# The Oxford Spanish Dictionary and The Graphical Law

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## Abstract

We study the Spanish head entries of The Oxford Spanish Dictionary, Spanish-English. English-Spanish, the fourth edition, 2008. We draw the natural logarithm of the number of the Spanish 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,$\beta H$=0.01) i.e. a magnetisation curve in the Bethe-Peierls approximation of the Ising model with four nearest neighbours in the presence of external magnetic field, H, with $\beta H = 0.01$. $\beta$ is $\frac{1}{k_B T}$ where, T is the ambient temperature and $k_B$ is the tiny Boltzmann constant.

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# I. INTRODUCTION

"The more, the merrier."

In this article, we go over to The Oxford Spanish Dictionary, [1]. We count one by one all the Spanish head entries of The Oxford Spanish Dictionary, Spanish-English. English-Spanish, the fourth edition, 2008,[1], looking 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 [89].

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 Spanish head entries of The Oxford Spanish Dictionary, Spanish-English. English-Spanish, the fourth edition, 2008,[1]. Sections IV and V are Acknowledgment 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 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 $\sigma_i$ 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, $\mu NL$, $M_{max} = \mu N$. $\frac{M}{M_{max}} = L$. $\frac{M}{M_{max}}$ is referred to as reduced magnetisation. Moreover, the Ising Hamiltonian,[90], for the lattice of spins, setting $\mu$ 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, [91], $2\epsilon\gamma\bar{\sigma} + 2H$, where $\gamma$ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_B T})$, [92]. In the Bragg-Williams approximation,[93], $\bar{\sigma} = L$, 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, $c = \frac{H}{\gamma\epsilon}$ , $T_c = \gamma\epsilon/k_B$, [94]. $\frac{T}{T_c}$ 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 [91]. 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 the presence of four nearest neighbours, in the absence of external magnetic field

In the approximation scheme which is improvement over the Bragg-Williams, [90],[91],[92],[93],[94], due to Bethe-Peierls, [95], reduced magnetisation varies with reduced temperature, for $\gamma$ 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 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 the presence of four nearest neighbours, in the presence of external magnetic field

In the Bethe-Peierls approximation scheme , [95], reduced magnetisation varies with reduced temperature, for $\gamma$ neighbours, in presence of external magnetic field, as

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

| BW | BW(c=0.01) | BP(4,$\beta H$ = 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 [95] 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,

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

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

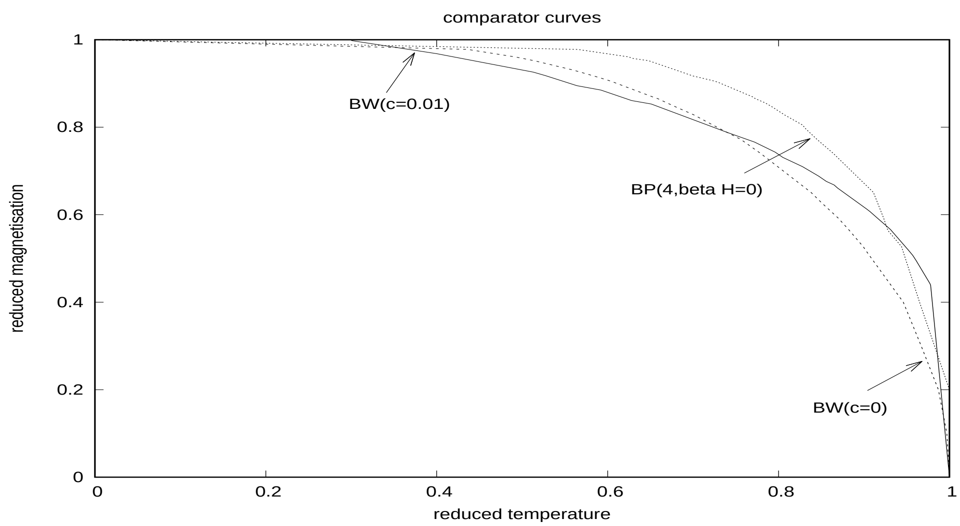


FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in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

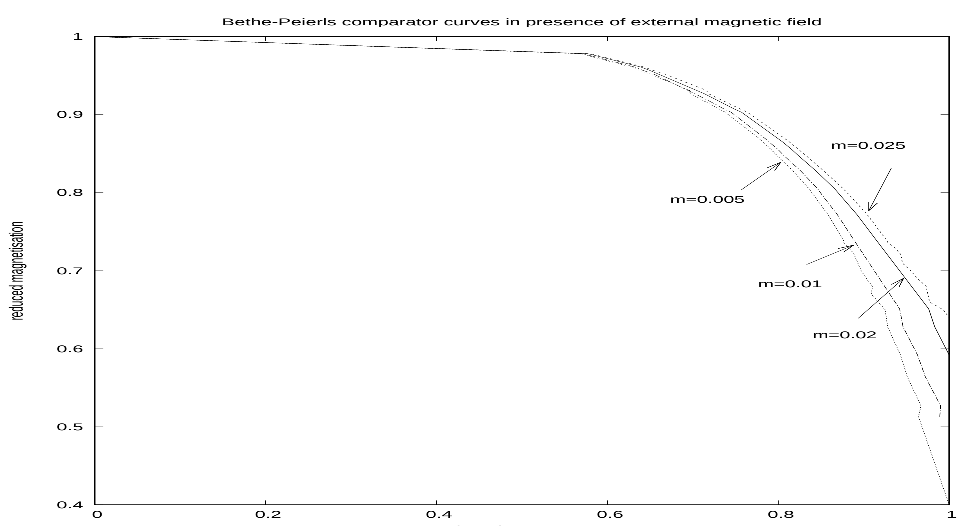


FIG. 2. Reduced magnetisation vs reduced temperature curves for the Bethe-Peierls approximation in the presence of little external magnetic fields, for four nearest neighbours, of the Ising model, with $\beta H = 2m$.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | Ñ | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5707 | 2344 | 7303 | 3606 | 4167 | 1979 | 1816 | 1434 | 2534 | 553 | 203 | 1588 | 3474 | 944 | 42 | 1104 | 5226 | 309 | 2788 | 3087 | 3038 | 454 | 1496 | 72 | 32 | 153 | 303 |

TABLE III. Spanish Head Entries

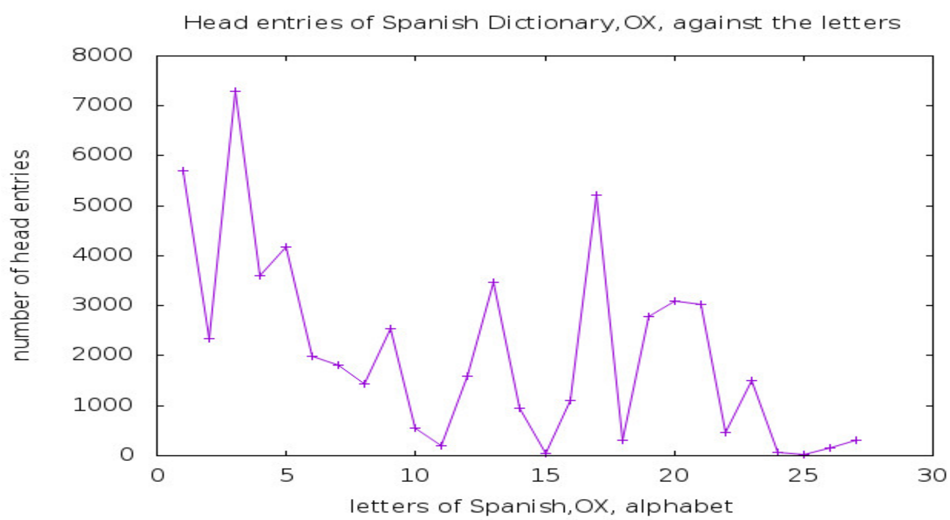


FIG. 3. The vertical axis is number of the Spanish head entries, [1], and the horizontal axis is the respective letters. Letters are represented by the sequence number in the alphabet or, the dictionary sequence,[1].

## III. ANALYSIS OF WORDS OF THE SPANISH-ENGLISH DICTIONARY

The Spanish language alphabet is composed of twenty seven letters ala,[1]. As we count all the Spanish head entries, [1], one by one from the beginning to the end, starting with different letters, we obtain the table, III. Highest number of head entries, seven thousand three hundred three, starts with the letter C followed by head entries numbering five thousand seven hundred seven beginning with A, five thousand two hundred twenty six with the letter P etc. To visualise we plot the number of head entries against the 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 head entries, in the descending order, denoted by $f$ and the respective rank, denoted by $k$. $k$ is a positive integer starting from one. Moreover, we attach a limiting rank, $k_{lim}$, and a limiting number of head entries. The limiting rank is maximum rank plus one, here it is twenty eight and the limiting number of head entries 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.4.

We then ignore the letter with the highest number of head entries, tabulate in the adjoining table, IV and redo the plot, normalising the $lnf$s with next-to-maximum $lnf_{n-max}$, and starting from $k = 2$ in the figure fig.5. Normalising the $lnf$s with next-to-next-to-maximum $lnf_{2n-max}$, we tabulate in the adjoining table, IV, and starting from $k = 3$ we draw in the figure fig.6. Normalising the $lnf$s with next-to-next-to-next-to-maximum $lnf_{3n-max}$ we record in the adjoining table, IV, and plot starting from $k = 4$ in the figure fig.7. Normalising the $lnf$s with next-to-next-to-next-to-next-to-maximum $lnf_{4n-max}$ we record in the adjoining table, IV, and plot starting from $k = 5$ in the figure fig.8. Normalising the $lnf$s with nextnextnextnextnext-maximum $lnf_{5n-max}$ we record in the adjoining table, IV, and plot starting from $k = 6$ in the figure fig.9.

| k | lnk | lnk/$lnk_{lim}$ | f | lnf | lnf/$lnf_{max}$ | lnf/$lnf_{n-max}$ | lnf/$lnf_{2n-max}$ | lnf/$lnf_{3n-max}$ | lnf/$lnf_{4n-max}$ | lnf/$lnf_{5n-max}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 7303 | 8.896 | 1 | Blank | Blank | Blank | Blank | Blank |
| 2 | 0.69 | 0.207 | 5707 | 8.649 | 0.972 | 1 | Blank | Blank | Blank | Blank |
| 3 | 1.10 | 0.330 | 5226 | 8.561 | 0.962 | 0.990 | 1 | Blank | Blank | Blank |
| 4 | 1.39 | 0.417 | 4167 | 8.335 | 0.937 | 0.964 | 0.974 | 1 | Blank | Blank |
| 5 | 1.61 | 0.483 | 3606 | 8.190 | 0.921 | 0.947 | 0.957 | 0.983 | 1 | Blank |
| 6 | 1.79 | 0.538 | 3474 | 8.153 | 0.916 | 0.943 | 0.952 | 0.978 | 0.995 | 1 |
| 7 | 1.95 | 0.586 | 3087 | 8.035 | 0.903 | 0.929 | 0.939 | 0.964 | 0.981 | 0.986 |
| 8 | 2.08 | 0.625 | 3038 | 8.019 | 0.901 | 0.927 | 0.937 | 0.962 | 0.979 | 0.984 |
| 9 | 2.20 | 0.661 | 2788 | 7.933 | 0.892 | 0.917 | 0.927 | 0.952 | 0.969 | 0.973 |
| 10 | 2.30 | 0.691 | 2534 | 7.838 | 0.881 | 0.906 | 0.916 | 0.940 | 0.957 | 0.961 |
| 11 | 2.40 | 0.721 | 2344 | 7.760 | 0.872 | 0.897 | 0.906 | 0.931 | 0.947 | 0.952 |
| 12 | 2.48 | 0.745 | 1979 | 7.590 | 0.853 | 0.878 | 0.887 | 0.911 | 0.927 | 0.931 |
| 13 | 2.56 | 0.769 | 1816 | 7.504 | 0.844 | 0.868 | 0.877 | 0.900 | 0.916 | 0.920 |
| 14 | 2.64 | 0.793 | 1588 | 7.370 | 0.828 | 0.852 | 0.861 | 0.884 | 0.900 | 0.904 |
| 15 | 2.71 | 0.814 | 1496 | 7.311 | 0.822 | 0.845 | 0.854 | 0.877 | 0.893 | 0.897 |
| 16 | 2.77 | 0.832 | 1434 | 7.268 | 0.817 | 0.840 | 0.849 | 0.872 | 0.887 | 0.891 |
| 17 | 2.83 | 0.850 | 1104 | 7.007 | 0.788 | 0.810 | 0.818 | 0.841 | 0.856 | 0.859 |
| 18 | 2.89 | 0.868 | 944 | 6.850 | 0.770 | 0.792 | 0.800 | 0.822 | 0.836 | 0.840 |
| 19 | 2.94 | 0.883 | 553 | 6.315 | 0.710 | 0.730 | 0.738 | 0.758 | 0.771 | 0.775 |
| 20 | 3.00 | 0.901 | 454 | 6.118 | 0.688 | 0.707 | 0.715 | 0.734 | 0.747 | 0.750 |
| 21 | 3.04 | 0.913 | 309 | 5.733 | 0.644 | 0.663 | 0.670 | 0.688 | 0.7 | 0.703 |
| 22 | 3.09 | 0.928 | 303 | 5.714 | 0.642 | 0.661 | 0.667 | 0.686 | 0.698 | 0.701 |
| 23 | 3.14 | 0.943 | 203 | 5.313 | 0.597 | 0.614 | 0.621 | 0.637 | 0.649 | 0.652 |
| 24 | 3.18 | 0.955 | 153 | 5.030 | 0.565 | 0.582 | 0.588 | 0.603 | 0.614 | 0.617 |
| 25 | 3.22 | 0.967 | 72 | 4.277 | 0.481 | 0.495 | 0.500 | 0.513 | 0.522 | 0.525 |
| 26 | 3.26 | 0.979 | 42 | 3.738 | 0.420 | 0.432 | 0.437 | 0.448 | 0.456 | 0.458 |
| 27 | 3.30 | 0.991 | 32 | 3.466 | 0.390 | 0.401 | 0.405 | 0.416 | 0.423 | 0.425 |
| 28 | 3.33 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE IV. Spanish head entries of The Oxford Spanish Dictionary,[1] :ranking,natural logarithm, normalisations

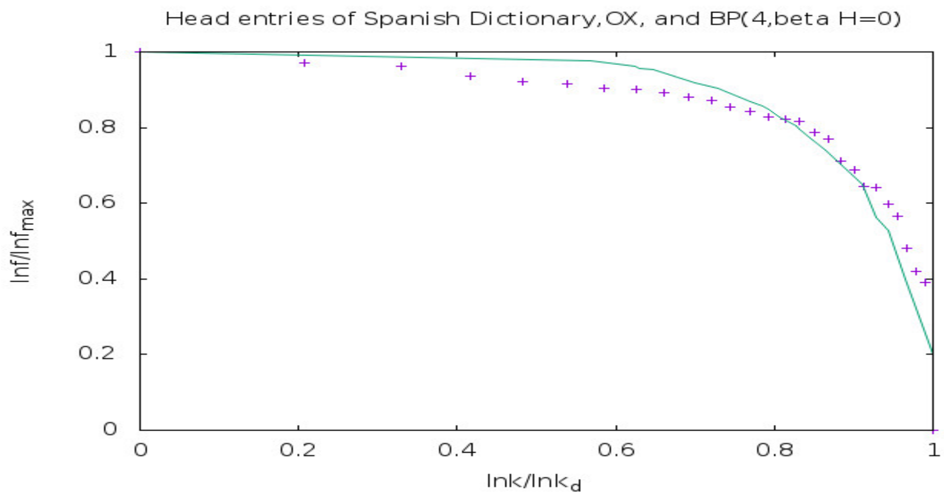


FIG. 4. The vertical axis is $\frac{lnf}{lnf_{max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the absence of external or,$\beta H = 0$.

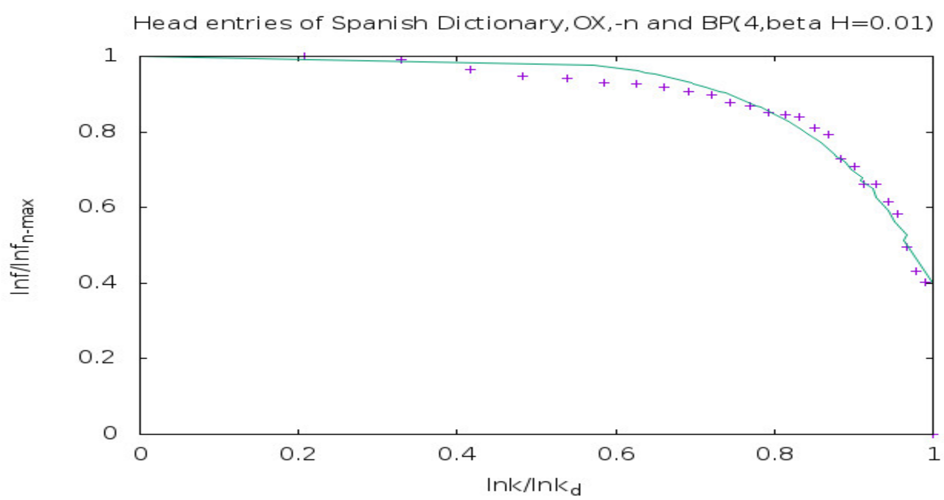


FIG. 5. The vertical axis is $\frac{lnf}{lnf_{n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the presence of little external magnetic field, m=0.005 or, $\beta H = 0.01$.

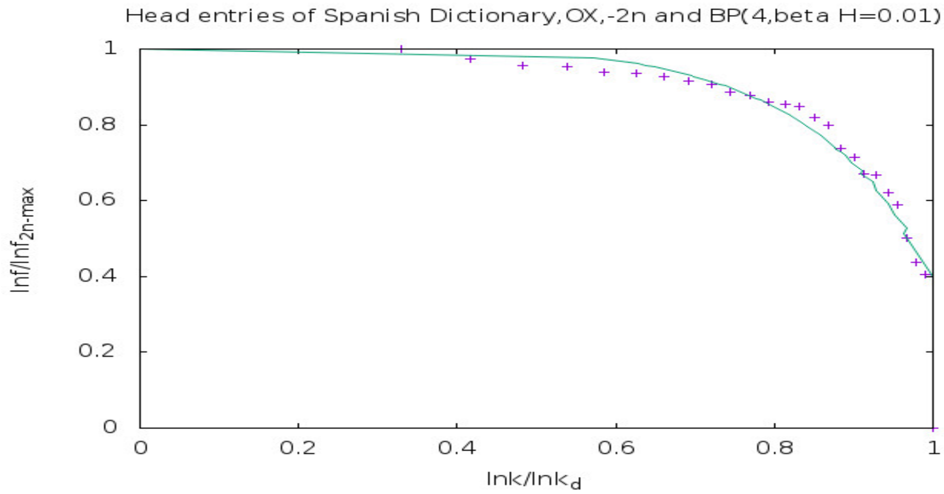


FIG. 6. The vertical axis is $\frac{lnf}{lnf_{2n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the presence of little external magnetic field, m=0.005 or, $\beta H = 0.01$.

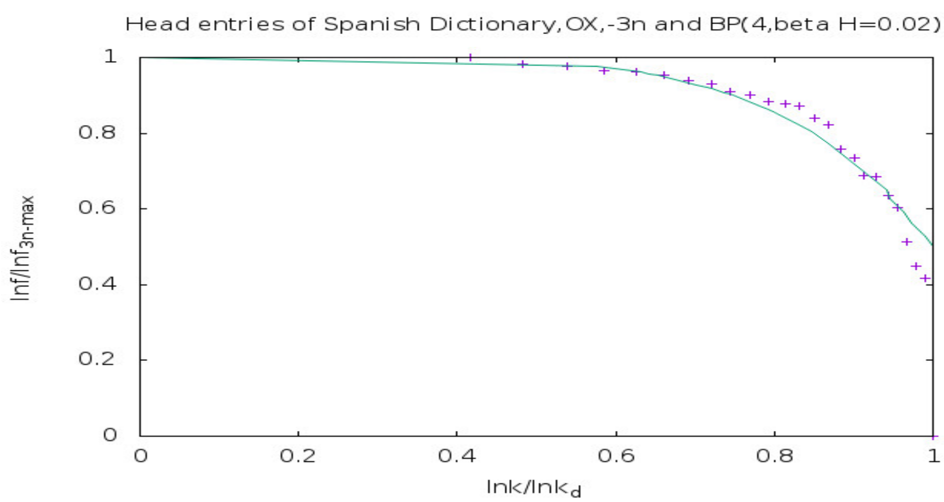


FIG. 7. The vertical axis is $\frac{lnf}{lnf_{3n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the presence of little external magnetic field, m=0.01 or, $\beta H = 0.02$.

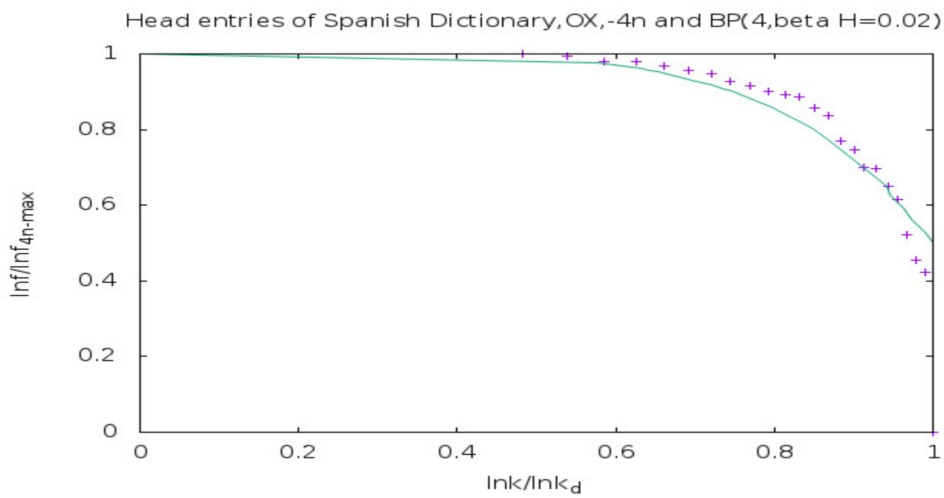


FIG. 8. The vertical axis is $\frac{lnf}{lnf_{4n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the presence of little external magnetic field, m=0.01 or, $\beta H = 0.02$.

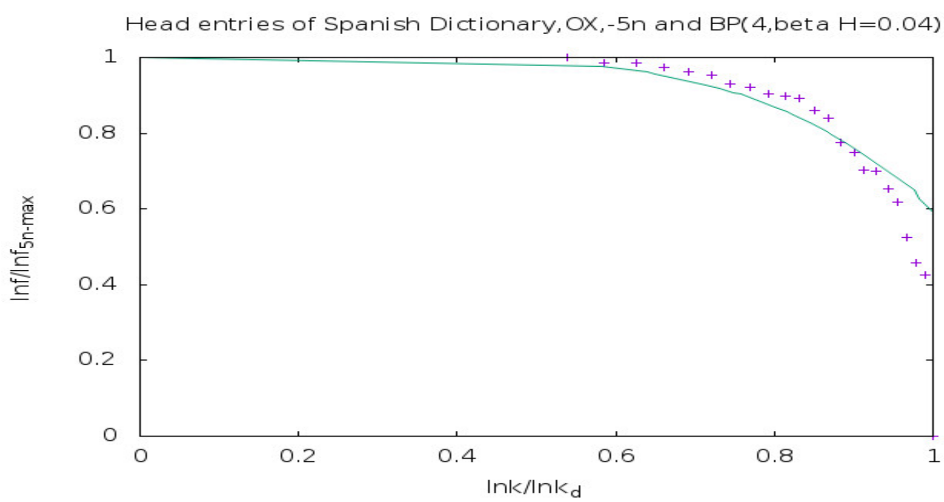


FIG. 9. The vertical axis is $\frac{lnf}{lnf_{5n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the Spanish head entries of the Oxford Spanish Dictionary with the fit curve being the Bethe-Peierls curve of the Ising model with four nearest neighbours, in the presence of little external magnetic field, m=0.02 or, $\beta H = 0.04$.

### A. conclusion

From the figures (fig.4-fig.9), we observe that there is a curve of magnetisation, behind the Spanish head entries of The Oxford Spanish Dictionary,[1]. This is the magnetisation curve, BP(4,$\beta H$=0.01), in the Bethe-Peierls approximation of the Ising model, with four nearest neighbours in the presence of little external magnetic field, H, with $\beta H = 0.01$.

Moreover, the associated correspondence is,

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

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [97].

## IV. ACKNOWLEDGMENT

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

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[1] The Oxford Spanish Dictionary, Spanish-English . English-Spanish, Chief Editors: B. G. Jarman and R. Russell; Fourth Edition, edited by N. Rollin and C. S. Carvajal, 2008; Oxford University Press, Great Clarendon Street, Oxford ox26DP; ISBN 978-0-19-954340-3.

[2] Anindya Kumar Biswas, "Graphical Law beneath each written natural language", arXiv:1307.6235v3[physics.gen-ph]. A preliminary study of head entries of dictionaries of twenty six languages, more accurate study of head entries 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 Lyngkhoi, "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] Anindya Kumar Biswas, ”Oxford Dictionary of Chemistry, the seventh edition and the Graphical Law”, viXra: 2212.0113[Chemistry].

[53] Anindya Kumar Biswas, ”A Burmese-English Dictionary, Part I-Part V, by J. A. Stewart and C. W. Dunn et al, head entries and the Graphical Law”, viXra: 2212.0127[Linguistics].

[54] Anindya Kumar Biswas, ”The Graphical Law behind the head entries of Dictionary Kannada and English written by W. Reeve, revised, corrected and enlarged by Daniel Sanderson”, viXra: 2212.0185[Linguistics].

[55] Anindya Kumar Biswas, ”Sanchayita and the Graphical Law”, viXra: 2301.0075[Social Science].

[56] Anindya Kumar Biswas, ”Samsad Bangla Abhidan and The Graphical Law”, viXra: 2302.0026[Linguistics].

[57] Anindya Kumar Biswas, ”Bangiya Sabdakosh and The Graphical Law”, viXra: 2302.0060[Linguistics].

[58] Anindya Kumar Biswas, ”Samsad Bengali-English Dictionary and The Graphical Law ”, viXra: 2304.0047[Linguistics].

[59] Anindya Kumar Biswas, ”Rudyard Kipling’s Verse and the Graphical Law”, viXra: 2304.0207[Social Science].

[60] Anindya Kumar Biswas, ”W. B. Yeats, The Poems and the Graphical Law”, viXra: 2305.0008[Social Science].

[61] Anindya Kumar Biswas, ”The Penguin Encyclopedia of Places by W. G. Moore and the Graphical Law”, viXra: 2305.0147[Archaeology].

[62] Anindya Kumar Biswas, ”The Poems of Tennyson and the Graphical Law”, viXra: 2305.0157[Social Science].

[63] Anindya Kumar Biswas, ”Khasi-Jaintia Jaids(Surnames) and the Graphical law”, viXra:2307.0135[Social Science].

[64] Anindya Kumar Biswas, ”Age, Amplitude of accommodation and the Graphical law”, viXra:2311.0110[Physics of Biology].

[65] Anindya Kumar Biswas, ”Dictionary of Ayurveda by Dr. Ravindra Sharma and the Graphical law”, viXra:2401.0030[General Science and Philosophy].

[66] Anindya Kumar Biswas, ”The Practical Sanskrit-English Dictionary by Vaman Shivram Apte and The Graphical Law”, viXra:2402.0041[Linguistics].

[67] Anindya Kumar Biswas, ”The Langenscheidt's Pocket Russian Dictionary and The Graphical Law”, viXra:2402.0049[Linguistics]

[68] Anindya Kumar Biswas, ”The Scholar Dictionary Portuguese and The Graphical Law”, viXra:2402.0044[Linguistics]

[69] Anindya Kumar Biswas, ”The Langenscheidt's Pocket Japanese Dictionary and the Onsager's solution”, viXra:2402.0052[Condensed Matter]

[70] Anindya Kumar Biswas, ”Langenscheidt's Pocket Chinese Dictionary and The Graphical Law”, viXra:2403.0066[Linguistics]

[71] Anindya Kumar Biswas, ”Oxford Hindi-English Dictionary and The Graphical Law”, viXra:2403.0129[Linguistics]

[72] Anindya Kumar Biswas, ”Concise Urdu to English Dictionary and The Graphical Law”, viXra:2404.0006[Linguistics]

[73] Anindya Kumar Biswas, ”The Standard Urdu-English Dictionary by Abdul Haq and The Graphical Law”, viXra:2404.0034[Linguistics]

[74] Anindya Kumar Biswas, ”The Urdu-Hindi Shabdakosh by Muhammad Sajjad Osmani, Sudhindra Kumar and The Graphical Law”, viXra:2404.0114[Linguistics]

[75] Anindya Kumar Biswas, ”The Hadronic Resonance Masses and The Graphical Law”, viXra:2404.0141[High Energy Particle Physics]

[76] Anindya Kumar Biswas, ”A Dictionary of British Surnames by P. H. Reaney and the Graphical Law”, viXra:2408.0099[Social Science].

[77] Anindya Kumar Biswas, ”Dictionary of Sports by Dr. S.K.Srivastava and Ms. Tanvangi Singh and the Graphical Law”, viXra:2409.0014[Social Science].

[78] Anindya Kumar Biswas, ”Dictionary of American Family Names by Elsdon C. Smith and the Graphical Law”, viXra:2409.0049[Social Science].

[79] Anindya Kumar Biswas, ”Political Map of Northeast India and the Graphical Law”, viXra:2409.0092[Social Science].

[80] Anindya Kumar Biswas, ”Dictionary of Computers Edited by Pankaj Dhaka and the Graphical Law”, viXra:2409.0132[General Science and Philosophy].

[81] Anindya Kumar Biswas, "Swedish Dictionary and the Graphical Law", viXra:2409.0165[Linguistics].

[82] Anindya Kumar Biswas, "Tourist Guide and Map, Meghalaya and the Graphical Law", viXra:2410.0002[Social Science].

[83] Anindya Kumar Biswas, "Tourist Guide and Map, Aizawl and the Graphical Law", IJASR:2024;3(5):44-52.

[84] Anindya Kumar Biswas, "The Thai-English Student's Dictionary compiled by Mary R. Haas and the Graphical Law", viXra:2410.0093[Linguistics].

[85] Anindya Kumar Biswas, "Santali and The Graphical Law", viXra:2411.0151[Linguistics].

[86] Anindya Kumar Biswas, "The Oxford Dictionary of English Christian Names by E. G. Withycombe and the Graphical Law", viXra:2412.0008[Social Science].

[87] Anindya Kumar Biswas, "Pali-English Dictionary by T. W. Rhys Davids and William Stede and The Graphical Law", viXra:2412.0082[Linguistics].

[88] Anindya Kumar Biswas, "The Penguin Dictionary of Archaeology by Warwick Bray and David Trump and the Graphical Law", viXra:2412.0173[Archaeology].

[89] Anindya Kumar Biswas, "Cassell's New Latin Dictionary and The Graphical Law", viXra:2412.0183[Social Science].

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

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

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

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

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

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

[96] 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.

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