

A New Dictionary of the Portugese and English Languages enriched by H. Michaelis and The Graphical Law

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Abstract

We study the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis. 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 the magnetisation curve, $BP(4, \beta H = 0)$, in the Bethe-Peierls approximation of the Ising model, in the presence of four nearest neighbours and in the absence of external magnetic field, β is $\frac{1}{k_B T}$ where, T is temperature and k_B is the tiny Boltzmann constant.

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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
5475	1985	4594	2541	3306	1073	1180	370	1322	334	51	988	2175	461	606	2909	163	2025	2701	1953	188	941	6	102	22	192

TABLE I. The Portugese Head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis

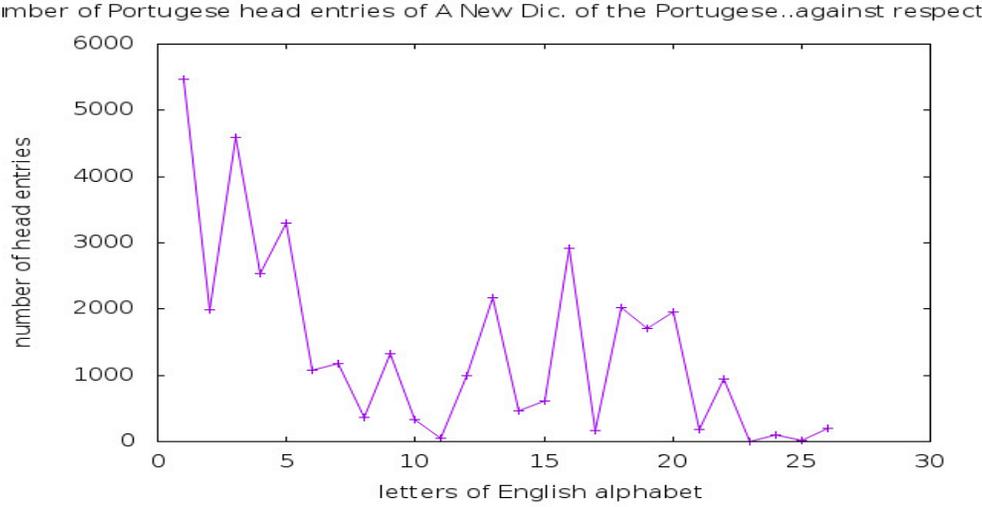


FIG. 1. The vertical axis is number of the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis,[1]. The horizontal axis is the letters of the English alphabet. Letters are represented by the sequence number in the alphabet.

I. INTRODUCTION

In this paper, we count all the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], one by one from beginning to the end. We do not count the appendix entries. The result is the table, tableI. To visualise we plot the number of head entries against the respective letters in the dictionary sequence, [1] , in the adjoining figure, fig.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 references from [4] to [93].

The planning of the paper is as follows. In the next section, we describe the Graphical Law analysis of the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis , [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.

II. 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, [94], denoted by k . k is a positive integer starting from one. Moreover, the minimum non-zero number of head entries is six. Hence, we attach a limiting head entry number one. The limiting rank is maximum rank plus one, here it is twenty seven. As a result both $\frac{\ln f}{\ln f_{max}}$ and $\frac{\ln k}{\ln k_{lim}}$ varies from zero to one. Then we tabulate in the adjoining table,II, and plot $\frac{\ln f}{\ln f_{max}}$ against $\frac{\ln k}{\ln k_{lim}}$ in the figure fig.2. We then ignore the letter with the highest number of head entries, tabulate in the adjoining table,II,and redo the plot, normalising the $\ln f$ s with $\ln f_{n-max}$, and starting from $k = 2$ in the figure fig.3. Normalising the $\ln f$ s with $\ln f_{2n-max}$, we tabulate in the adjoining table,II, and starting from $k = 3$ we draw in the figure fig.4. Normalising the $\ln f$ s with $\ln f_{3n-max}$ we record in the adjoining table,II, and plot starting from $k = 4$ in the figure fig.5. In this way we obtain up to the figure fig.7.

k	lnk	lnk/ lnk_{lim}	f	lnf	lnf/ lnf_{max}	lnf/ lnf_{nmax}	lnf/ lnf_{2nmax}	lnf/ lnf_{3nmax}	lnf/ lnf_{4nmax}	lnf/ lnf_{5nmax}
1	0	0	5475	8.608	1	Blank	Blank	Blank	Blank	Blank
2	0.69	0.209	4594	8.433	0.980	1	Blank	Blank	Blank	Blank
3	1.10	0.333	3306	8.103	0.941	0.961	1	Blank	Blank	Blank
4	1.39	0.421	2909	7.976	0.927	0.946	0.984	1	Blank	Blank
5	1.61	0.488	2701	7.901	0.918	0.937	0.975	0.991	1	Blank
6	1.79	0.542	2541	7.840	0.911	0.930	0.968	0.983	0.992	1
7	1.95	0.591	2175	7.685	0.893	0.911	0.948	0.964	0.973	0.980
8	2.08	0.630	2025	7.613	0.884	0.903	0.940	0.954	0.964	0.971
9	2.20	0.667	1985	7.593	0.882	0.900	0.937	0.952	0.961	0.968
10	2.30	0.697	1953	7.577	0.880	0.898	0.935	0.950	0.959	0.966
11	2.40	0.727	1322	7.187	0.835	0.852	0.887	0.901	0.910	0.917
12	2.48	0.752	1180	7.073	0.822	0.839	0.873	0.887	0.895	0.902
13	2.56	0.776	1073	6.978	0.811	0.827	0.861	0.875	0.883	0.890
14	2.64	0.800	988	6.896	0.801	0.818	0.851	0.865	0.873	0.880
15	2.71	0.821	941	6.847	0.795	0.812	0.845	0.858	0.867	0.873
16	2.77	0.839	606	6.407	0.744	0.760	0.791	0.803	0.811	0.817
17	2.83	0.858	461	6.133	0.712	0.727	0.757	0.769	0.776	0.782
18	2.89	0.876	370	5.914	0.687	0.701	0.730	0.741	0.749	0.754
19	2.94	0.891	334	5.811	0.675	0.689	0.717	0.729	0.735	0.741
20	3.00	0.909	192	5.257	0.611	0.623	0.649	0.659	0.665	0.671
21	3.04	0.921	188	5.236	0.608	0.621	0.646	0.656	0.663	0.668
22	3.09	0.936	163	5.094	0.592	0.604	0.629	0.639	0.645	0.650
23	3.14	0.952	102	4.625	0.537	0.548	0.571	0.580	0.585	0.590
24	3.18	0.964	51	3.932	0.457	0.466	0.485	0.493	0.498	0.502
25	3.22	0.976	22	3.091	0.359	0.367	0.381	0.388	0.391	0.394
26	3.26	0.988	6	1.792	0.208	0.212	0.221	0.225	0.227	0.229
27	3.30	1	1	0	0	0	0	0	0	0

TABLE II. The Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1]: ranking, natural logarithms, normalisations

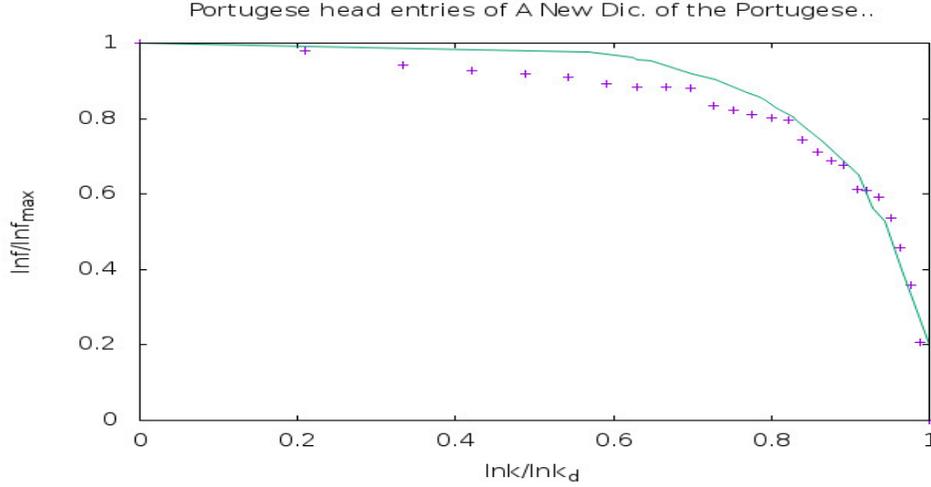


FIG. 2. The vertical axis is $\frac{\ln f}{\ln f_{max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H, i.e. $\beta H = 0$.

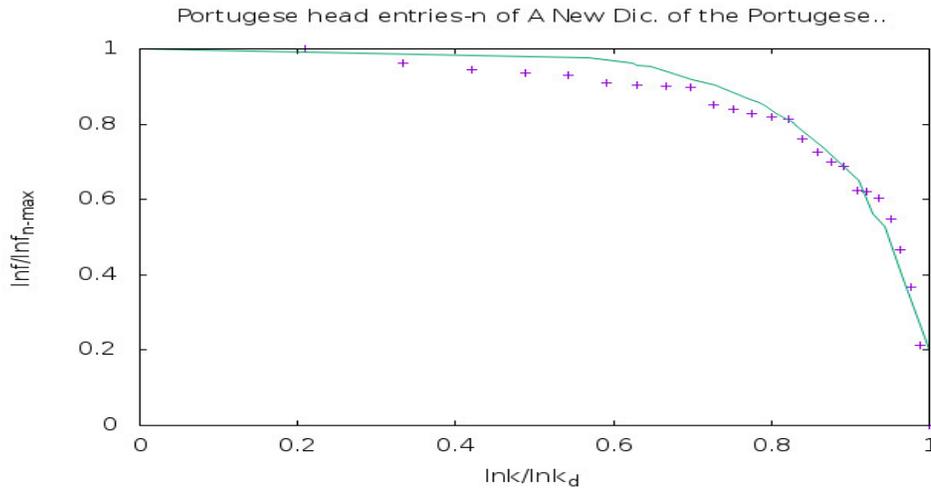


FIG. 3. The vertical axis is $\frac{\ln f}{\ln f_{n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H, i.e. $\beta H = 0$.

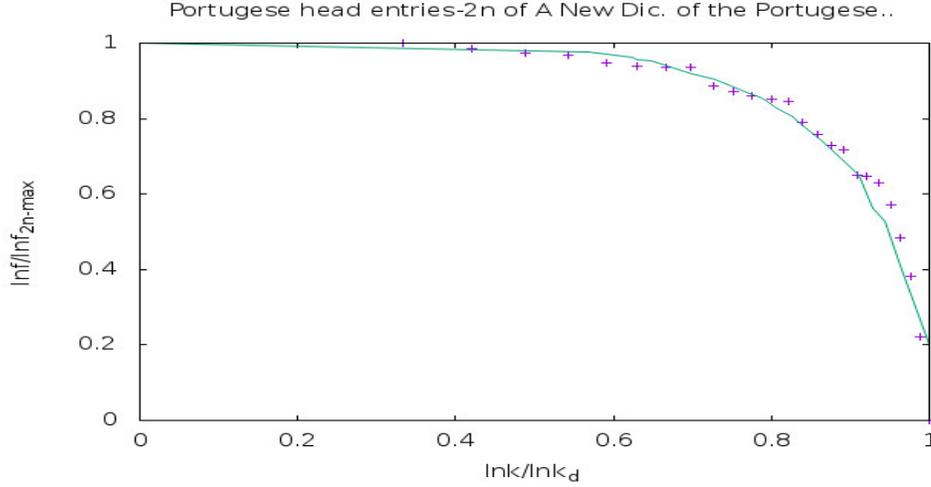


FIG. 4. The vertical axis is $\frac{\ln f}{\ln f_{2n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H, i.e. $\beta H = 0$.

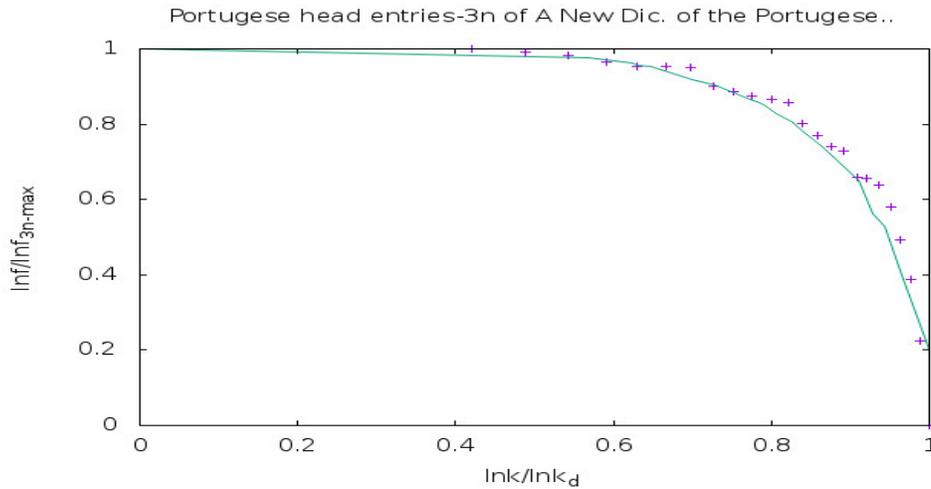


FIG. 5. The vertical axis is $\frac{\ln f}{\ln f_{3n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H, i.e. $\beta H = 0$.

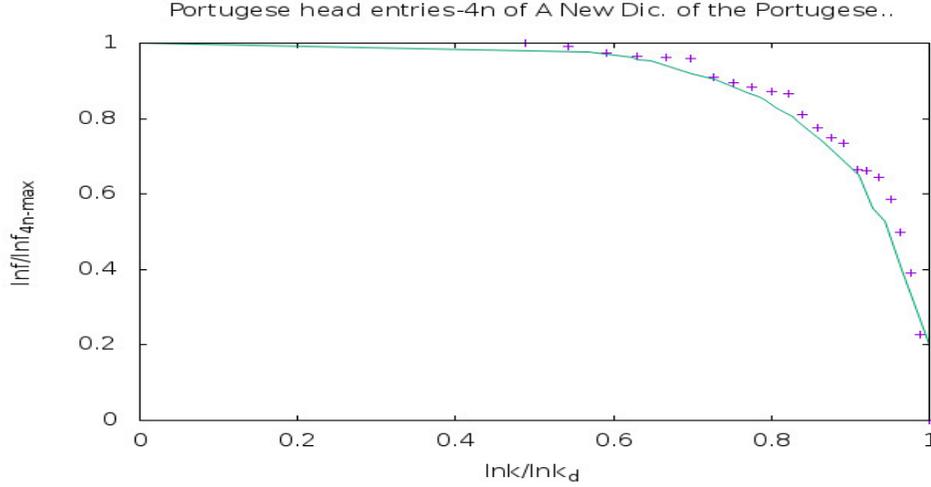


FIG. 6. The vertical axis is $\frac{\ln f}{\ln f_{4n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H , i.e. $\beta H = 0$.

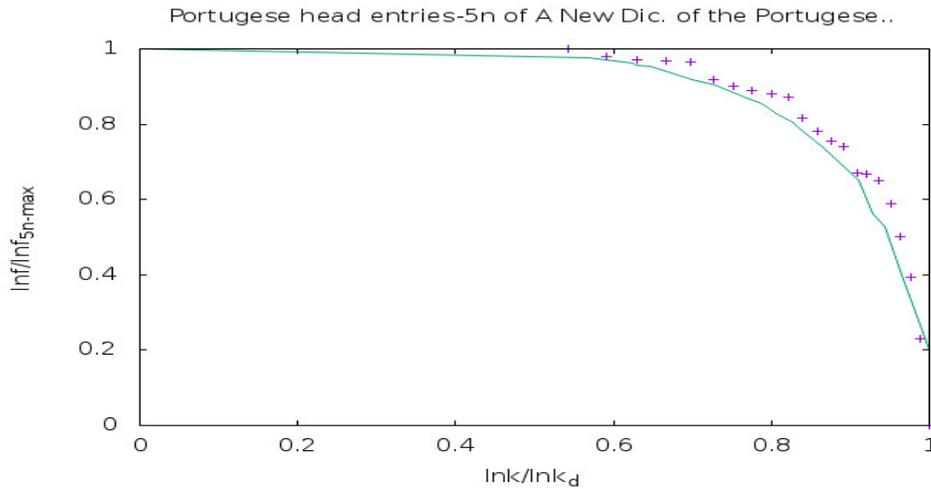


FIG. 7. The vertical axis is $\frac{\ln f}{\ln f_{5n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], with the fit curve, $BP(4, \beta H = 0)$, being the Bethe-Peierls curve of the Ising Model in the presence of four nearest neighbours and in the absence of external magnetic field, H , i.e. $\beta H = 0$.

A. conclusion

From the figures (fig.2-fig.7), we observe that there is a curve of magnetisation, behind the Portugese head entries of A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1]. This is the magnetisation curve in the Bethe-Peierls approximation of the Ising model, $BP(4, \beta H = 0)$, in the presence of four nearest neighbours and in the absence of external magnetic field, H , i.e. $\beta H = 0$.

Moreover, the associated correspondence is,

$$\frac{\ln f}{\ln f_{2n-max}} \longleftrightarrow \frac{M}{M_{max}},$$
$$\ln k \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [101].

III. APENDIX: 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 para magnet, 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 $L = \frac{1}{N}\sum_i\sigma_i$, 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 $\mu\sum_i\sigma_i$ 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,[95], for the lattice of spins, setting μ to one, is $-\epsilon \sum_{n.n} \sigma_i \sigma_j - H \sum_i \sigma_i$, where n.n refers to nearest neighbour pairs. The difference ΔE of energy if we flip an up spin to down spin is, [96], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $\exp(-\frac{\Delta E}{k_B T})$, [97]. In the Bragg-Williams approximation,[98], $\bar{\sigma} = L$, considered in the thermal average sense. Consequently,

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

where, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [99]. $\frac{T}{T_c}$ is referred to as reduced temperature.

Plot of L vs $\frac{T}{T_c}$ or, reduced magnetisation 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 [96]. W. L. Bragg was a professor of Hans Bethe. Rudolf Peierls was a friend of Hans Bethe. At the suggestion of W. L. Bragg, Rudolf 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, [95],[96],[97],[98],[99], due to Bethe-Peierls, [100], reduced magnetisation varies with reduced temperature, for γ neighbours, in absence of external magnetic field, as

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

$\ln \frac{\gamma}{\gamma-2}$ 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

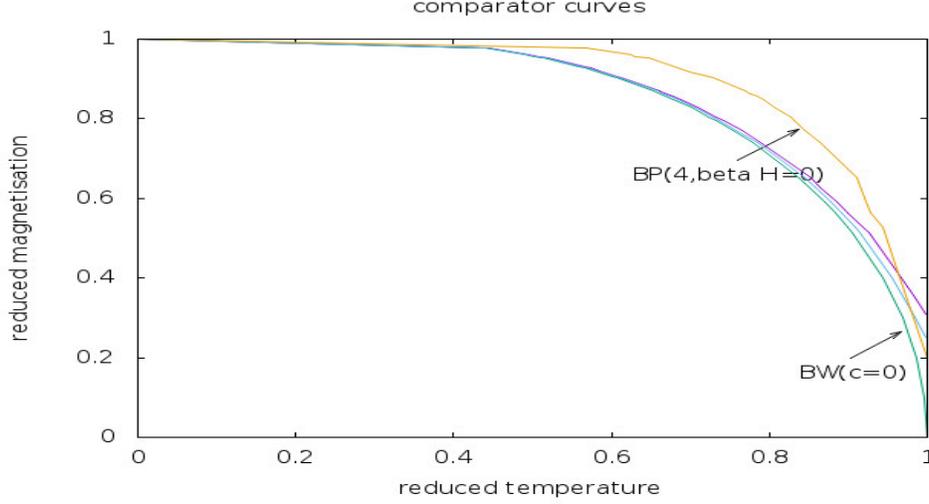


FIG. 8. Reduced magnetisation vs reduced temperature curves, for the Bragg-Williams approximation, in the absence (BW($c=0$)) and in the presence (BW($c=0.005$), BW($c=0.01$)) of magnetic field, $c = 0$, $c = \frac{H}{\gamma\epsilon} = 0.005$, $c = \frac{H}{\gamma\epsilon} = 0.01$, outwards; and in the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

data s generated from the equation(1) and the equation(2) in the table, III, and curves of magnetisation plotted on the basis of those data s. 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.8. Empty spaces in the table, III, mean corresponding point pairs were not used for plotting a line.

BW(c=0)	BW(c=0.005)	BW(c=0.01)	BP(4, $\beta H = 0$)	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 III. 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, $\beta H=0$), in the absence of magnetic field, for four nearest neighbours] vs reduced magnetisation. Reduced temperature is drawn along the x-axis and Reduced magnetisation 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.

IV. ACKNOWLEDGMENT

The author would like to thank the National Library, Calcutta, to allow us to use A New Dictionary of the Portugese and English Languages enriched by H. Michaelis, [1], in its premises. We have used gnuplot for plotting the figures in this paper.

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