Mursi-English-Amharic Dictionary and the Graphical law

Anindya Kumar Biswas[*]

Department of Physics;

North-Eastern Hill University,

Mawkynroh-Umshing, Shillong-793022.

(Dated: September 13, 2020)

Abstract

We study Mursi-English-Amharic Dictionary. We draw the natural logarithm of the number of 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,$\beta H = 0.02$) 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.

[*] anindya@nehu.ac.in

I. INTRODUCTION

Mursi people comes from Lower Omo valley of southwestern Ethiopia, Africa. They call themselves Mun. Their language is known as the Mursi language. Words stock of this people of small population though small is interesting. "bi'" in this langauge means cow, "bôrrôda" means jump, "burbur" means helicopter, "boshu" means youngest child, "buti'" means limestone, "bibi" means big, "bha" means place, " bha lalini" means cool place, "bhacha" means sharpen, "bhêla" means divide, "bhilai" means small cattle bells, "bhogi" means poor, "bhoi" means wide, "bhure" means morning, "chai" means the Suri people, "chawa" means satisfied, "chinyi" means small, "chita" means boil, "cholla" means intenstines, "daha" means poor, "dê" means compound, "dus" means bush land, "dhobi" means bark cloth, "dhône" means one, "dhum" means hill, "dhuna" means to pierce, "gaanô" means to know, "galta" means a small hoe, "ganyo" means my, "gino" means to ask, "guddi" means a false banana, "haanan" means five, "haali" means later, "hôli" means waterbuck, "hôri" means deep(of a river), "huin" means thirst, "hula" means when, "hunai" means small stream, "ito" means to carry(on head), "ja" means near, "jala" means flowering tip of corn stalk, "kabari" means seed, "kabi" means clan, "kakka" means grand parent, "kali" means day, "kasai" means sand, "kilung" means old settlement site, "kirre" means thread, "kôha" means to cultivate, "koli" means a kind of bird, "kôn" means one, "kônkôna" means to turn someone against another person, "kori" means hat, "kuli" means time, "lai" means silent, "lugo" means to build(a fence), "ma" means water, "mara" means dislike, "môta" means to soften, "nai" means our, "nunai" means fish roe, " ông" means what, "rabha" means to make a small hut in a tree, "rana" means to go to get something, "rêggê" means pink, "saan" means news, "sakkal" means nine, "sari" means to fence around a homestead, "sissa" means bees, "su" means sun, "sudor" means to build up the fire(under a pot), "taka" means to understand, "tila" means food, "tini" means young, "tui" means cattle enclosure, "usa" means to eat, "usha" means finished, "wala" means flame, "wana" means hurt, "yugo" means to speak, "zel" means short stick, "zibu" means medicine and so on.

In this article, we study magnetic field pattern behind this dictionary of the Mursi language,[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.

There among other languages, we have studied two languages Onge and Taraon which have similar number of words as that of Mursi. Those were tentatively characterised by BW(c=0) for the leading curve. Here we will see that the $\frac{lnf}{lnf_{max}}$ curve against $\frac{lnk}{lnk_{lim}}$ is also best fit by BW(c=0).

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], and Garo to English School Dictionary, [13], 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 analysis of the entries of the Mursi language, [1]. Sections IV, V 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,[14], 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, [15], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_BT})$, [16]. In the Bragg-Williams approximation,[17], $\bar{\sigma} = L$, considered in the thermal average sense. Consequently,

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

where, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [18]. $\frac{T}{T_c}$ 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 [15]. 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, [14],[15],[16],[17],[18], due to Bethe-Peierls, [19], 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 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.

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

In the Bethe-Peierls approximation scheme , [19], reduced magnetisation varies with reduced temperature, for γ neighbours, in presence of external magnetic field, as

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

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 datas 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 .

Derivation of this formula ala [19] 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

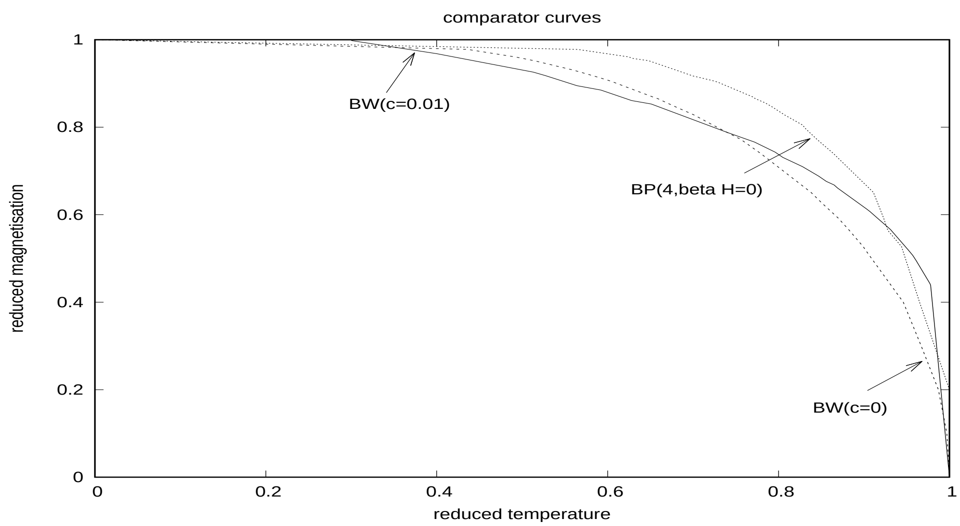

FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in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

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.

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, [20], [21], [22], [19],

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

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

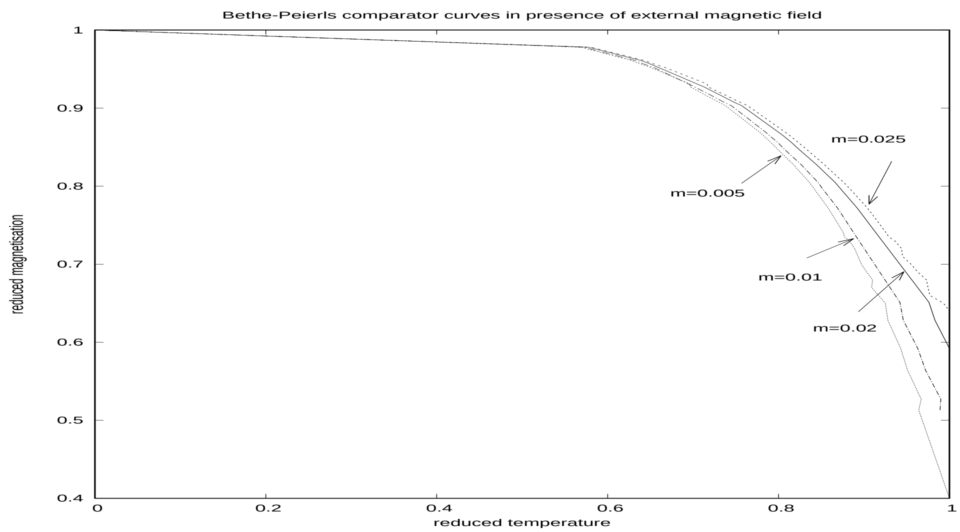

FIG. 2. Reduced magnetisation vs reduced temperature curves for Bethe-Peierls approximation in presence of little external magnetic fields, for four nearest neighbours, with $\beta H = 2m$.

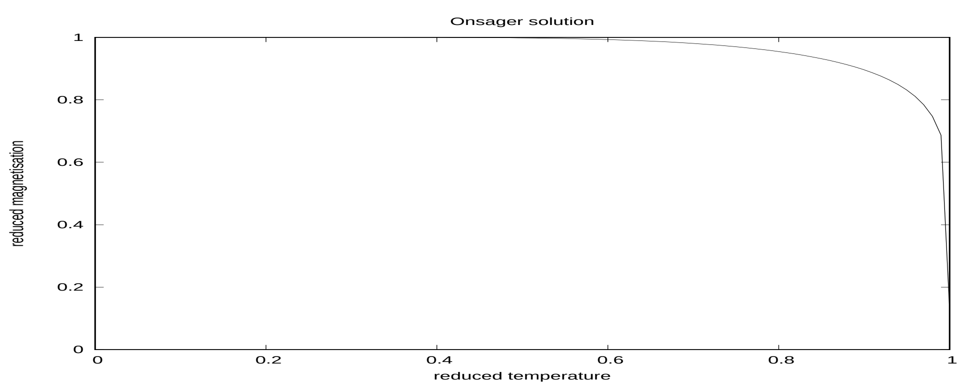

FIG. 3. Reduced magnetisation vs reduced temperature curves for exact solution of two dimensional Ising model, due to Onsager, in absence of external magnetic field

A	B	Bh	Ch	D	Dh	E	Ê	G	H	I	J	K	L	M	N	Ng	Ny	O	Ô	R	S	Sh	T	U	W	Y	Z
51	86	84	55	60	57	16	20	123	62	60	18	202	78	97	15	50	18	9	16	46	65	38	104	35	26	17	19

TABLE III. Entries of the Mursi-English-Amharic Dictionary: the first row represents letters of the Mursi alphabet in the serial order, the second row is the respective number of entries.

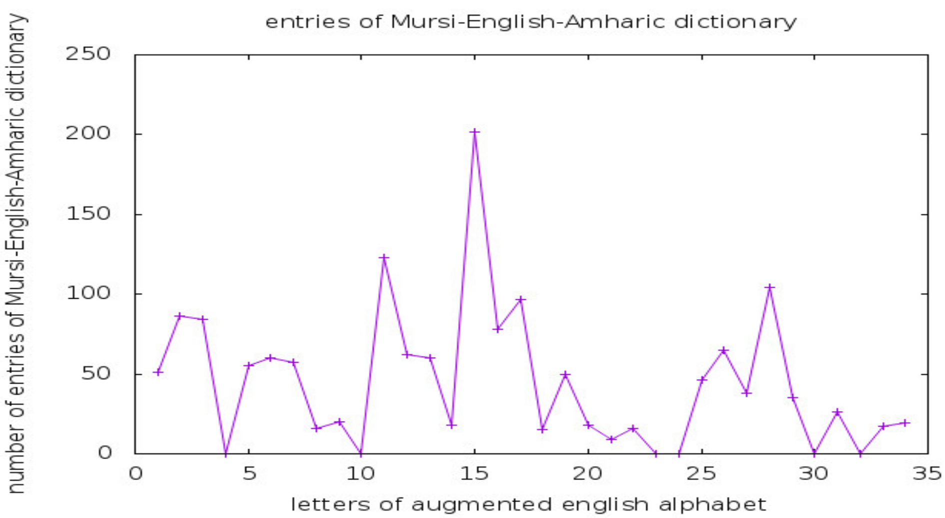

FIG. 4. Vertical axis is number of entries of the Mursi-English-Amharic Dictionary,[1]. Horizontal axis is the letters of the augmented English alphabet. Letters are represented by the sequence number in the alphabet.

III. METHOD OF STUDY AND RESULTS

The Mursi language written in English alphabet is composed of twenty six letters. We count all the entries in the dictionary, [1], one by one from the beginning to the end, starting with different letters. The result is the table, III.

Highest number of entries, two hundred two, starts with the letter K followed by words numbering one hundred twenty three beginning with G, one hundred four with the letter T etc. To visualise we plot the number of entries against the respective letters of the augmented English alphabet i.e. English alphabet with Bh, Ch, Dh, Ê, Ng, Ny, Ô, Sh included, in the figure fig.4. 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, [23], denoted by k. k is a positive integer starting from one. Moreover, we attach a limiting rank, k_{lim}, and a limiting number of words. The limiting rank is maximum rank plus one, here it is twenty six and the limiting number of words is one. 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, IV, and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure fig.5.

We then ignore the letter with the highest number of words, tabulate in the adjoining table, IV, and redo the plot, normalising the lnfs with next-to-maximum $lnf_{nextmax}$, and starting from $k = 2$ in the figure fig.6. Normalising the lnfs with next-to-next-to-maximum $lnf_{nextnextmax}$, we tabulate in the adjoining table, IV, and starting from $k = 3$ we draw in the figure fig.7. Normalising the lnfs with next-to-next-to-next-to-maximum $lnf_{nextnextnextmax}$ we record in the adjoining table, IV, and plot starting from $k = 4$ in the figure fig.8. Normalising the lnfs with 4n-maximum lnf_{4n-max} we record in the adjoining table, IV, and plot starting from $k = 5$ in the figure fig.9. Normalising the lnfs with 5n-maximum lnf_{5n-max} we record in the adjoining table, IV, and plot starting from $k = 6$ in the figure fig.10, with 6n-maximum lnf_{6n-max} we record in the adjoining table, IV, and plot starting from $k = 7$ in the figure fig.11. We end our graphical analysis with the figure fig.12, plotting lnf_{7n-max} against $\frac{lnk}{lnk_{lim}}$.

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}	lnf/lnf_{6nmax}	lnf/lnf_{7nmax}
1	0	0	202	5.308	1	Blank	Blank	Blank	Blank	Blank	Blank	Blank
2	0.69	0.212	123	4.812	0.907	1	Blank	Blank	Blank	Blank	Blank	Blank
3	1.10	0.337	104	4.644	0.875	0.965	1	Blank	Blank	Blank	Blank	Blank
4	1.39	0.426	97	4.575	0.862	0.951	0.985	1	Blank	Blank	Blank	Blank
5	1.61	0.494	86	4.454	0.839	0.926	0.959	0.974	1	Blank	Blank	Blank
6	1.79	0.549	84	4.431	0.835	0.921	0.954	0.969	0.995	1	Blank	Blank
7	1.95	0.598	78	4.357	0.821	0.905	0.938	0.952	0.978	0.983	1	Blank
8	2.08	0.638	65	4.174	0.786	0.867	0.899	0.912	0.937	0.942	0.958	1
9	2.20	0.675	62	4.127	0.778	0.858	0.889	0.902	0.927	0.931	0.947	0.989
10	2.30	0.706	60	4.094	0.771	0.851	0.882	0.895	0.919	0.924	0.940	0.981
11	2.40	0.736	57	4.043	0.762	0.840	0.871	0.884	0.908	0.912	0.928	0.969
12	2.48	0.761	55	4.007	0.755	0.833	0.863	0.876	0.900	0.904	0.920	0.960
13	2.56	0.785	51	3.932	0.741	0.817	0.847	0.859	0.883	0.887	0.902	0.942
14	2.64	0.810	50	3.912	0.737	0.813	0.842	0.855	0.878	0.883	0.898	0.937
15	2.71	0.831	46	3.829	0.721	0.796	0.825	0.837	0.860	0.864	0.879	0.917
16	2.77	0.850	38	3.638	0.685	0.756	0.783	0.795	0.817	0.821	0.835	0.872
17	2.83	0.868	35	3.555	0.670	0.739	0.766	0.777	0.798	0.802	0.816	0.852
18	2.89	0.887	26	3.258	0.614	0.677	0.702	0.712	0.731	0.735	0.748	0.781
19	2.94	0.902	20	2.996	0.564	0.623	0.645	0.655	0.673	0.676	0.688	0.718
20	3.00	0.920	19	2.944	0.555	0.612	0.634	0.643	0.661	0.664	0.676	0.705
21	3.04	0.933	18	2.890	0.544	0.601	0.622	0.632	0.649	0.652	0.663	0.692
22	3.09	0.948	17	2.833	0.534	0.589	0.610	0.619	0.636	0.639	0.650	0.679
23	3.14	0.963	16	2.773	0.522	0.576	0.597	0.606	0.623	0.626	0.636	0.664
24	3.18	0.975	15	2.708	0.510	0.563	0.583	0.592	0.608	0.611	0.622	0.649
25	3.22	0.988	9	2.197	0.414	0.457	0.473	0.480	0.493	0.496	0.504	0.526
26	3.26	1	1	0	0	0	0	0	0	0	0	0

TABLE IV. Entries of the Mursi-English-Amharic Dictionary: ranking, natural logarithm, normalisations

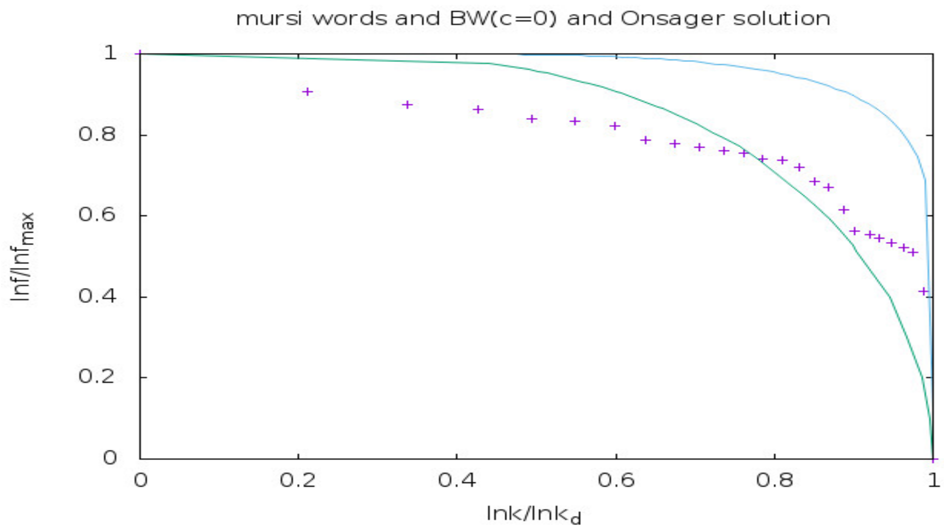

FIG. 5. Vertical axis is $\frac{lnf}{lnf_{max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being the Bragg-Williams curve in absence of external magnetic field, BW(c=0). The uppermost curve is the Onsager solution.

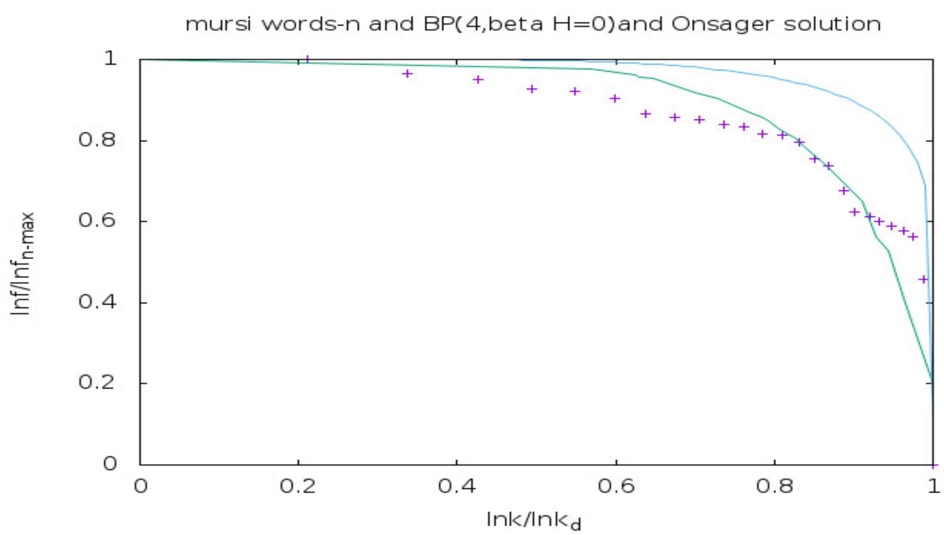

FIG. 6. Vertical axis is $\frac{lnf}{lnf_{next-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and in absence of external magnetic field BP(4, $\beta H =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

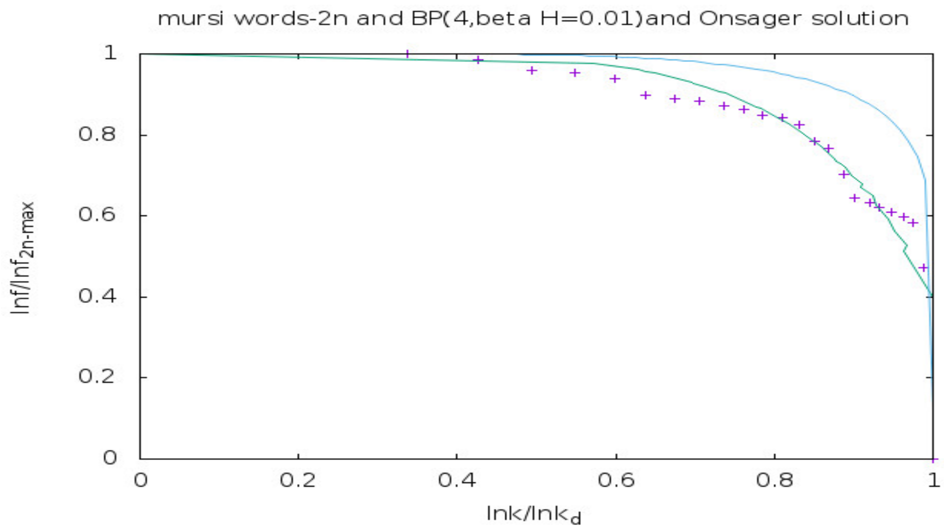

FIG. 7. Vertical axis is $\frac{lnf}{lnf_{nn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.005$ or, $\beta H = 0.01$. The uppermost curve is the Onsager solution.

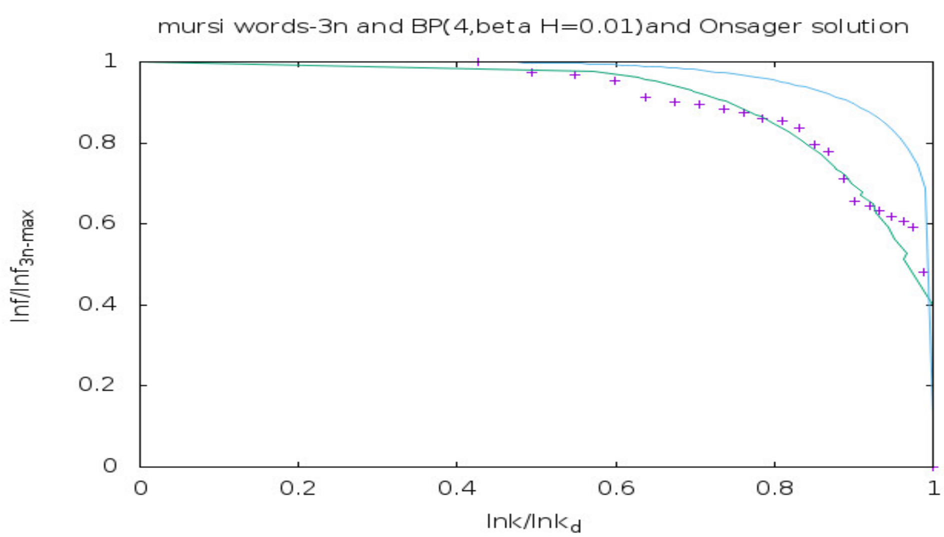

FIG. 8. Vertical axis is $\frac{lnf}{lnf_{nnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.005$ or, $\beta H = 0.01$. The uppermost curve is the Onsager solution.

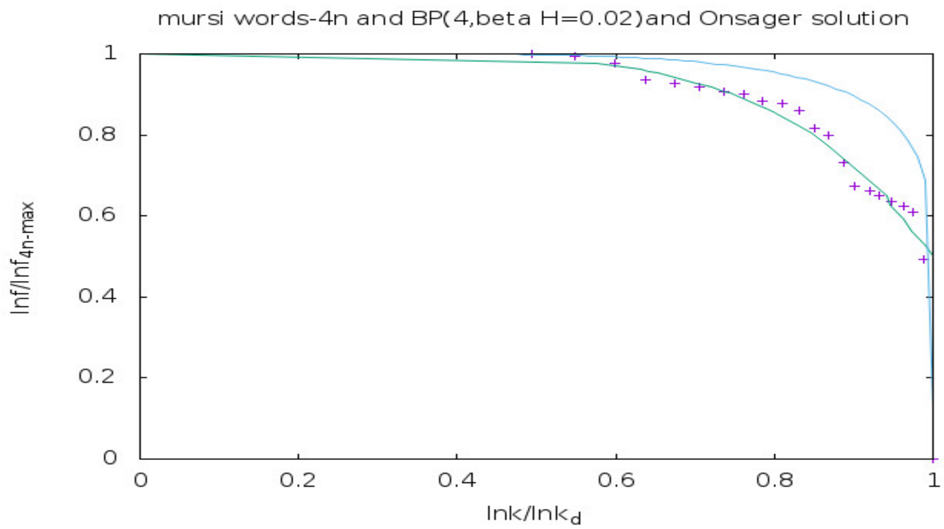

FIG. 9. Vertical axis is $\frac{lnf}{lnf_{nnnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

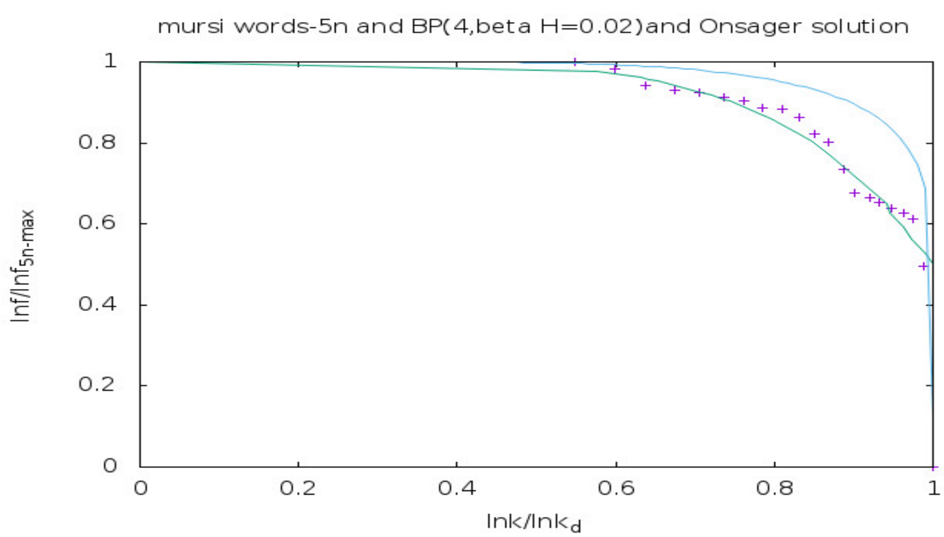

FIG. 10. Vertical axis is $\frac{lnf}{lnf_{nnnnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the Mursi language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$. The uppermost curve is the Onsager solution.

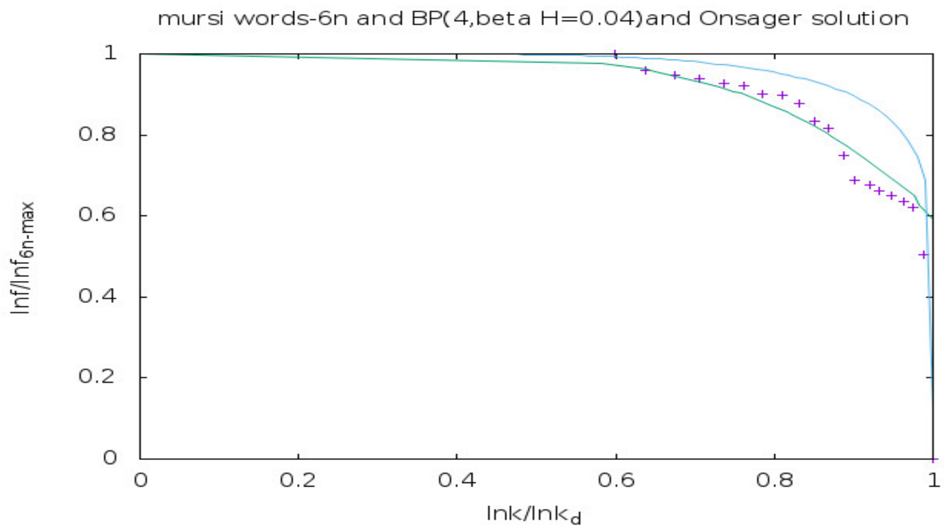

FIG. 11. Vertical axis is $\frac{lnf}{lnf_{nnnnnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the english language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little magnetic field, $m = 0.02$ or, $\beta H = 0.04$. The uppermost curve is the Onsager solution.

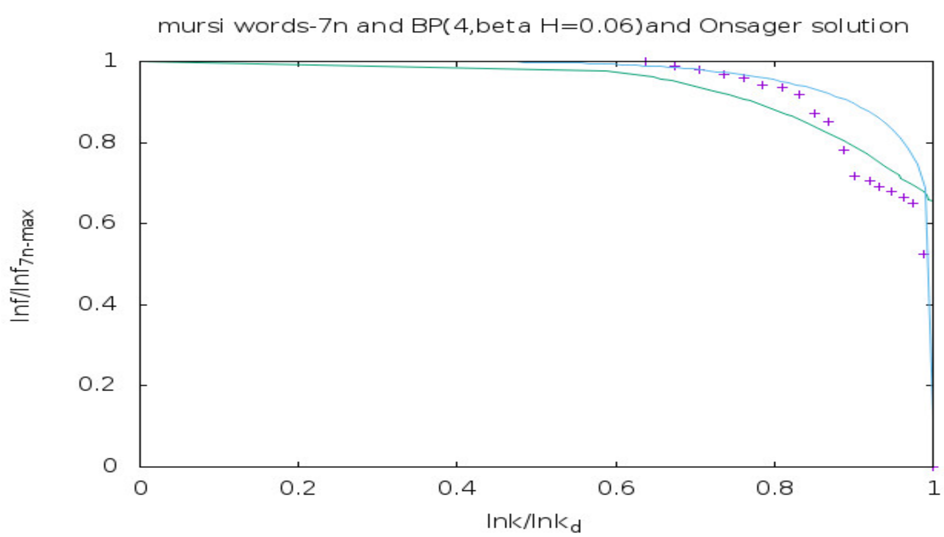

FIG. 12. Vertical axis is $\frac{lnf}{lnf_{nnnnnnn-max}}$ and horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of the english language with the fit curve being Bethe-Peierls curve in presence of four nearest neighbours and little magnetic field, $m = 0.03$ or, $\beta H = 0.06$. The uppermost curve is the Onsager solution. The points of the Mursi language do not go over to Onsager's solution i.e. the Mursi language as viewed through this dictionary does not have Onsager core.

1. conclusion

From the figures (fig.5-fig.12), we observe that behind the entries of the dictionary, [1], there is a magnetisation curve, BP(4,$\beta H = 0.02$), in the Bethe-Peierls approximation with four nearest neighbours, in presence of liitle magnetic field, $\beta H = 0.02$.
Moreover, the associated correspondance with the Ising model is,

$$\frac{lnf}{lnf_{4n-maximum}} \longleftrightarrow \frac{M}{M_{max}},$$

and

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [24]. 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. As the Mursi language expands, the letters which get enriched more and more, fall at lower and lower temperatures. This is a manifestation of cooling effect as was first observed in [25] in another way.

IV. ACKNOWLEDGEMENT

We have used gnuplot for drawing the figures.

V. BIBLIOGRAPHY

[1] D. Turton, M. Yigezu and O. Olibui, Mursi-English-Amharic Dictionary, 2008; published by CASE, printed by Ermias Advertising, Addis Ababa, Ethiopia. ISBIN 978-99944-831-0-5.

[2] Anindya Kumar Biswas, "Graphical Law beneath each written natural language", arXiv:1307.6235v3[physics.gen-ph]. A preliminary study of words of dictionaries of twenty six languages, more accurate study of words of dictionary of Chinese usage and all parts of speech of dictionary of Lakher(Mara) language and of verbs, adverbs and adjectives of dictionaries of six languages are included.

[3] Anindya Kumar Biswas, "A discipline of knowledge and the graphical law", IJARPS Volume 1(4), p 21, 2014; viXra: 1908:0090[Linguistics].

[4] Anindya Kumar Biswas, "Bengali language and Graphical law ", viXra: 1908:0090[Linguistics].

[5] Anindya Kumar Biswas, "Basque language and the Graphical Law", viXra: 1908:0414[Linguistics].

[6] Anindya Kumar Biswas, "Romanian language, the Graphical Law and More ", viXra: 1909:0071[Linguistics].

[7] Anindya Kumar Biswas, "Discipline of knowledge and the graphical law, part II", viXra:1912.0243 [Condensed Matter],International Journal of Arts Humanities and Social Sciences Studies Volume 5 Issue 2 February 2020.

[8] Anindya Kumar Biswas, "Onsager Core of Abor-Miri and Mising Languages", viXra: 2003.0343[Condensed Matter].

[9] Anindya Kumar Biswas, "Bengali language, Romanisation and Onsager Core", viXra: 2003.0563[Linguistics].

[10] Anindya Kumar Biswas, "Little Oxford English Dictionary and the Graphical Law", viXra:

2008.0041[Linguistics].

[11] Anindya Kumar Biswas, ”Oxford Dictionary Of Social Work and Social Care and the Graphical law”, viXra: 2008.0077[Condensed Matter].

[12] Anindya Kumar Biswas, ”Visayan-English Dictionary and the Graphical law”, viXra: 2009.0014[Linguistics].

[13] Anindya Kumar Biswas, ”Garo to English School Dictionary and the Graphical law”, viXra: 2009.0056[Condensed Matter].

[14] E. Ising, Z.Physik 31,253(1925).

[15] R. K. Pathria, Statistical Mechanics, p400-403, 1993 reprint, Pergamon Press,© 1972 R. K. Pathria.

[16] C. Kittel, Introduction to Solid State Physics, p. 438, Fifth edition, thirteenth Wiley Eastern Reprint, May 1994, Wiley Eastern Limited, New Delhi, India.

[17] W. L. Bragg and E. J. Williams, Proc. Roy. Soc. A, vol.145, p. 699(1934);

[18] P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, p. 148, first edition, Cambridge University Press India Pvt. Ltd, New Delhi.

[19] Kerson Huang, Statistical Mechanics, second edition, John Wiley and Sons(Asia) Pte Ltd.

[20] S. M. Bhattacharjee and A. Khare, ”Fifty Years of the Exact solution of the Two-dimensional Ising Model by Onsager”, arXiv:cond-mat/9511003v2.

[21] L. Onsager, Nuovo Cim. Supp.6(1949)261.

[22] C. N. Yang, Phys. Rev. 85, 809(1952).

[23] A. M. Gun, M. K. Gupta and B. Dasgupta, Fundamentals of Statistics Vol 1, Chapter 12, eighth edition, 2012, The World Press Private Limited, Kolkata.

[24] Sonntag, Borgnakke and Van Wylen, Fundamentals of Thermodynamics, p206-207, fifth edition, John Wiley and Sons Inc.

[25] Alexander M. Petersen, Joel N. Tenenbaum, Shlomo Havlin, H. Eugene Stanley, and Matjaž Perc, ”Languages cool as they expand: Allometric scaling and the decreasing need for new words”, Sci. Rep.2(2012) 943, arXiv:1212.2616v1. and references therein.