

Oxford Dictionary of Chemistry, the seventh edition and the Graphical Law

Anindya Kumar Biswas*

Department of Chemistry;

North-Eastern Hill University,

Mawkynroh-Umshing, Shillong-793022.

(Dated: December 10, 2022)

Abstract

We study the Oxford Dictionary Of Chemistry, the seventh edition. 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 $BP(4, \beta H = 0)$ 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.

* anindya@nehu.ac.in

I. INTRODUCTION

In the star studded sky over our head, Berzelius, Avogadro, John Dalton, Lavoisier, Mendeleevare the shining stars, showing us paths for our day to day survival. Chemicals are here, chemicals are there. To look for the graphical law in this chemical world, we take recourse to a dictionary, the Oxford Dictionary Of Chemistry, [1]. We study magnetic field pattern behind the entries of this dictionary, [1], in this article. We count all the head entries one by one to probe for the magnetic field pattern. 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 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], a Dictionary Of Critical Theory by Ian Buchanan, [33],

the Penguin Dictionary Of Economics, [34], the Concise Gojri-English Dictionary by Dr. Rafeeq Anjum, [35], A Dictionary of the Kachin Language by Rev.O.Hanson, [36], A Dictionary Of World History by Edmund Wright, [37], Ekagi-Dutch-English-Indonesian Dictionary by J. Steltenpool, [38], A Dictionary of Plant Sciences by Michael Allaby, [39], respectively. The graphical law was pursued more in Along the side of the Onsager’s solution, the Ekagi language ,[40], Along the side of the Onsager’s solution, the Ekagi language-Part Three, [41], Oxford Dictionary of Biology by Robert S. Hine and the Graphical law, [42], A Dictionary of the Mikir Language by G. D. Walker and the Graphical law, [43], A Dictionary of Zoology by Michael Allaby and the Graphical Law, [44], Dictionary of all Scriptures and Myths by G. A. Gaskell and the Graphical Law, [45], Dictionary of Culinary Terms by Philippe Pilibossian and the Graphical law, [46], A Greek and English Lexicon by H.G.Liddle et al simplified by Didier Fontaine and the Graphical law, [47], Learner’s Mongol-English Dictionary and the Graphical law, [48], Complete Bulgarian-English Dictionary and the Graphical law, [49], A Dictionary of Sindhi Literature by Dr. Motilal Jotwani and the Graphical Law, [50], Penguin Dictionary of Physics, the Fourth Edition, by John Cullerne, and the Graphical law, [51], respectively.

We describe how the graphical law is hidden within the Oxford Dictionary Of Chemistry 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 analysis of the head entries of the Oxford Dictionary Of Chemistry, [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 $L = \frac{1}{N}\sum_i\sigma_i$, 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,[52], 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, [53], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\Delta E}{k_B T})$, [54]. In the Bragg-Williams approximation,[55], $\bar{\sigma} = L$, 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, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [56]. $\frac{T}{T_c}$ 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 [53]. 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, [52],[53],[54],[55],[56], due to Bethe-Peierls, [57], 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 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 .

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

In the Bethe-Peierls approximation scheme , [57], reduced magnetisation varies with reduced temperature, for γ neighbours, in presence of external magnetic field, as

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

Derivation of this formula Ala [57] 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,

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

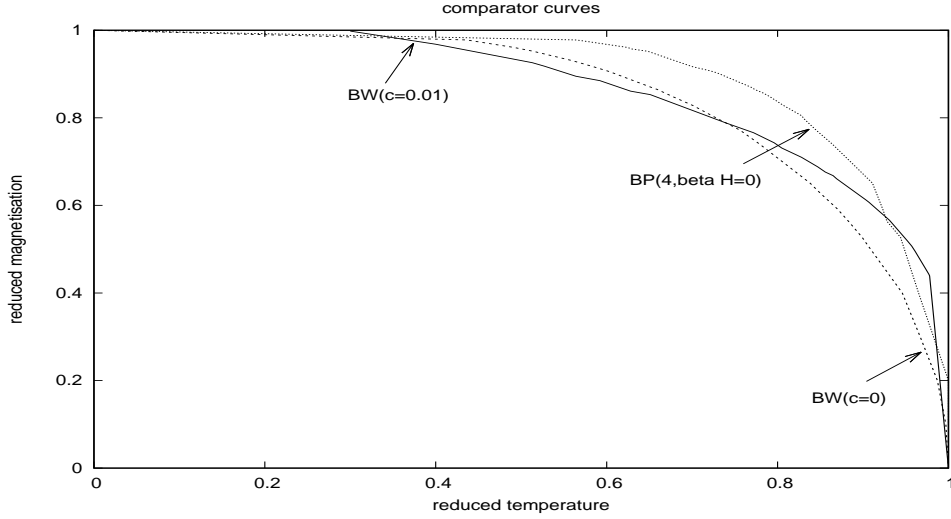


FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in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

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

| 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 |
| | | | 1.00 | 0.964 | 0.513 |
| | | | | 1.00 | 0.500 |
| | | | | | 0.400 |
| | | | | | 0.300 |
| | | | | | 0.200 |
| | | | | | 0.100 |
| | | | | | 0 |

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

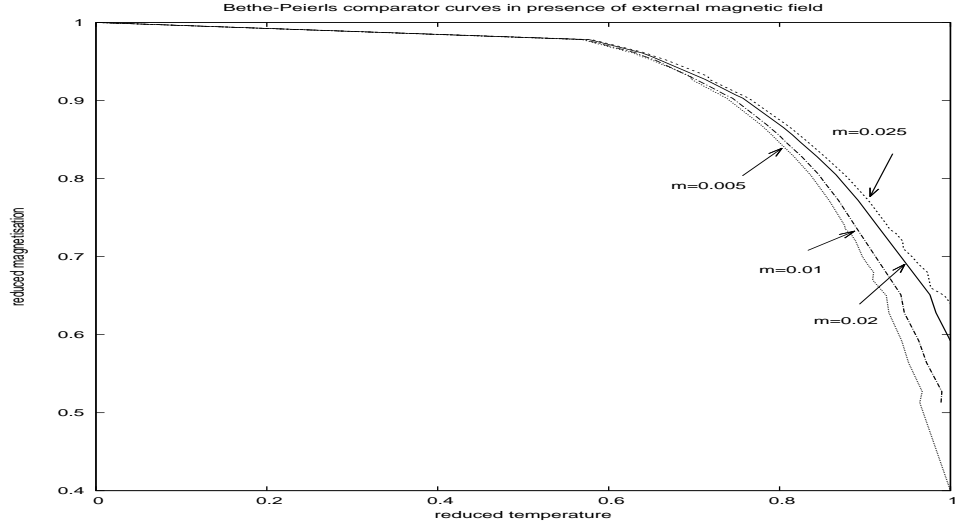


FIG. 2. Reduced magnetisation vs reduced temperature curves for Bethe-Peierls approximation in presence of little external magnetic fields, for four nearest neighbours, with $\beta H = 2m$.

| 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 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|----|----|----|----|---|----|
| 439 | 309 | 594 | 289 | 255 | 194 | 154 | 248 | 154 | 18 | 56 | 203 | 300 | 151 | 126 | 453 | 39 | 179 | 437 | 211 | 41 | 65 | 51 | 15 | 5 | 31 |

TABLE III. Head entries of the Oxford Dictionary Of Chemistry along the English letters

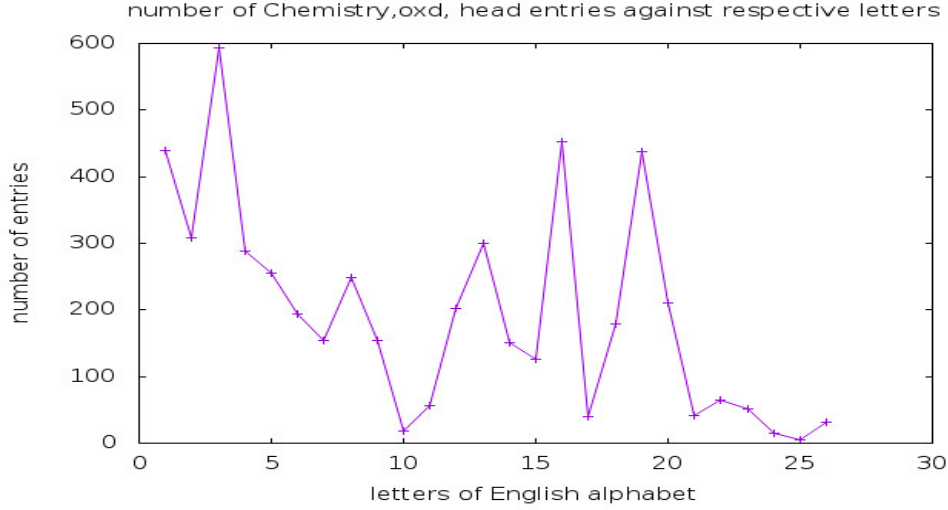


FIG. 3. The vertical axis is the number of entries of the Oxford Dictionary Of Chemistry, [1], and the horizontal axis is the respective letters. Letters are represented by the sequence number in the alphabet or, dictionary sequence,[1].

III. ANALYSIS OF THE HEAD ENTRIES OF THE OXFORD DICTIONARY OF CHEMISTRY

We count all the head entries of Oxford Dictionary Of Chemistry, [1], one by one from the beginning to the end, starting with different letters. The result is the table, III. Highest number of head entries, five hundred ninety four, starts with the letter C followed by entries numbering four hundred fifty three beginning with P, four hundred thirty nine with the letter A etc. To visualise we plot the number of head entries against respective letters in the dictionary sequence, [1], in the figure fig.3.

For the purpose of exploring graphical law, we assort the letters according to the number of 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 five. Hence we attach a limiting f equal to one. The corresponding rank, k , denoted as k_{lim} is twenty six. 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, IV and

| 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 | 594 | 6.387 | 1 | Blank | Blank | Blank | Blank | Blank |
| 2 | 0.69 | 0.212 | 453 | 6.116 | 0.958 | 1 | Blank | Blank | Blank | Blank |
| 3 | 1.10 | 0.337 | 439 | 6.084 | 0.953 | 0.995 | 1 | Blank | Blank | Blank |
| 4 | 1.39 | 0.426 | 437 | 6.080 | 0.952 | 0.994 | 0.999 | 1 | Blank | Blank |
| 5 | 1.61 | 0.494 | 309 | 5.733 | 0.898 | 0.937 | 0.942 | 0.943 | 1 | Blank |
| 6 | 1.79 | 0.549 | 300 | 5.704 | 0.893 | 0.933 | 0.938 | 0.938 | 0.995 | 1 |
| 7 | 1.95 | 0.598 | 289 | 5.666 | 0.887 | 0.926 | 0.931 | 0.932 | 0.988 | 0.993 |
| 8 | 2.08 | 0.638 | 255 | 5.541 | 0.868 | 0.906 | 0.911 | 0.911 | 0.967 | 0.971 |
| 9 | 2.20 | 0.675 | 248 | 5.513 | 0.863 | 0.901 | 0.906 | 0.907 | 0.962 | 0.967 |
| 10 | 2.30 | 0.706 | 211 | 5.352 | 0.838 | 0.875 | 0.880 | 0.880 | 0.934 | 0.938 |
| 11 | 2.40 | 0.736 | 203 | 5.313 | 0.832 | 0.869 | 0.873 | 0.874 | 0.927 | 0.931 |
| 12 | 2.48 | 0.761 | 194 | 5.268 | 0.825 | 0.861 | 0.866 | 0.866 | 0.919 | 0.924 |
| 13 | 2.56 | 0.785 | 179 | 5.187 | 0.812 | 0.848 | 0.853 | 0.853 | 0.905 | 0.909 |
| 14 | 2.64 | 0.810 | 154 | 5.037 | 0.789 | 0.824 | 0.828 | 0.828 | 0.879 | 0.883 |
| 15 | 2.71 | 0.831 | 151 | 5.017 | 0.786 | 0.820 | 0.825 | 0.825 | 0.875 | 0.880 |
| 16 | 2.77 | 0.850 | 126 | 4.836 | 0.757 | 0.791 | 0.795 | 0.795 | 0.844 | 0.848 |
| 17 | 2.83 | 0.868 | 65 | 4.174 | 0.654 | 0.682 | 0.686 | 0.687 | 0.728 | 0.732 |
| 18 | 2.89 | 0.887 | 56 | 4.025 | 0.630 | 0.658 | 0.662 | 0.662 | 0.702 | 0.706 |
| 19 | 2.94 | 0.902 | 51 | 3.932 | 0.616 | 0.643 | 0.646 | 0.647 | 0.686 | 0.689 |
| 20 | 3.00 | 0.920 | 41 | 3.714 | 0.581 | 0.607 | 0.610 | 0.611 | 0.648 | 0.651 |
| 21 | 3.04 | 0.933 | 39 | 3.664 | 0.574 | 0.599 | 0.602 | 0.603 | 0.639 | 0.642 |
| 22 | 3.09 | 0.948 | 31 | 3.434 | 0.538 | 0.561 | 0.564 | 0.565 | 0.599 | 0.602 |
| 23 | 3.14 | 0.963 | 18 | 2.890 | 0.452 | 0.473 | 0.475 | 0.475 | 0.504 | 0.507 |
| 24 | 3.18 | 0.975 | 15 | 2.708 | 0.424 | 0.443 | 0.445 | 0.445 | 0.472 | 0.475 |
| 25 | 3.22 | 0.988 | 5 | 1.609 | 0.252 | 0.263 | 0.264 | 0.265 | 0.281 | 0.282 |
| 26 | 3.26 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE IV. Head entries of the Oxford Dictionary Of Chemistry: ranking, natural logarithm, normalisations

plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure fig.4. We then ignore the letter with the highest of entries, 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.5. This program then we repeat up to $k = 6$, resulting in figures up to fig.9.

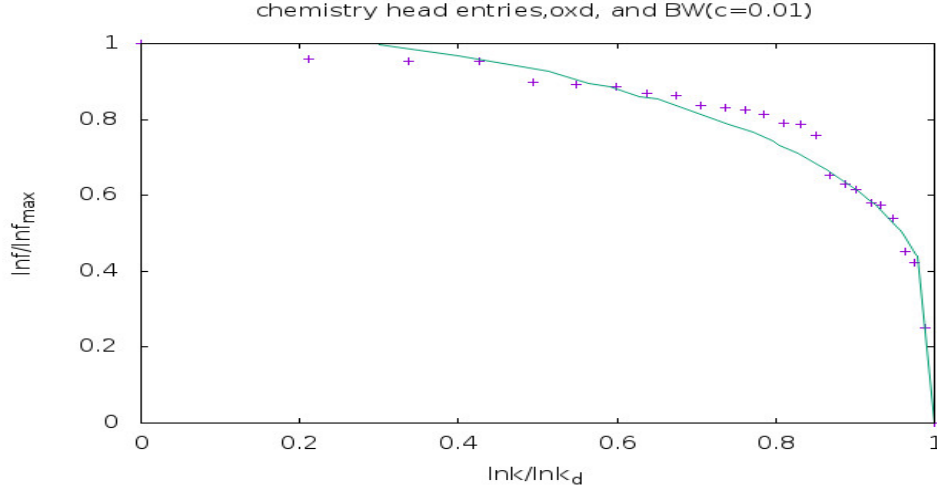


FIG. 4. The vertical axis is $\frac{\ln f}{\ln f_{max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the head entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bragg-Williams line, BW($c=0.01$), in the presence of little external magnetic field.

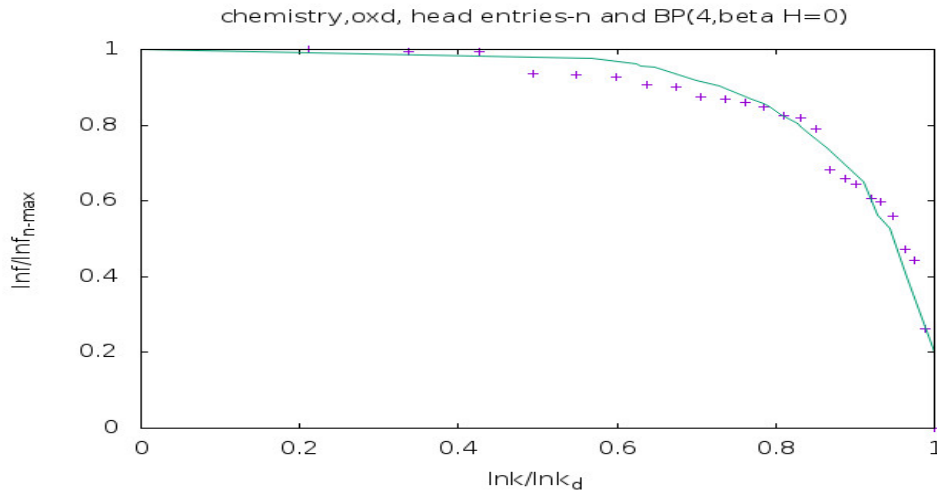


FIG. 5. The vertical axis is $\frac{\ln f}{\ln f_{n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the head entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bethe-Peierls curve, BP(4, $\beta H = 0$), with four nearest neighbours, in the absence of external magnetic field.

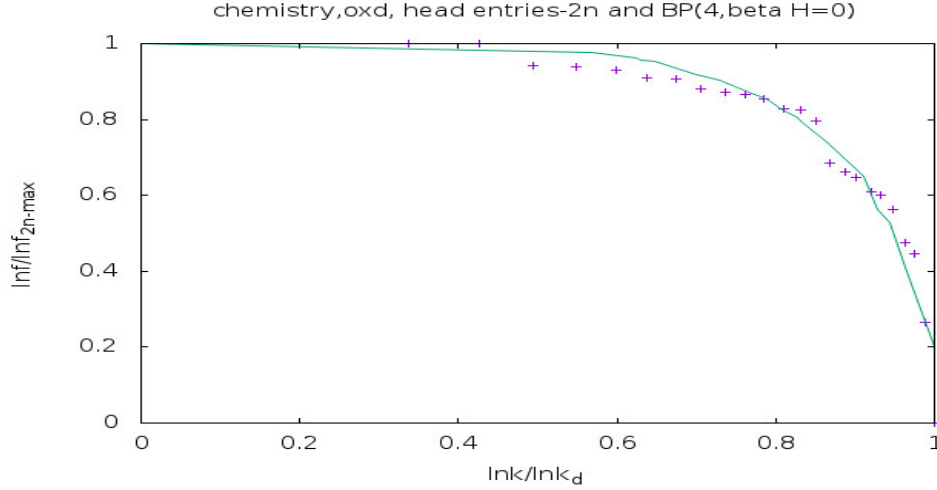


FIG. 6. The vertical axis is $\frac{\ln f}{\ln f_{2n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the head entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bethe-Peierls curve, $BP(4, \beta H = 0)$, with four nearest neighbours, in the absence of external magnetic field.

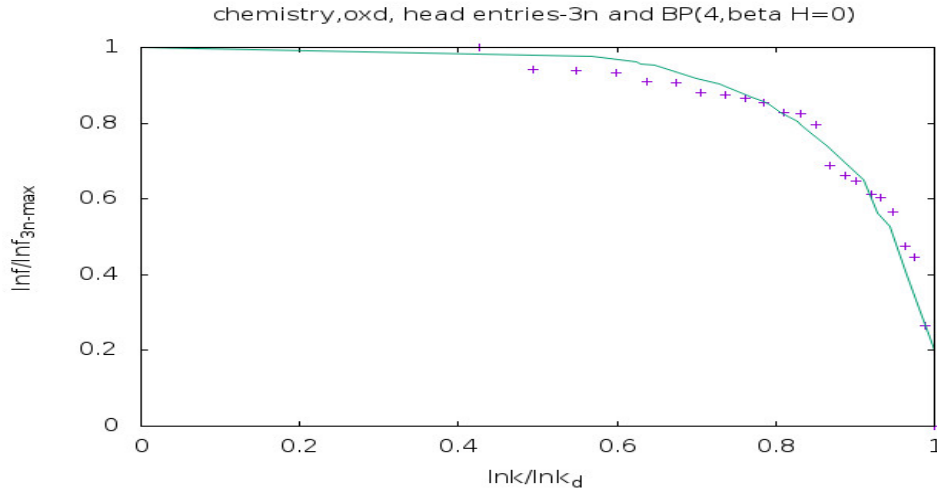


FIG. 7. The vertical axis is $\frac{\ln f}{\ln f_{3n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the head entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bethe-Peierls curve, $BP(4, \beta H = 0)$, with four nearest neighbours, in the absence of external magnetic field.

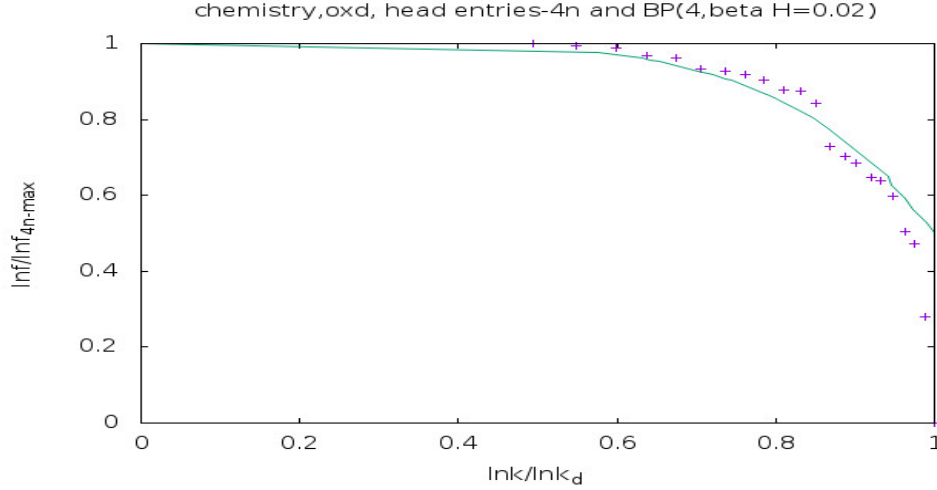


FIG. 8. The vertical axis is $\frac{\ln f}{\ln f_{4n-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$.

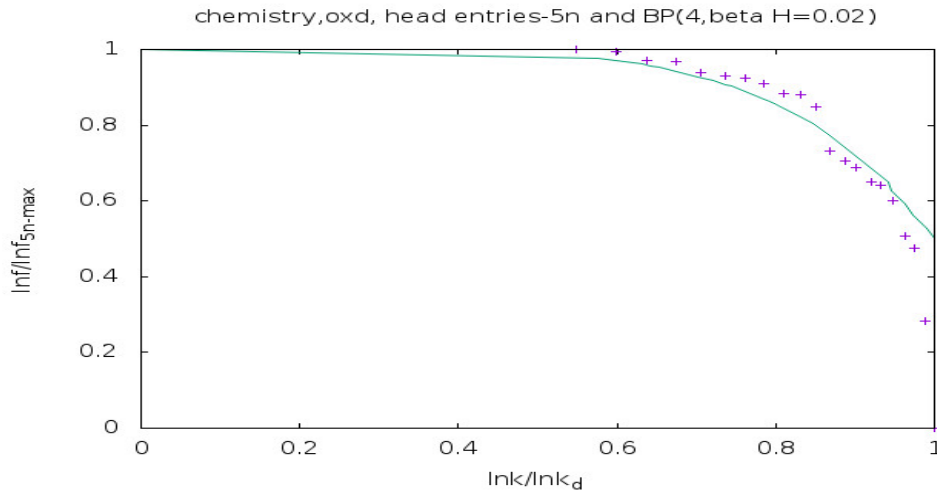


FIG. 9. The vertical axis is $\frac{\ln f}{\ln f_{nextnextnextnext-max}}$ and the horizontal axis is $\frac{\ln k}{\ln k_{lim}}$. The + points represent the entries of the Oxford Dictionary Of Chemistry, with the fit curve being the Bethe-Peierls curve in presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$.

A. conclusion

From the figures (fig.4-fig.9), we observe that there is a curve of magnetisation, behind the entries of the Oxford Dictionary of Chemistry,[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,

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

k corresponds to temperature in an exponential scale, [59]. As temperature decreases, i.e. $\ln k$ decreases, f increases. The letters which are recording higher entries compared to those which have lesser entries are at lower temperature. As the subject of Chemistry expands, the letters like ...,A,P,C which get enriched more and more, fall at lower and lower temperatures. This is a manifestation of cooling effect, as was first observed in [60], in another way.

IV. ACKNOWLEDGMENT

We have used gnuplot for plotting the figures in this paper.

-
- [1] Oxford Dictionary Of Chemistry, seventh edition, edited by Richard Rennie, 2016; Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, United Kingdom. ISBN 978-0-19-872282-3.
 - [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] Anindya Kumar Biswas, "Mursi-English-Amharic Dictionary and the Graphical law", viXra: 2009.0100[Linguistics].
- [15] Anindya Kumar Biswas, "Names of Minor Planets and the Graphical law", viXra: 2009.0158[History and Philosophy of Physics].
- [16] Anindya Kumar Biswas, "A Dictionary of Tibetan and English and the Graphical law", viXra: 2010.0237[Condensed Matter].
- [17] Anindya Kumar Biswas, "Khasi English Dictionary and the Graphical law", viXra: 2011.0011[Linguistics].
- [18] Anindya Kumar Biswas, "Turkmen-English Dictionary and the Graphical law", viXra: 2011.0069[Linguistics].
- [19] Anindya Kumar Biswas, " Webster's Universal Spanish-English Dictionary, the Graphical law and A Dictionary of Geography of Oxford University Press", viXra: 2103.0175[Condensed Matter].

- [20] Anindya Kumar Biswas, "A Dictionary of Modern Italian, the Graphical law and Dictionary of Law and Administration, 2000, National Law Development Foundation", viXra: 2107.0171[Condensed Matter].
- [21] Anindya Kumar Biswas, "Langenscheidt's German-English English-German Dictionary and the Graphical law", viXra: 2107.0179[Linguistics].
- [22] Anindya Kumar Biswas, "Essential Dutch dictionary by G. Quist and D. Strik, the Graphical law Classification", viXra: 2108.0040[Linguistics].
- [23] Anindya Kumar Biswas, "Swahili, a lingua franca, Swahili-English Dictionary by C. W. Rechenbach and the Graphical law", viXra: 2108.0101[Linguistics].
- [24] Anindya Kumar Biswas, "The French, Larousse Dictionnaire De Poche and the Graphical law", viXra: 2109.0080[Linguistics].
- [25] Anindya Kumar Biswas, "An Arabic dictionary: "al-Mujam al-wáfi" or, "adhunik arabi-bangla abhidhan" and the Onsager's solution", viXra: 2109.0119[Condensed Matter].
- [26] Anindya Kumar Biswas, "Langenscheidt Taschenwörterbuch Deutsch-Englisch / Englisch-Deutsch, Völlige Neubearbeitung and the Graphical law", viXra: 2109.0141[Linguistics].
- [27] Anindya Kumar Biswas, Bawansuk Lyngkhai, "The Graphical law behind the NTC's Hebrew and English Dictionary by Arie Comey and Naomi Tsur", viXra: 2109.0164[Linguistics].
- [28] Anindya Kumar Biswas, "Oxford Dictionary Of Media and Communication and the Graphical law", viXra: 2109.0202[Social Science].
- [29] Anindya Kumar Biswas, "Oxford Concise Dictionary Of Mathematics, Penguin Dictionary Of Mathematics and the Graphical law", viXra: 2112.0054[Social Science].
- [30] Anindya Kumar Biswas, "An Arabic dictionary: "al-Mujam al-wáfi" or, "adhunik arabi-bangla abhidhan" and the Onsager's solution Second part", viXra: 2201.0021[Condensed Matter].
- [31] Anindya Kumar Biswas, "The Penguin Dictionary Of Sociology and the Graphical law", viXra: 2201.0046[Social Science].
- [32] Anindya Kumar Biswas, "The Concise Oxford Dictionary Of Politics and the Graphical law", viXra: 2201.0069[Social Science].
- [33] Anindya Kumar Biswas, "A Dictionary Of Critical Theory by Ian Buchanan and the Graphical law", viXra: 2201.0136[Social Science].
- [34] Anindya Kumar Biswas, "The Penguin Dictionary Of Economics and the Graphical law", viXra: 2201.0169[Economics and Finance].

- [35] Anindya Kumar Biswas, "The Concise Gojri-English Dictionary by Dr. Rafeeq Anjum and the Graphical law", viXra: 2201.0205[Linguistics].
- [36] Anindya Kumar Biswas, "A Dictionary of the Kachin Language by Rev.O.Hanson and the Graphical law" ("A Dictionary of the Kachin Language by Rev.o.Hanson and the Graphical law", viXra: 2202.0030[Linguistics]).
- [37] Anindya Kumar Biswas, "A Dictionary Of World History by Edmund Wright and the Graphical law", viXra: 2202.0130[History and Philosophy of Physics].
- [38] Anindya Kumar Biswas, "Ekagi-Dutch-English-Indonesian Dictionary by J. Steltenpool and the Onsager's solution", viXra: 2202.0157[Condensed Matter].
- [39] Anindya Kumar Biswas, "A Dictionary of Plant Sciences by Michael Allaby and the Graphical law", viXra: 2203.0011[Mind Science].
- [40] Anindya Kumar Biswas, "Along the side of the Onsager's solution, the Ekagi language", viXra: 2205.0065[Condensed Matter].
- [41] Anindya Kumar Biswas, "Along the side of the Onsager's solution, the Ekagi language-Part Three", viXra: 2205.0137[Condensed Matter].
- [42] Anindya Kumar Biswas, "Oxford Dictionary of Biology by Robert S. Hine and the Graphical law", viXra: 2207.0089[Phyiscs of Biology].
- [43] Anindya Kumar Biswas, "A Dictionary of the Mikir Language by G. D. Walker and the Graphical law", viXra: 2207.0165[Linguistics].
- [44] Anindya Kumar Biswas, "A Dictionary of Zoology by Michael Allaby and the Graphical law", viXra: 2208.0075[Phyiscs of Biology].
- [45] Anindya Kumar Biswas, "Dictionary of all Scriptures and Myths by G. A. Gaskell and the Graphical law", viXra: 2208.0093[Religion and Spiritualism].
- [46] Anindya Kumar Biswas, "Dictionary of Culinary Terms by Philippe Pilibossian and the Graphical law", viXra: 2211.0061[Social Sciences].
- [47] Anindya Kumar Biswas, "A Greek and English Lexicon by H.g.liddle et al simplified by Didier Fontaine and the Graphical law", viXra: 2211.0087[Linguistics].
- [48] Anindya Kumar Biswas, "Learner's Mongol-English Dictionary and the Graphical law", viXra: 2211.0101[Linguistics].
- [49] Anindya Kumar Biswas, "Complete Bulgarian-English Dictionary and the Graphical law", viXra: 2212.0009[Linguistics].

- [50] Anindya Kumar Biswas, "A Dictionary of Sindhi Literature by Dr. Motilal Jotwani and the Graphical Law", viXra: 2212.0015[Social Sciences].
- [51] Anindya Kumar Biswas, "Penguin Dictionary of Physics, the Fourth Edition, by John Cullerne, and the Graphical law", viXra: 2212.0072[History and Philosophy of Physics].
- [52] E. Ising, Z.Physik 31,253(1925).
- [53] R. K. Pathria, Statistical Mechanics, p400-403, 1993 reprint, Pergamon Press,© 1972 R. K. Pathria.
- [54] C. Kittel, Introduction to Solid State Physics, p. 438, Fifth edition, thirteenth Wiley Eastern Reprint, May 1994, Wiley Eastern Limited, New Delhi, India.
- [55] W. L. Bragg and E. J. Williams, Proc. Roy. Soc. A, vol.145, p. 699(1934);
- [56] P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, p. 148, first edition, Cambridge University Press India Pvt. Ltd, New Delhi.
- [57] Kerson Huang, Statistical Mechanics, second edition, John Wiley and Sons(Asia) Pte Ltd.
- [58] 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.
- [59] Sonntag, Borgnakke and Van Wylen, Fundamentals of Thermodynamics, p206-207, fifth edition, John Wiley and Sons Inc.
- [60] 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.