The Concise Gojri-English Dictionary by Dr. Rafeeq Anjum and the graphical law

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(Dated: January 31, 2022)

Abstract

We study the Concise Gojri-English Dictionary by Dr. Rafeeq Anjum. We draw the natural logarithm of the number of words, 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,$\beta H = 0$) i.e. a magnetisation curve for the Bethe-Peierls approximation of the Ising model with four nearest neighbours with $\beta H = 0$, in the absence of external magnetic field, H. β is $\frac{1}{k_B T}$ where, T is temperature and k_B is the tiny Boltzmann constant. Moreover, the naturalness number of the Gojri language as seen through this dictionary is one.

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I. INTRODUCTION

"The more, the merrier!"

In this article, we study the Concise Gojri-English Dictionary by Dr. Rafeeq Anjum, [1], looking for the graphical law. We study magnetic field pattern behind the words of this dictionary, [1], in this work. 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], Mursi-English-Amharic Dictionary, [14] and Names of Minor Planets, [15], A Dictionary of Tibetan and English, [16], Khasi English Dictionary, [17], Turkmen-English Dictionary, [18], Websters Universal Spanish-English Dictionary, [19], A Dictionary of Modern Italian, [20], Langenscheidt's German-English Dictionary, [21], Essential Dutch dictionary by G. Quist and D. Strik, [22], Swahili-English dictionary by C. W. Rechenbach, [23], Larousse Dictionnaire De Poche for the French, [24], the Onsager's solution behind the Arabic, [25], the graphical law behind Langenscheidt Taschenwörterbuch Deutsch-Englisch / Englisch-Deutsch, Völlige Neubearbeitung, [26], the graphical law behind the NTC's Hebrew and English Dictionary by Arie Comey and Naomi Tsur, [27], the graphical law behind the Oxford Dictionary Of Media and Communication, [28], the graphical law behind the Oxford Dictionary Of Mathematics, Penguin Dictionary Of Mathematics, [29], the Onsager's solution behind the Arabic Second part, [30], the graphical law behind the Penguin Dictionary Of Sociology, [31], behind the Concise Oxford Dictionary Of Politics, [32], behind a Dictionary Of Critical Theory by Ian Buchanan, [33], behind the Penguin Dictionary Of Economics, [34], respectively.

We describe how a graphical law is hidden within the Concise Gojri-English Dictionary, [1], in this article. 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 the analysis of the words of the Concise Gojri-English Dictionary, [1]. The section IV is Acknowledgment. The last section is Bibliography.

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 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 $L = \frac{1}{N}\Sigma_i \sigma_i$, 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,[35], 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, [36], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_B T})$, [37]. In the Bragg-Williams approximation,[38], $\bar{\sigma} = L$, 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, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [39]. $\frac{T}{T_c}$ 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 [36]. 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, [35],[36],[37],[38],[39], due to Bethe-Peierls, [40], reduced magnetisation varies with reduced temperature, for γ

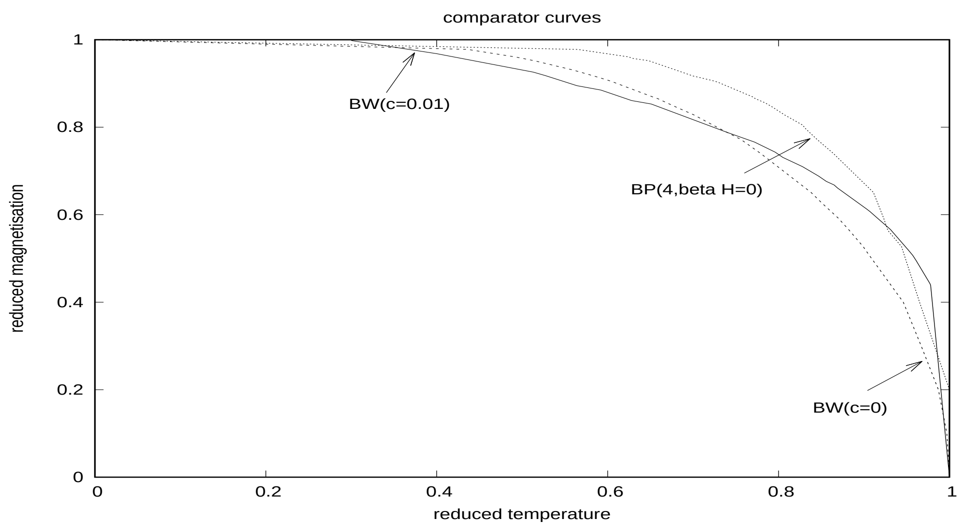

FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in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

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 data s generated from the equation(1) and the equation(2) in the table, I, 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.1. Empty spaces in the table, I, mean corresponding point pairs were not used for plotting a line.

BW	BW(c=0.01)	BP(4,βH = 0)	reduced magnetisation
0	0	0	1
0.435	0.439	0.563	0.978
0.439	0.443	0.568	0.977
0.491	0.495	0.624	0.961
0.501	0.507	0.630	0.957
0.514	0.519	0.648	0.952
0.559	0.566	0.654	0.931
0.566	0.573	0.7	0.927
0.584	0.590	0.7	0.917
0.601	0.607	0.722	0.907
0.607	0.613	0.729	0.903
0.653	0.661	0.770	0.869
0.659	0.668	0.773	0.865
0.669	0.676	0.784	0.856
0.679	0.688	0.792	0.847
0.701	0.710	0.807	0.828
0.723	0.731	0.828	0.805
0.732	0.743	0.832	0.796
0.756	0.766	0.845	0.772
0.779	0.788	0.864	0.740
0.838	0.853	0.911	0.651
0.850	0.861	0.911	0.628
0.870	0.885	0.923	0.592
0.883	0.895	0.928	0.564
0.899	0.918		0.527
0.904	0.926	0.941	0.513
0.946	0.968	0.965	0.400
0.967	0.998	0.965	0.300
0.987		1	0.200
0.997		1	0.100
1	1	1	0

TABLE I. Reduced magnetisation vs reduced temperature data s for Bragg-Williams approximation, in absence of and in presence of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours .

letter	Alif	Be	Pe	te	Te	Se	Jeem	Che	He	Khe	daal	Daal	Zaal	Re	Arhe	Ze	Seen	Sheen
number	880	1022	920	687	311	13	580	760	151	208	622	274	28	410	0	84	907	219
letter	Suaad	Zuaad	Toey	Zoe	Aen	Gen	Fe	Qaaf	Kaaf/Keef	Gaaf	Laam	Meem	Noon	Waa	He	alif/hamza	Ye	Ye
number	48	21	57	9	101	77	153	138	1000	547	402	881	458	124	298	0	46	0

TABLE II. Gojri words: the first row represents letters of the Gojri alphabet in the serial order, the second row is the respective number of words.

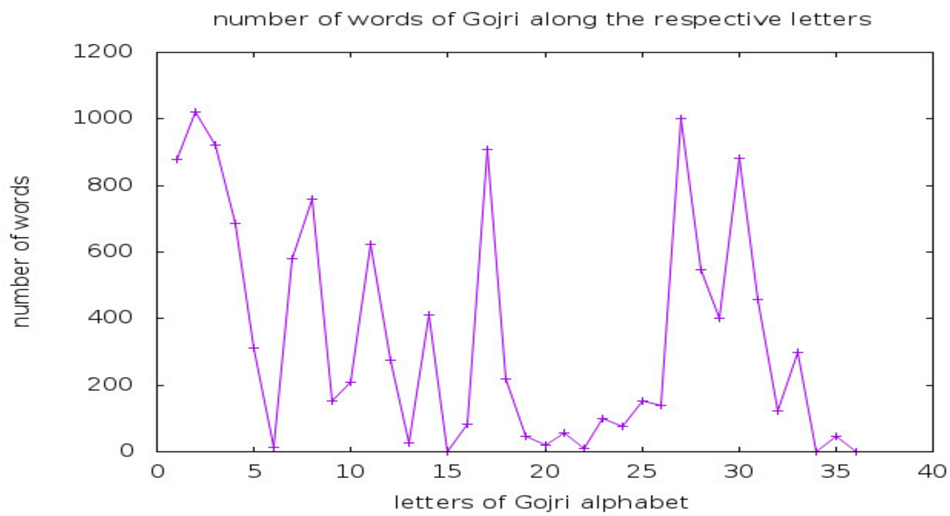

FIG. 2. The vertical axis is the number of words of the Concise Gojri-English Dictionary [1], and the horizontal axis is the respective letters. Letters are represented by the sequence number in the alphabet or, dictionary sequence,[1].

III. ANALYSIS OF THE WORDS OF THE CONCISE GOJRI-ENGLISH DICTIONARY

We count all the words of the Concise Gojri-English Dictionary [1], one by one from the beginning to the end, starting with different letters. We have not counted synonyms, antonyms, idioms, phrases, proverbs and words appearing in a letter's section beginning with other letters(those are very few). The result is the table, II.

Highest number of words, one thousand twenty two, starts with the letter Be followed by words numbering one thousand beginning with Kaaf/Keef, nine hundred twenty with the letter Pe etc. To visualise we plot the number of words against respective letters in the dictionary sequence, [1], in the figure fig.2.

It was proposed in [23], that it may be reasonable to define naturalness of a language by the ratio of number of major peaks to the number of minor peaks. One may take major peaks as those with height up to the half of the height of the highest peak. The naturalness number of the French, [24], tuned out to be 11/5. The naturalness number of the German, [26], tuned out to be 7/9. The naturalness number of the Hebrew, [27], tuned out to be 1/3. In this case,[1], the highest peak has the frequency 1022. Half of it is 511. Number of peaks greater than 511 is 6. Number of peaks less than 511 is 6. Hence the naturalness number is one.

For the purpose of exploring graphical law, we assort the letters according to the number of words, in the descending order, denoted by f and the respective rank, [41], denoted by k. k is a positive integer starting from one. The lowest value of f is nine. Hence we attach a limiting f with the value one. The corresponding rank, k, denoted as k_{lim} is thirty four. 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, III and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure fig.3. We then ignore the letter with the highest of words, tabulate in the adjoining table, III and redo the plot, normalising the lnfs with next-to-maximum $lnf_{nextmax}$, and starting from $k = 2$ in the figure fig.4. This program then we repeat up to $k = 4$, resulting in figures up to fig.6.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/$lnf_{next-max}$	lnf/lnf_{nnmax}	lnf/lnf_{nnnmax}
1	0	0	1022	6.930	1	Blank	Blank	Blank
2	0.69	0.197	1000	6.908	0.997	1	Blank	Blank
3	1.10	0.312	920	6.824	0.985	0.988	1	Blank
4	1.39	0.393	907	6.810	0.983	0.986	0.998	1
5	1.61	0.456	881	6.781	0.978	0.982	0.994	0.996
6	1.79	0.508	880	6.780	0.978	0.981	0.994	0.996
7	1.95	0.552	760	6.633	0.957	0.960	0.972	0.974
8	2.08	0.590	687	6.532	0.943	0.946	0.957	0.959
9	2.20	0.623	622	6.433	0.928	0.931	0.943	0.945
10	2.30	0.653	580	6.363	0.918	0.921	0.932	0.934
11	2.40	0.680	547	6.304	0.910	0.913	0.924	0.926
12	2.48	0.705	458	6.127	0.884	0.887	0.898	0.900
13	2.56	0.727	410	6.016	0.868	0.871	0.882	0.883
14	2.64	0.748	402	5.996	0.865	0.868	0.879	0.880
15	2.71	0.768	311	5.740	0.828	0.831	0.841	0.843
16	2.77	0.786	298	5.697	0.822	0.825	0.835	0.837
17	2.83	0.803	274	5.613	0.810	0.813	0.823	0.824
18	2.89	0.820	219	5.389	0.778	0.780	0.790	0.791
19	2.94	0.835	208	5.338	0.770	0.773	0.782	0.784
20	3.00	0.850	153	5.030	0.726	0.728	0.737	0.739
21	3.04	0.863	151	5.017	0.724	0.726	0.735	0.737
22	3.09	0.877	138	4.927	0.711	0.713	0.722	0.723
23	3.14	0.889	124	4.820	0.696	0.698	0.706	0.708
24	3.18	0.901	101	4.615	0.666	0.668	0.676	0.678
25	3.22	0.913	84	4.431	0.639	0.641	0.649	0.651
26	3.26	0.924	77	4.344	0.627	0.629	0.637	0.639
27	3.30	0.935	57	4.043	0.583	0.585	0.592	0.594
28	3.33	0.945	48	3.871	0.559	0.560	0.567	0.568
29	3.37	0.955	46	3.829	0.553	0.554	0.561	0.562
30	3.40	0.965	28	3.332	0.481	0.482	0.488	0.489
31	3.43	0.974	21	3.045	0.439	0.441	0.446	0.447
32	3.47	0.983	13	2.565	0.370	0.371	0.376	0.377
33	3.50	0.992	9	2.197	0.317	0.318	0.322	0.323
34	3.53	1	1	0	0	0	0	0

TABLE III. Words of the Concise Gojri-English Dictionary: ranking, natural logarithm, normalisations

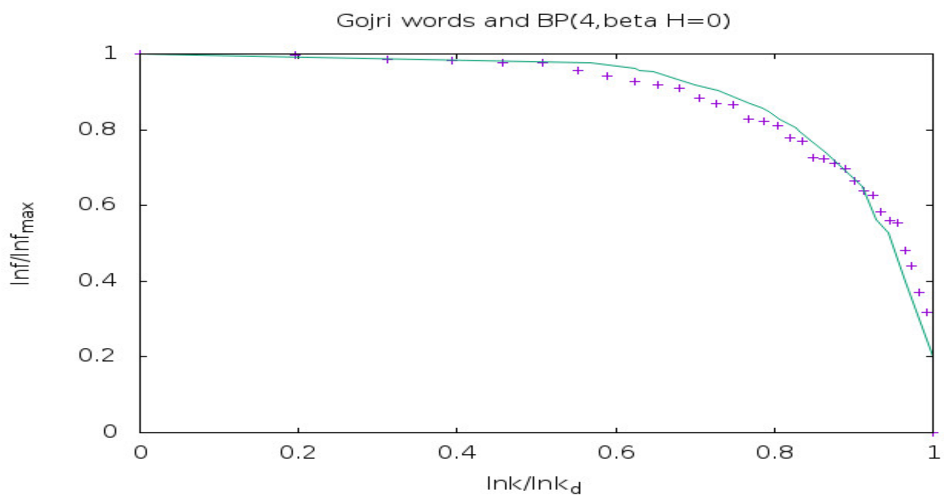

FIG. 3. The vertical axis is $\frac{lnf}{lnf_{max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the words of the Concise Gojri-English Dictionary with the fit curve being the Bethe-Peierls curve, BP(4, $\beta H = 0$), with four nearest neighbours, in the absence of external magnetic field.

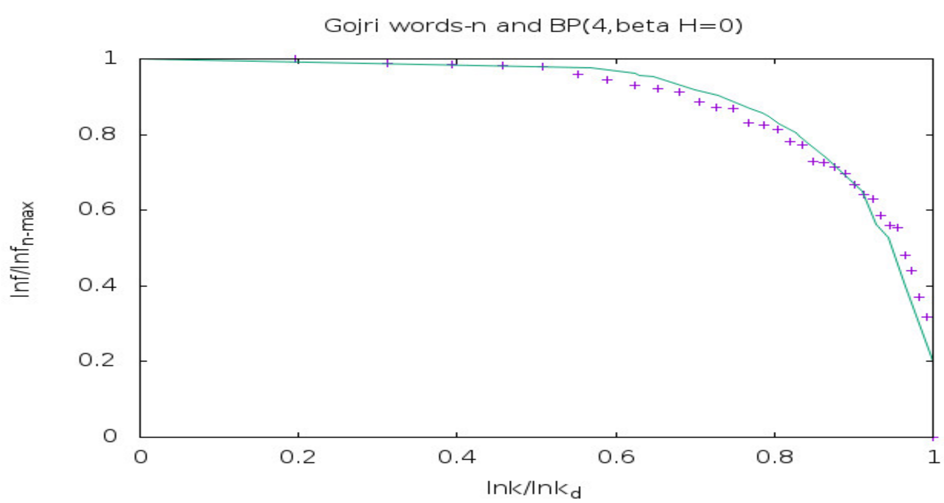

FIG. 4. The vertical axis is $\frac{lnf}{lnf_{next-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the words of the Concise Gojri-English Dictionary with the fit curve being the Bethe-Peierls curve, BP(4, $\beta H = 0$), with four nearest neighbours, in the absence of external magnetic field.

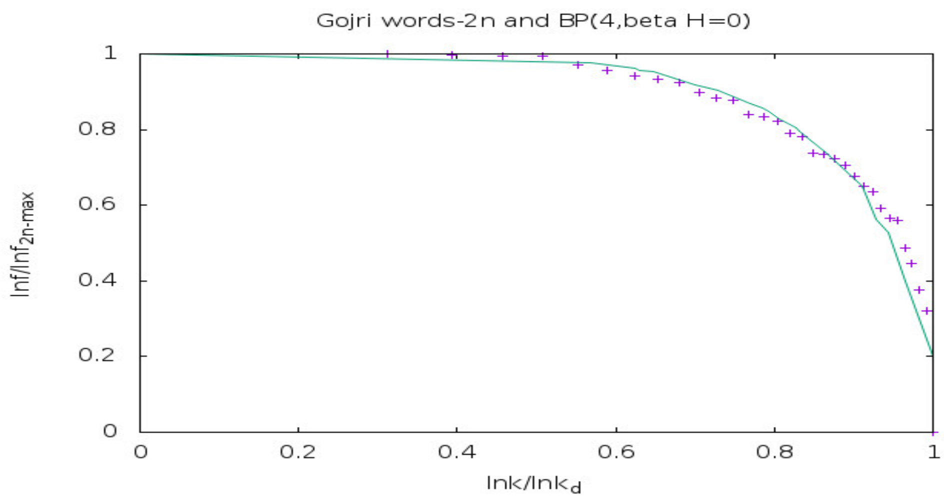

FIG. 5. The vertical axis is $\frac{lnf}{lnf_{nextnext-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the words of the Concise Gojri-English Dictionary with the fit curve being the Bethe-Peierls curve, BP(4, $\beta H = 0$), with four nearest neighbours, in the absence of external magnetic field.

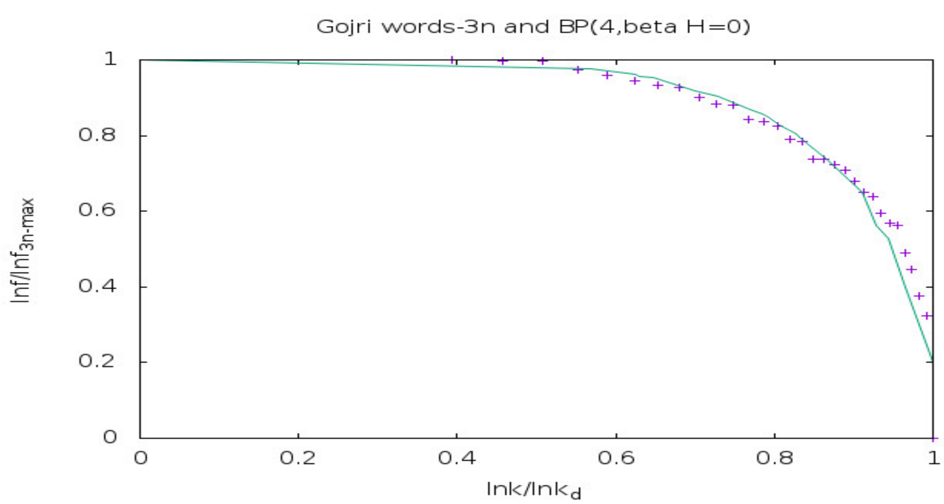

FIG. 6. The vertical axis is $\frac{lnf}{lnf_{nextnextnext-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the words of the Concise Gojri-English Dictionary with the fit curve being the Bethe-Peierls curve, BP(4, $\beta H = 0$), with four nearest neighbours, in the absence of external magnetic field.

A. conclusion

From the figures (fig.3-fig.6), we observe that there is a curve of magnetisation, behind the words of the the Concise Gojri-English Dictionary,[1]. This is the magnetisation curve in the Bethe-Peierls approximation with four nearest neighbours and in the absence of external magnetic field. Moreover, the associated correspondence is,

$$\frac{lnf}{lnf_{max}} \longleftrightarrow \frac{M}{M_{max}}, \quad lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [42]. As temperature decreases, i.e. lnk decreases, f increases. The letters which are recording higher words compared to those which have lesser words are at lower temperature. As the Gojri language expands, the letters like ...Pe, Keef/Keef, Be, which get enriched more and more, fall at lower and lower temperatures. This is a manifestation of cooling effect, as was first observed in [43], in another way.

IV. ACKNOWLEDGMENT

We have used gnuplot for plotting the figures in this paper. We would like to thank the nehu library for allowing us to use the book, [1].

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