given in the appendix of [7]. For γ=4 i.e. for four nearest neighbours, ln$\frac{\gamma}{\gamma-2}$ is 0.693.

For four neighbours, 0.693/(ln (factor-1)/D) = T/T_c (4)

In the following, we describe datas in the table, Table-4, 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 βH =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 βH =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 βH =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 βH =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 βH =0.01 calculated from the Equation 4. The data set is used to plot Figure 9. Empty spaces in the table, Table-4, mean corresponding point pairs were not used for plotting a line.

Table 4: Bethe-Peierls approx. in presence of little external magnetic fields

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

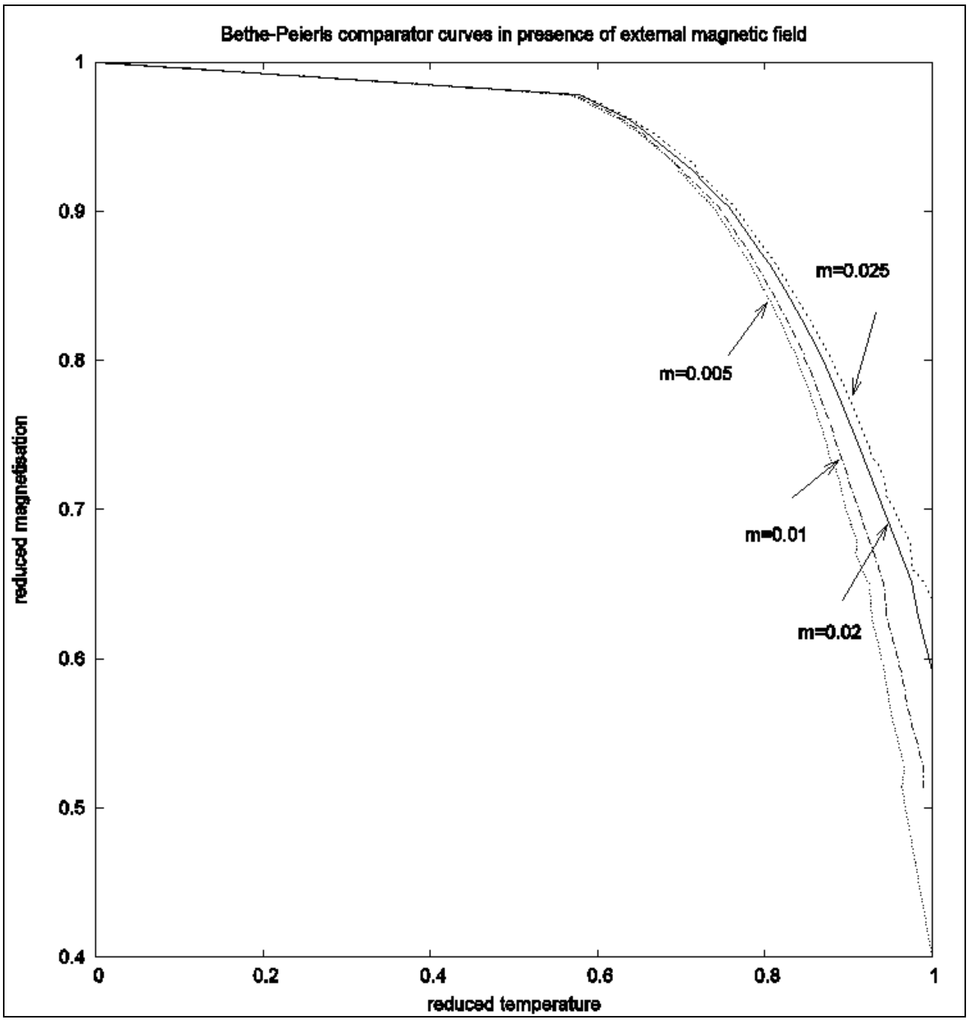

Fig 9: Reduced magnetisation vs reduced temperature curves for Bethe-Peierls approximation in presence of little external magnetic fields, for four nearest neighbours, with βH=2m.

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