

Introduction to Science Based on Symmetry*

K. R. CHAKRABORTY**

6/12, Central Park, Jadavpur, Calcutta-700 032

In order to comprehend what is "Science Based on Symmetry" it is essential to get acquainted with the mechanism of development of the equilibrium configuration of symmetry as an assembly of five identical regular tetrahedrons and its projected configuration in a plane as a square consisting of 25 identical square units. Deductions from the different inbuilt properties of this configuration can be applied to explain any aspect of the universal phenomenal nature. The talk covers the following important topics :

The concepts of nine digits, the numerical continuum having critical states at 1, 10, 100, 1000, etc. and that of one and zero, have their origin in this configuration.

In the phenomenal nature, the whole square of the total aspects is equal to the sum of the squares of the condensed and uncondensed aspects. They explain progressive evolution of numbers of elements in atomic continuum in periodic system in macrosphere following 2, 2 ; 8, 8 ; 18, 18 ; 32, 32, etc. and the progressive increase of electrons in orbits within the microsphere of atoms following 2, 2 ; 2, 6 ; 2, 6 ; 2, 6, 10 ; 2, 6, 10 ; 2, 6, 10, 14 ; 2, 6, 10, 14, etc

They give eight forms of transformations (including the one of Lorentz) each having a distinct geometrical configuration. These have been applied in correlating changes in variable properties in thermodynamics and specific heats in terms of changes in temperatures maintaining conservation. In space time transformations they show that both space and time can dilate as well as contract. When Einstein propounded the relativistic relationship, the only form of transformation available to him was that of Lorentz. In the light of the discovery of these forms of transformations there is bound to be rethinking in the entire concept of relativistic science.

They explain dynamic aspect of mechanism of catalytic chemical reactions.

SYMMETRY" is a very familiar expression generally conveying the sense of uniformity, identity, perfectly balanced arrangement of things etc. However, one may ponder over questions such as "symmetry of what, amongst what or between what—the implication involving the kind of relativity in similarity or identity between at least two things. Symmetry among or between ideas ; symmetry among or between things which are static ; or actions which are dynamic may be cited as examples. Progressively deeper and deeper probes in this manner ultimately reveal that the expression in fact is a concept of quantitative significance, having geometrical configuration amenable to quantitative mathematical treatment and deductions from the concept can be applied to explain scientific aspects of phenomenal nature.

The speaker attempts to briefly describe the science based on symmetry in the talk that follows.

Section 1.

Fundamental Configuration of Symmetry

1(a) Suppose a point source of energy radiation radiates rays in a perfectly symmetrical manner in all possible directions from the position of the point source. Conventionally, it is taken for granted that after emission, the rays *at an instant*, will be at equal distances from the point source and the radiated rays will describe a

spherical surface with the position of the point source as their centre. As a result, *with respect to the centre*, all the rays residing on the spherical surface will be identical and the emission of rays is symmetrical. From the point of view of the *position of the point source*, no doubt, all the rays forming the spherical surface (*at that instant*) would be symmetrical. But, what about the relative status of the individual rays themselves vis-a-vis others while they are on the spherical surface ? Are all other rays identical with respect to any one ray ? Since *with respect to the point source*, which is the cause, its emitted rays, which are the effects, are identical and symmetrical, it is logically expected that each ray would also want the other effect rays to be symmetrical and identical with respect to it. There should not be discrimination in symmetrical relationship between centre vis-a-vis the emanated rays and any individual ray vis-a-vis the other rays on the spherical surface. But at the spherical surface with respect to any ray all the other rays are not symmetrical. Thus all the emanated rays do not, *at an instant*, describe spherical surface front during emission. We, therefore, require to find an alternative configuration for the rays (at an instant) which will symmetrically satisfy both the point source as well as the emanated rays among themselves. There is only one configuration, namely, a regular tetrahedral mode, which would completely satisfy both the source at the centre and the 4 rays (at an

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** Ex-Managing Director, Fertiliser Corporation of India, New Delhi.

instant) occupying the 4 corner positions of the tetrahedron. Thus *with respect to any ray* the other 3 rays will be symmetrical and identical and with respect to the centre the 4 emanated rays are identical. In other words the point source has 4 directional symmetry and each ray has three directional symmetry. This is the picture, *at an instant*, during emission. To oppose this action of the point-source and to get an equilibrium configuration, each of the four identical equilateral triangular faces must be opposed (as reaction) face to face by one identical regular tetrahedron. The action of the central one is due to energy and the reaction of the outer ones is due to matter significance. Thus the equilibrium configuration consists of a unit package of 5 regular tetrahedrons : one at the centre and 4 outer ones placed against the four equilateral triangular faces of the one at the centre. One can call this as an unit universal wave or unit square wave or can call this as a quantum of unit configuration of the Universe in its miniature form, just like a seed and a tree. We shall call this as fundamental configuration of symmetry or simply configuration of symmetry. The central tetrahedron represents (action) energy radiation and the four opposing outer tetrahedrons represent matter significance as reactions to the action of the former. A tetrahedron when projected on a plane passing through the centre and parallel to a pair of opposite sides is a square (Fig. 1) in the plane.

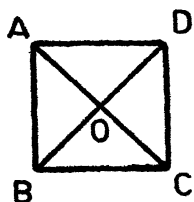


Fig. 1

Similarly, the composite configuration of 5 tetrahedrons, when projected on a plane passing through the centre and parallel to a pair of opposite sides of the central tetrahedron would also be projected as a square as shown in Fig. 2.

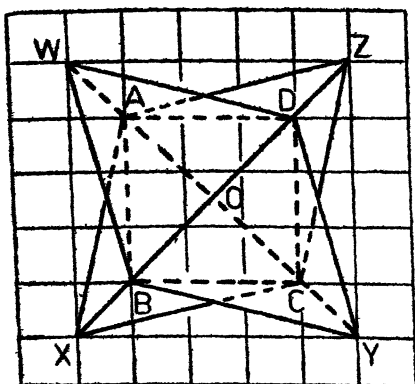


Fig. 2

The Fig. 2 thus, when expressed in terms of identical square units on the plane generates a square comprising 25 identical square units as shown in Fig. 3. This is derived from the inbuilt magnitudes of the dimensions in a regular tetrahedron. For example, in a regular tetrahedron if the magnitude of distance between the centre and centre of the triangular faces is 1, the distance between the

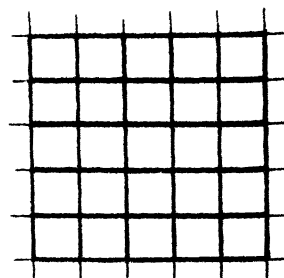


Fig. 3

centre and the corner positions is 3, the distance between a corner position and centre of the opposite triangular face is $3+1=4$. When a regular tetrahedron is placed against one equilateral triangular face of the central tetrahedron, the distance between the centre of the central tetrahedron and apex corner position of the outer tetrahedron is $1+4=5$. Applying these data, we get the projected square comprising 25 identical square units, the two diagonals will have $(10+10)=20$ identical units of distance and 4 sides of the square will have 20 identical units of distance ($5+5+5+5$) of sides (Fig. 4). This square configuration consisting of 25 identical square units has 9 diagonals and 10

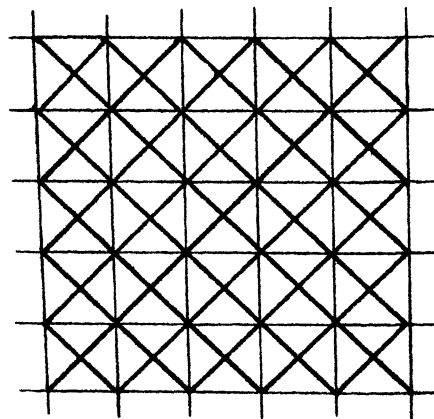


Fig. 4

equal linear units on the central diagonal (Figs. 6 and 7). Fig. 5 shows the arrangement of the square units in the configuration of 25 ; there are 8 units in four pairs in continuity of the central square unit and there are 4 times 4 units along the 4 divergent directions of the two diagonals which are discontinuous with respect to the central unit.

Further, it may be noticed that when the configuration expands, the size of the new square units

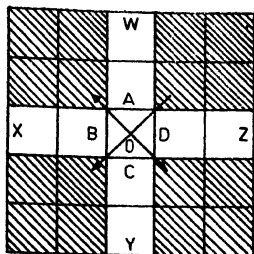


Fig. 5

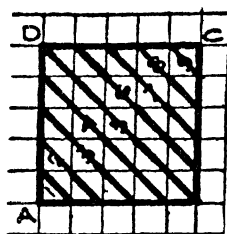


Fig. 6

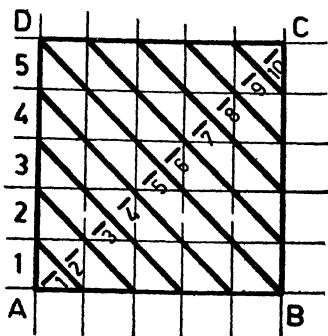


Fig. 7

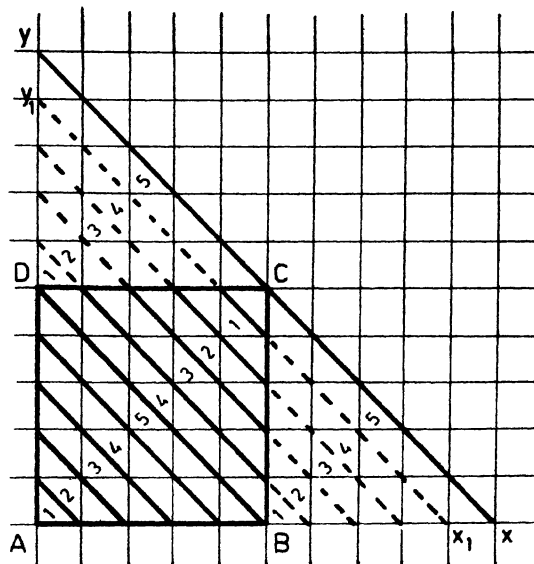


Fig. 8

to be added in continuity of the central unit always maintain constant magnitude of size of each unit. But in the diverging 4 directions towards the corners along the diagonals, the size of square units can vary. This aspect of continuity and discontinuity, it may be noted, will play important role in the development of science based on symmetry.

1(b) *Some of the important properties of the fundamental configuration of symmetry :*

Digits and numerical continuum : From a glance at the fundamental configuration of symmetry (Figs. 6 and 7) comprising 25 identical square units it can be seen that in between two opposite corner positions there are nine finite diagonals, situated apart at equal units of linear distances numbering 10 on the main diagonal. But the number of identical units on each side is always 5.

Numerically, the sum of the roots of two squares of 5 units of side is equal to root of square of 10 units of diagonal :

$$\sqrt{5^2} + \sqrt{5^2} = \sqrt{10^2}$$

It should be noted that the magnitude of units on the left hand side is different from the units on right hand side. Actually $\sqrt{2}$ unit of side is equal to one unit of diagonal.

In the square ABCD, the magnitudes of the 9 diagonals vary in an undulatory mode in the square configuration. Thus the magnitudes of diagonals (Fig. 8) within the square configuration ABCD increase progressively starting with zero at A and then as 1, 2, 3, 4 reaches maximum of 5 at BD after which they progressively decrease as 4, 3, 2, 1 and zero at C. But on either of the outer sides of the

configuration the magnitudes increase as shown by dotted lines as two times 1, 2, 3, 4 and 5. Thus the magnitude of the diagonal passing through C is $5+5=10$. In this manner the numerical continuum develops in magnitude. The numerical continuum on this basis is shown in Fig. 9.

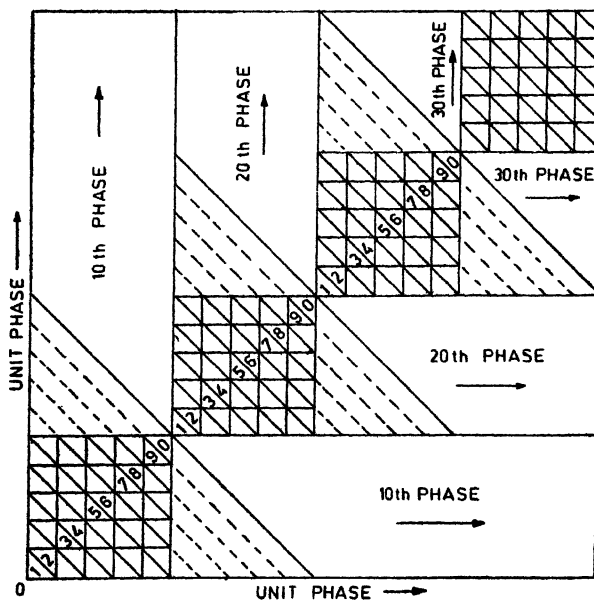


Fig. 9. Evolution of numbers from square continuum in one direction.

It should be emphasised that *the method of derivation of the fundamental configuration of symmetry as a package unit of 5 regular tetrahedrons and their projected square configuration in a plane consisting of 25 identical square units were the basis for the development of 9 and only 9 digits, 10 magnitudes, concepts of zero and one, and the*

numerical continuum as unit, 10, 100, 1000 etc. etc., have been possible. A significant aspect should be realised that the numerical continuum is not a uniform continuity as far as digits are concerned. The digits start with least magnitude in a phase and rise to maximum in that phase. Again the digits, in a higher phase, starts with least and rises to maximum. This process is repeated as the numerical magnitudes increase in terms of higher and higher magnitudes of phase continuum as unit, 10, 100, 1000, 10000, etc. etc. or as unit, 10, 20, 30, 40, ... These states are designated as critical states.

1(c). *Criteria for development of square continuum of identical square units in a plane are the operation of the 4 symbols +, -, ×, ÷ :*

| | | | |
|-------|-------|-------|------------------|
| 1+1=2 | 2+2=4 | 3+3=6 | 4+4=8 |
| 1-1=0 | 2-2=0 | 3-3=0 | 4-4=0 |
| 1×1=1 | 2×2=4 | 3×3=9 | 4×4=16 |
| 1÷1=1 | 2÷2=1 | 3÷3=1 | 4÷4=1 and so on. |

| | | | |
|-------------------------------|-------------------------------|--------------------------------|--------------------------------|
| Sum total is 4=2 ² | Sum total is 9=3 ² | Sum total is 16=4 ² | Sum total is 25=5 ² |
|-------------------------------|-------------------------------|--------------------------------|--------------------------------|

Let us start with zero and following the identical procedure as above, we get the series :

$$\begin{aligned} 0 + 0 &= 0 \\ 0 - 0 &= 0 \\ 0 \times 0 &= 0 \\ 0 \div 0 &= 1 \end{aligned}$$

whose sum total is 1²

As per the above criteria the development of increasing square magnitudes in a plane are :

$$1^2, 2^2, 3^2, 4^2, 5^2, \dots$$

Therefore 0÷0=1 and is not *indeterminate*. It can be called oneness.

From this one can realise that zero is an abstract concept, which has no configuration, whose magnitude is nil or nothing, which cannot cause anything, which has no root but whose homogeneity or identity or oneness contributes to the concept of one. When zero assumes the power of anything that is reduced to one. One is also an abstract concept, which has no cause ; it itself is its own cause and it is the cause of all others. It has no root, it itself is its root. It has configuration but that can assume any magnitude. It is powerless and anything which is powerless is reduced to one. Unless one assume the power of everything, objective existence is not possible. Unless one whole is differentiated into finite parts, the objective concept of existence cannot be realised or described.

1(d). *Swastika method of development of square towards increase in magnitude or decrease in magnitude :*

There are many methods of development of square configuration from lower to higher magnitudes or from higher to lower. Swastika method in Fig. 10 is the most generalised method among others.

The generalised formula is :

$$4 \left[\frac{\phi b - \phi a}{2} + \phi a \right] \left[\frac{\phi b - \phi a}{2} \right] + \phi a^2 = (\phi b)^2 \quad \text{Eq. 1.}$$

$$\text{or, } \left[\frac{4(\phi b + \phi a)}{2} \right] \left[\frac{\phi b - \phi a}{2} \right] + (\phi a)^2 = (\phi b)^2$$

'a' and 'b' can be magnitude of any function. It can be linear, square, root, numbers, cumulatives etc. Let ϕb be greater than ϕa . In the above formula when $(\phi a)^2=0$, Fig. 10(a) becomes the Fig. 10(b).

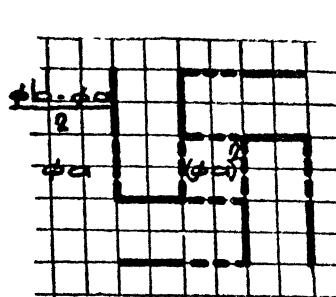


Fig. 10a

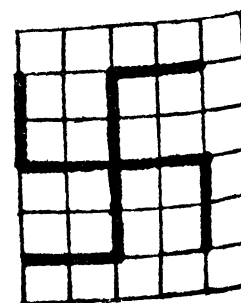


Fig. 10b

Illustrations : Suppose we want to increase 2² to 6², we will have $4 \left[\frac{(6-2)}{2} + 2 \right] \left[\frac{6-2}{2} \right] + 2^2$

$$\text{or } 4.(4).(2) + 2^2 = 32 + 2^2 = 6^2$$

In the reverse case, suppose we want to decrease 7² to 2² we will have

$$4 \left[\frac{(2+7)}{2} \right] \left[\frac{2-7}{2} \right] + 7^2$$

$$\text{or } (9).(-5) + 49 = 49 - 45 = 4 = 2^2$$

Two ways of expressing a square configuration : $a \times a = a^2$ where a is side of the square ; and $2\sum(a-1) + a = a^2$ where a=number of identical square units along the central diagonal.

1(e) *Differentiation of whole square into condensed square and uncondensed square :*

Suppose each of the 25 square units of the configuration is condensed to points of position at the centre of each square unit. There will then be 25 condensed points of positions and by linking these they generate 16 identical condensed square units (Fig. 11). The total whole square of 25 units minus 16 condensed square units leaves out 9 square units uncondensed. Thus total whole square is 25, condensed whole square is 16 and uncondensed whole square is 9. Thus $5^2 - 4^2 = 3^2$. If the central uncondensable square unit could be condensed to one point of position, that could only generate a point of nil square magnitude. The relationship in that case would be $1^2 - 0^2 = 1^2$. In this way the whole configuration will progressively develop in 4 directions as in the following [Figs. 13(a) and 14] :

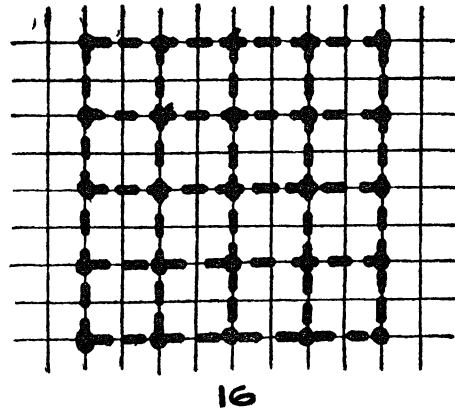
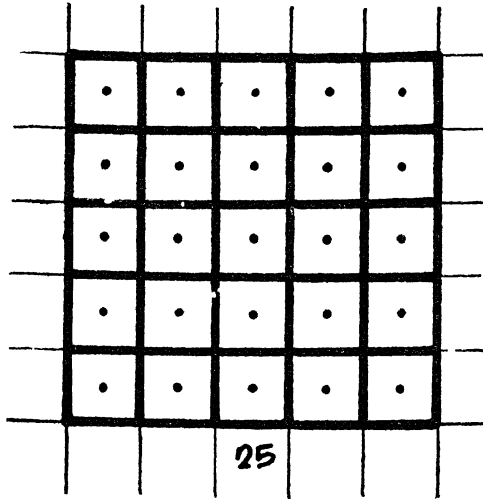


Fig. 11

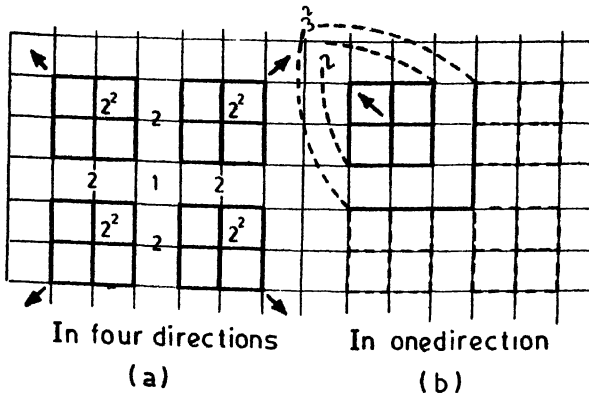


Fig. 13

| Total whole square | Condensed square | Uncondensed square |
|--------------------|------------------|--------------------------------------|
| 1 ² | — | 0 ² = (√1) ² |
| 3 ² | — | 2 ² = (√5) ² |
| 7 ² | — | 6 ² = (√13) ² |
| 13 ² | — | 12 ² = (√25) ² |
| 21 ² | — | 20 ² = (√41) ² |
| ... | ... | ... |

Formula $(2\sum N + 1)^2 - (2\sum N)^2 = \sqrt{(4\sum N + 1)^2}$.. Eq. 4

(a) In the configuration of symmetry and the continuum of square waves, sum of the number of square units at the starting front, in four directions, and finishing front is a square.

| Total whole square | Condensed square | Uncondensed square |
|--------------------|------------------|----------------------------------|
| 1 ² | — | 0 ² = 1 ² |
| 5 ² | — | 4 ² = 3 ² |
| 13 ² | — | 12 ² = 5 ² |
| 25 ² | — | 24 ² = 7 ² |
| ... | ... | ... |

| Total whole square | Square units in front |
|--------------------|-----------------------|
| 1 ² | 0 |
| 5 ² | 4 ² |
| 13 ² | 8 ² |
| 25 ² | 12 ² |
| 41 ² | 16 ² |

(b) The sum of the roots of total whole square and condensed whole square is equal to uncondensed whole square in four directions.

| Root of total whole square | Root of condensed whole square | Uncondensed whole square |
|----------------------------|--------------------------------|--------------------------|
| √1 ² | + √0 ² | = 1 ² |
| √5 ² | + √4 ² | = 3 ² |
| √13 ² | + √12 ² | = 5 ² |
| √25 ² | + √24 ² | = 7 ² |
| √41 ² | + √40 ² | = 9 ² |
| ... | ... | ... |

The above series can be expressed by the following relationships :

(i) $(4\sum N + 1)^2 - (4\sum N)^2 = (2N + 1)^2$.. Eq. 2.
where N can assume magnitudes 0, 1, 2, 3, 4, ...

(ii) $(a^2 + b^2)^2 - 4a^2b^2 = (a^2 - b^2)^2$.. Eq. 3.
where a is greater than b by unity.

Since the above deductions are in four directions and square development in each direction is identical, the development in any one direction is as in Table 2.

It shall be noted from Fig. 13(b), 15 and 16 that uncondensed square units in one direction are the roots of total whole square in 4 directions. In this manner many significant deductions can be mentioned. We shall mention here only a few important cases.

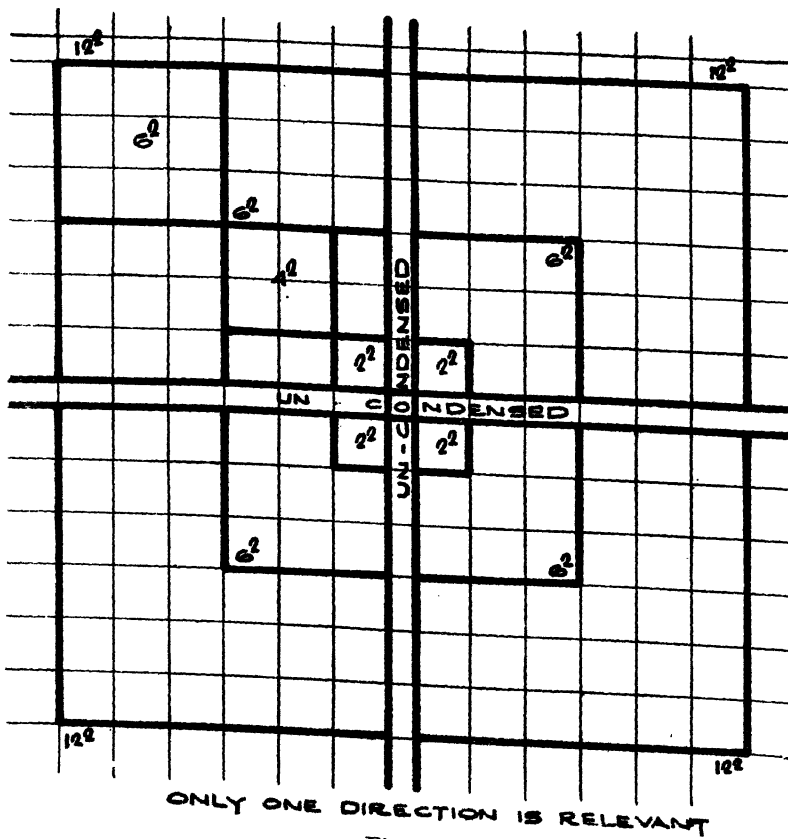


Fig. 14

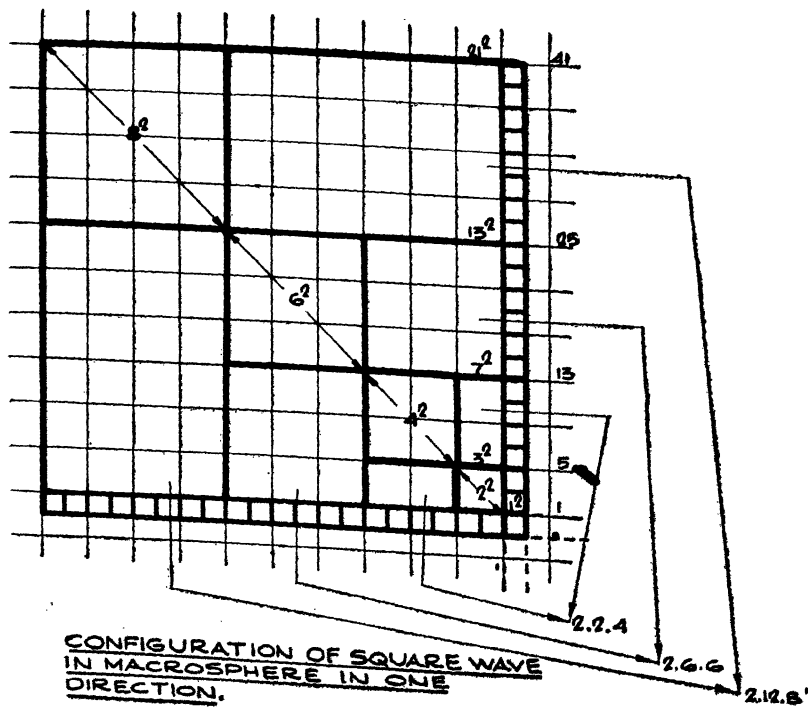


Fig. 15

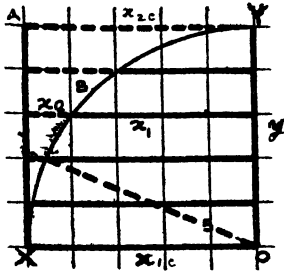


Fig. 12(a)

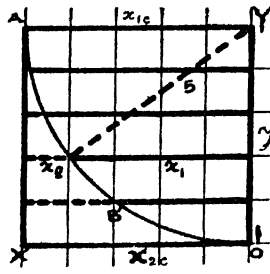


Fig. 12(b)

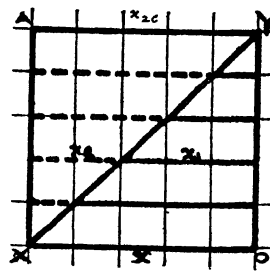


Fig. 12(c)

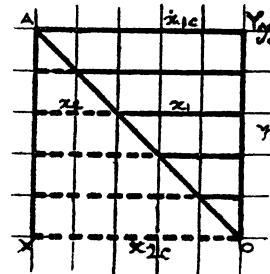


Fig. 12(d)

The above deductions giving three whole square relationships are unique in the sense that universal square waves propagate in terms of whole (not in parts or fractions) squares from a lower state to a higher state. The concept is similar to the concept of quanta.

(c) Figs. 15 and 16 show that in one direction, excluding the uncondensed square units in continuation of central square, total square groups in combination of both condensed and uncondensed in sequence increase as $1.2^2, 2.4^2, 3.6^2, 4.8^2, \dots$

1(f) Variation in forms of transformation of changes in properties of two dimensions, in equilibrium combination, between critical states within constant whole square, maintaining conservation :

One of the most important consequences derived from the configuration of symmetry is the progressive development of higher magnitudes of square waves in the universal context. The relationships have been presented in Table 1. Let us confine to the square configuration of 25 square units of configuration of symmetry and refer to Figs. 12(a), 12(b), 12(c) and 12(d).

(b), (c) and (d). In these figures the two magnitudes of changes of x_1 and x_2 vary together between the bottom and top sides maintaining conservation, in such a way that if at the bottom side OX, one of them x_1 will be zero and the other x_2 will be equal to the side OX, i.e., the maximum critical value as x_{2c} . At the top side, similarly if $x_2=0$ $x_1=x_{1c}$ maximum constant critical value. The bottom side of the square is one critical state and the top side of the square is another critical state. Above the top critical state there can be one or more critical states but the nature of those phases in combination will be different from x_1 and x_2 combination. Similarly below the bottom critical state there can be one or more critical states wherein also the phases, in combination will vary together but they will be different from x_1, x_2 combination. In between the two critical states changes of properties of the two components x_1 and x_2 will vary in two zones separated either by a circular line with radius 5 as in Figs. 12(a) and 12(b) or they may be separated by the diagonal of the square as shown in Figs. 12(c) and 12(d). The form of relationships of x_1 and x_2 in the four configurations would be as in Table 5.

TABLE 5

| | | |
|--|--|-------------|
| i(a). $x_1/x_{1c} = \sqrt{(y_0^2 - y^2)/y_c^2}$ | i(b). $x_2/x_{2c} = 1 - \sqrt{(y_c^2 - y^2)/y_c^2}$ | Fig. 12(a). |
| ii(a). $x_1/x_{1c} = \sqrt{(y_0^2 - (y_0 - y)^2)/y_c^2}$ | ii(b). $x_2/x_{2c} = 1 - \sqrt{(y_c^2 - (y_0 - y)^2)/y_c^2}$ | Fig. 12(b). |
| iii(a). $x_1/x_{1c} = (y_0 - y)/y_c$ | iii(b). $x_2/x_{2c} = 1 - (y_0 - y)/y_c$ | Fig. 12(c) |
| iv(a). $x_1/x_{1c} = (y_0 - (y_0 - y))/y_c$ | iv(b). $x_2/x_{2c} = 1 - (y_0 - (y_0 - y))/y_c$ | Fig. 12(d) |

| Total whole square | Condensed whole square | = | Uncondensed whole square |
|--------------------|------------------------|---|--------------------------|
| 1^2 | 0^2 | = | 1^2 |
| 5^2 | 4^2 | = | 3^2 |

The total whole square remaining constant as 5^2 , changes in the magnitudes of condensed x_1 and uncondensed x_2 vary in combination together along one axis say, horizontal axis OX maintaining conservation i.e., $x_1 + x_2 = 5$. They vary, with respect to variation of a dimension y along the vertical axis OY, from zero at O maximum 5 at Y where the dimension y will attain critical, constant maximum value y_0 . This is shown in Figs. 12(a),

It should be noted here that the form of relationship in equation i(a) has the same form of the famous Lorentz transformation for length contraction, and equation i(b) is the form of transformation for time dilation. All these forms have been verified by employing established data in the subsequent sections.

Section 2

Application in Phenomenal Nature : Macrosphere and Microsphere

The universal nature is phenomenal ; some aspects in it are distinguishable while some others

are indistinguishable or unobservable. The phenomenal nature cannot be wholly distinguishable or wholly unobservable. The universal nature exists always as an equilibrium combination of both these aspects. Nature is an ever changing entity. The change takes place in terms of progressively changing phase combinations through critical states towards either (Fig. 5) directions (higher or lower). In the fundamental configuration of symmetry the square units in continuation of the central square unit are most indistinguishable or uncondensable and 4 times 4 square units along diagonal are most segregated or condensed units (say atomic configurations). It may be noted that Fig. 11 gives 3² as uncondensed. Fig. 5 also gives 9 square units in continuation of and including the central one uncondensed.

The significance of critical state in the present context is identical with vapour liquid critical state of H₂O at 705.4°F through which vapour and liquid phase combination of H₂O changes to H₂O as permanent gas above 705.4°F. In the reverse direction, when H₂O as permanent gas is cooled below the critical temperature two phases namely, liquid H₂O and vapour H₂O in equilibrium combination, are formed. The above relates to macrosphere of Universal Nature only. As we have stated, the universal nature contains two opposite kinds of phenomenal development, one is macrosphere and the other is microsphere. The planets, galaxies, nebula, quasar, atomic continuum, plant and animal domains etc. etc. are macrospheric phenomenal manifestations. The microspheric development takes place within a constant configura-

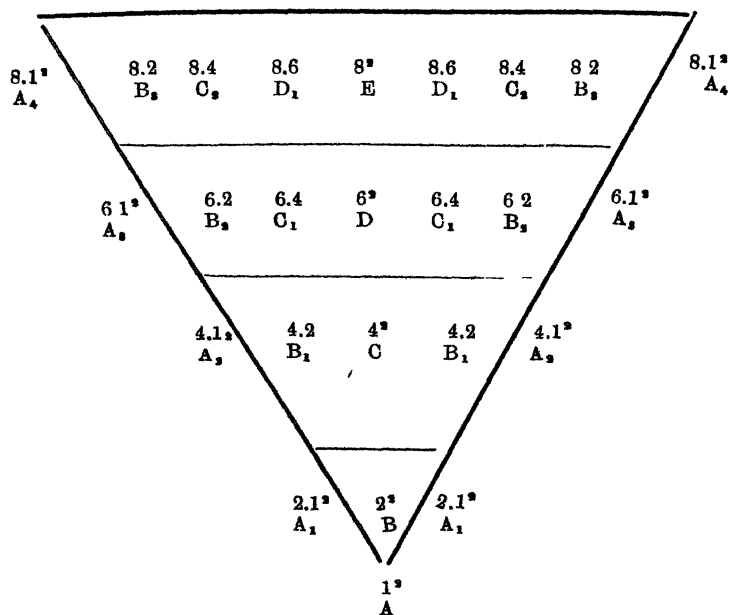
tion. The development of electrons in orbits indefinitely within atomic configurations, which remain constant, is a microspheric phenomenon. Thus as far as the chemical elements are concerned in macrosphere, number of elements progressively develops in free space; while in the other case, the atomic configuration remaining constant, the number of electrons progressively develops in the atomic orbits within the microsphere of atoms.

2(a) *Macrospheric development and periodic classification of elements :*

Since, square wave developments, in each of the 4 directions, are identical, we shall deal with the continuum in one direction to investigate the phenomenal nature of square wave development in one direction. This has been deduced in Figs. 15 and 16 employing condensed, uncondensed and total whole relationship in Table 2.

For easy understanding, the nature of square waves in sequence as detailed group-wise in Fig. 16 have been shown in Table 6 in which they are arranged horizontally, so that each horizontal column containing square and rectangular groups is one square wave and these can be termed as B wave, C wave, D wave, E wave etc. There is no wave of A because it is wholly uncondensed. In the other waves the groups containing A₁, A₂, A₃ etc. at the both ends of the horizontal columns of the square waves are uncondensed. In other words, the two ends of each wave are zero or nil waves. Leaving out the square units in A's continuity, the square magnitudes in increasing order of magnitudes of waves in sequence are 1.2², 2.4², 3.6², 4.8²,

TABLE 6



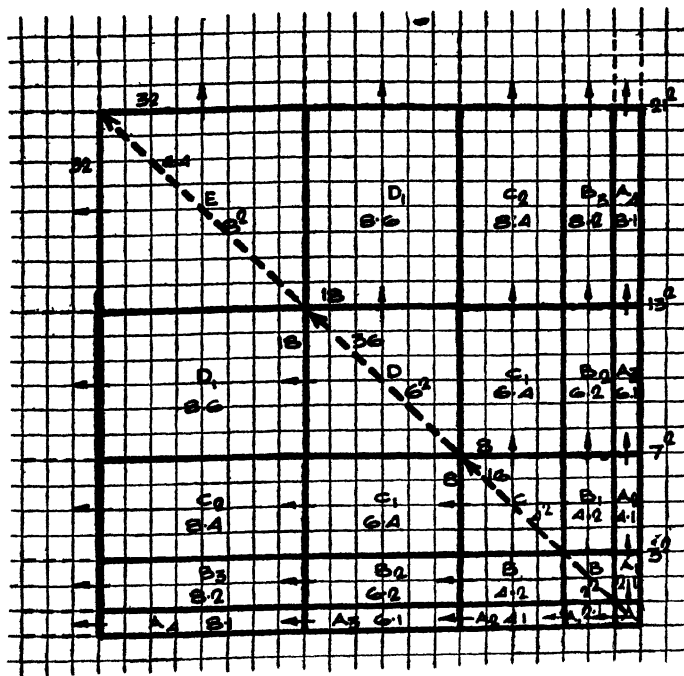


Fig. 16

Along the diagonal progressively more and more denser and segregated condensed matter elements develop as $2^2, 4^2, 6^2, 8^2, \dots$ in the universal context. In continuity of A, energy intensity progressively decreases as the numbers of square units increase. In between these two extreme states the intermediate phase groups exist, containing both matter and energy in combination. To maintain symmetry the squares along the diagonal will require to be split in two halves, one half for the left wing and the other for the right wing of a particular wave. This is shown in Fig. 18. Thus the number of chemical elements progressively develop as 2,2 ; 8,8 ; 18,18 ; 32,32 and so on. These aspects are elaborated in Fig. 18 and the periodic classification of elements in this approach has been shown in Fig. 19(a) and Fig. 19(b). (For detailed analysis refer to "Science Based on Symmetry"*, Chapter 3).

We do not intend to go into a detailed discussion on how the waves progressively develop more and more condensed phases while passing through critical states. We are mentioning some essential points, which are different from conventional classification. In this classification we cannot use the conventional atomic numbers, because here the first group (Fig. 19) contains 4 elements as against 2 in the conventional classification. The number 4 as 2^2 for the first group arises from the consideration of the square wave continuum developed from configuration of symmetry, in which two numbers only in the first group cannot be reconciled.

Therefore our assigned numbers for the elements will be two more than the conventional atomic numbers.

In the absence of any other data, to fill up the 4 positions we have suggested *ortho*- and *para*-hydrogen as two elements and neutron as an inert gas. Many properties of *ortho*- and *para*-hydrogen and of neutron suggest this approach. But it may be argued that *ortho*-hydrogen and *para*-hydrogen refer only to two molecular states of a single atomic species of hydrogen and that a neutron has got no detectable orbital electron. Nevertheless, it is asserted that if the theory propounded here, on the basis of configuration of symmetry, is correct the number of lighter elements ending with Helium, must comprise four members and not two. It is possible that with improved experimental techniques, discoveries may be made of a sub-hydrogenic element or perhaps distinguishing features in the atomic state which lead to the formation of molecular *ortho*- and *para*-hydrogen, and also of further details of the structure, which will confirm the validity of this hypothesis. In the absence of any other data we continue to use *ortho*- and *para*-hydrogen as two elements and neutron as an inert gas.

There could be another explanation. *Ortho* and *para* could represent combination of two opposite phases (periods) in the first group, just as every subsequent group consists of two periods. In similarity with H_2O as liquid and vapour combination, *ortho* and *para* may be two similar phase combination. At higher temperature vapour

* K. R. Chakravorty, "Science Based on Symmetry", FIRMA KLM(P) Ltd., Calcutta-12, 1977.

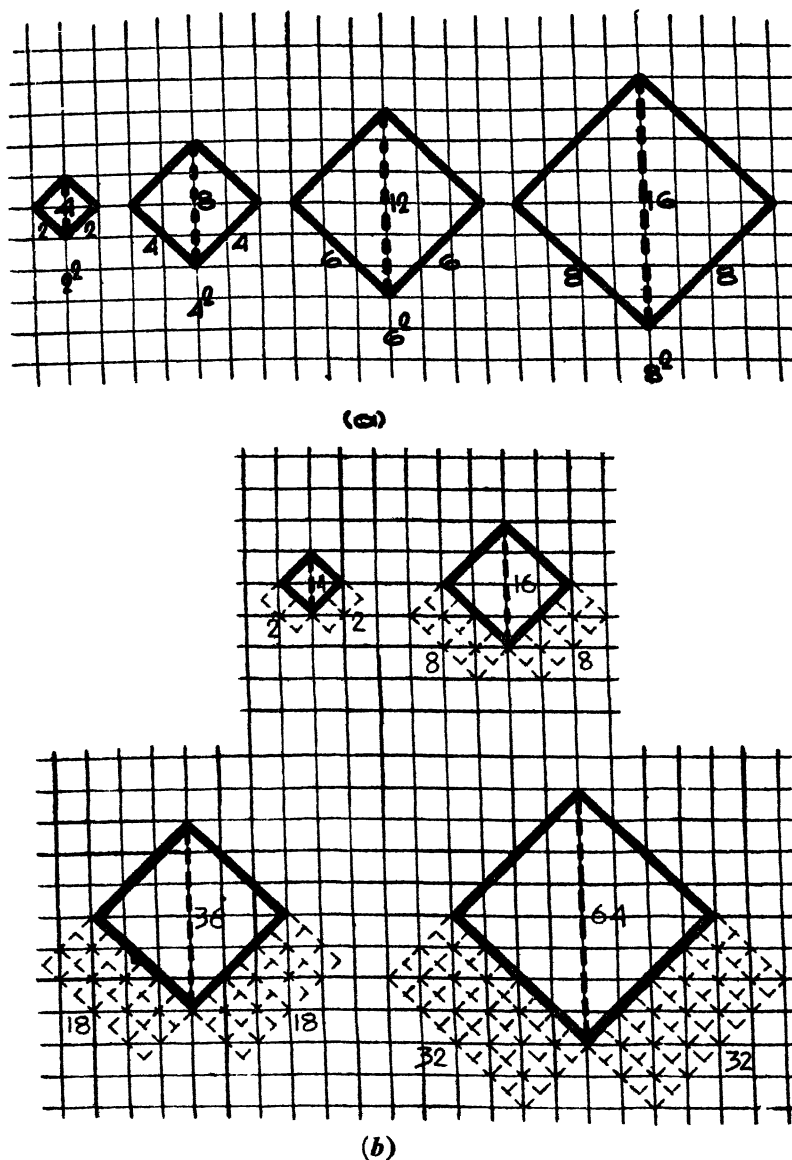


Fig. 18

density increases and liquid density decreases. At vap.-liq. critical state liquid phase is eliminated. Similarly, at lower temperature liquid density increases and vapour density decreases and at a certain lower critical temperature near about 4°C the liquid density is the highest and vapour density is negligible. In like manner, *ortho* % in equilibrium mixture increases with increase in temperature and *para* % decreases; and *ortho* % decreases and *para* % increases with decrease of temperature. At 20°K almost the whole is *para* (99.82%). Just as liquid and vapour phases have opposite properties, *ortho* and *para* also have certain opposite characteristics. Thus, *para* has antisymmetric nuclear spin function, whereas *ortho* has symmetric nuclear spin function. *Para* has only even rotational states while *ortho* has only odd rotational states. These are some suggestions which may be considered in order to see whether *ortho* and

para can fit in the first group of four elements. The number of chemical elements in the first group as four has been settled by the configuration of symmetry itself as 2^2 .

While discussing the periodic classification of elements, Feynman stated that it was necessary to find solutions of the form $\psi = f(r_1, r_2) e^{-(1/n)ET}$ to obtain the stationary states and energy levels as the geometrical dependence is contained in f , which is a function of six variables—the simultaneous positions of the two electrons but no one has found an analytical solution though solution for the lowest energy states has been obtained by numerical methods. According to him, it is hopeless to try to obtain exact solutions with 3, 4 or 5 electrons and it would be going too far to say that quantum mechanics has given a precise understanding of the periodic table.

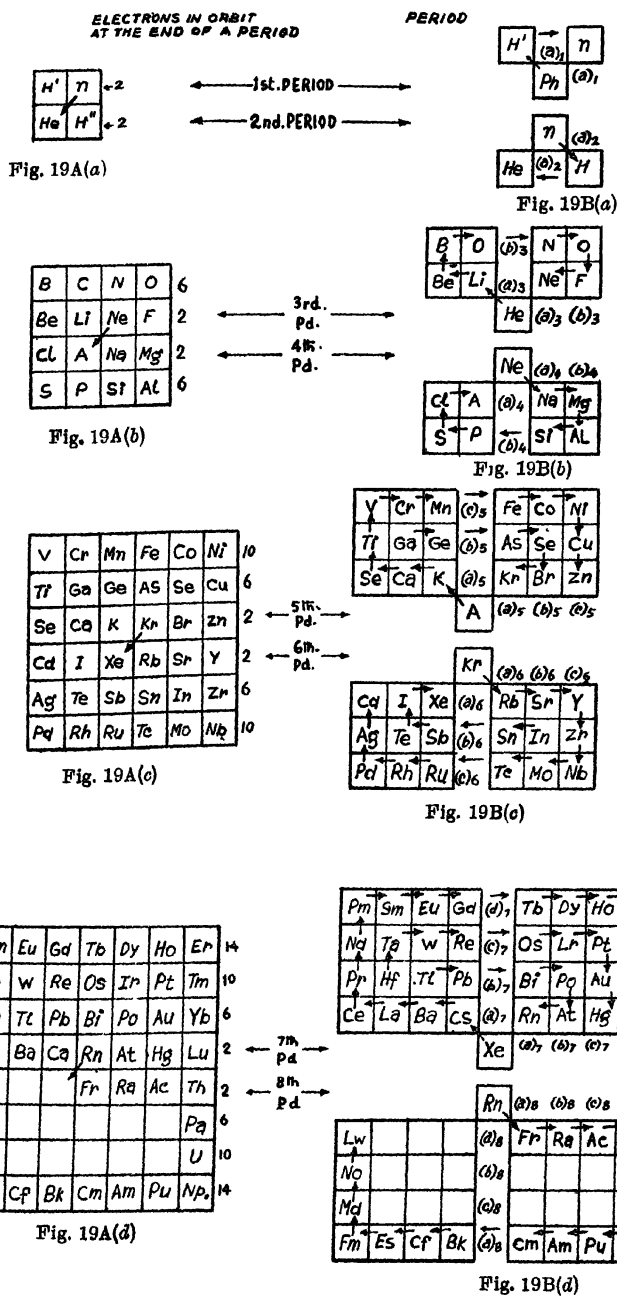


Fig. 19. Periodic table of elements as per evolution in plane square continuum.

We are not including detailed discussion on wave mechanism based on symmetry, as per our approach, because the scope is limited for the present purpose. Therefore in the following we are mentioning only a few relevant conclusions on the nature of matter energy wave, connected with the periodic classification of elements. (For details refer to "Science Based on Symmetry", Chapter 6).

(i) The magnitudes of condensed waves in nature progressively develop in terms of increasing integral multiples of square of increasing magnitudes of maximum amplitudes as even numbers. (Refer to Fig. 16 and Table 6). For example :

B wave C wave D wave E wave
 1.2^2 2.4^2 3.6^2 4.8^2 and so on.

(ii) The nature of development of the wave lengths can be expressed as the magnitudes of the average wave lengths of waves in nature progressively develop in terms of increasing integral multiples of maximum amplitudes, which must be even magnitudes. For example take D wave.

$$\begin{aligned} \text{Starting state } & \left| \begin{array}{cc|cc} B_2 & C_1 & D & C_1 & B_2 \\ \hline 2 & 4 & 0 & 4 & 2 \end{array} \right| \text{ finishing state } \left| \begin{array}{cc|cc} B_2 & C_1 & D & C_1 & B_2 \\ \hline 2 & 4 & 6 & 4 & 2 \end{array} \right| \\ \text{average} & \left| \begin{array}{cc|cc} B_2 & C_1 & D & C_1 & B_2 \\ \hline 2 & 4 & 3 & 4 & 2 \end{array} \right| \\ & = 18. \end{aligned}$$

(iii) The maximum amplitudes decide the whole wave as well as its wave length and ratio of whole wave magnitude and the magnitude of average wave length gives magnitude of maximum amplitude of the waves. For example :

$$\frac{1.2^2}{1.2}, \frac{2.4^2}{2.4}, \frac{3.6^2}{3.6}, \frac{4.8^2}{4.8}, \dots = \text{maximum amplitudes } 2, 4, 6, 8, \dots$$

(iv) Magnitude of each half of the square of maximum amplitude is identified with magnitude of average wave length. For example :

$$2^2, 4^2, 6^2, 8^2, \dots = 2+2, 8+8, 18+18, 32+32, \dots$$

Average wave lengths = 2, 8, 18, 32, ...

(v) Every group in the periodic table of elements represents square of maximum amplitude of a condensed wave of nature in wave continuum in the universal context. The squares of maximum amplitudes represent the magnitudes of total numbers of elements in the groups, each comprising two periods. The magnitude of numbers of elements in each period of a group represent magnitude of average wave length of the corresponding condensed wave of nature. Square of max. amplitude : $2^2, 4^2, 6^2, 8^2, \dots$ = number of elements in groups. Number of elements in two periods in each group are 2, 2 ; 8, 8 ; 18, 18 ; 32, 32 ; ..

(vi) The increase in the total number of elements from a previous to the next group in sequence in the periodic table occurs in terms of two times the sum of maximum amplitudes of the previous

and the next waves. For example :

$$\begin{aligned} & 2(0+2) & 2(2+4) & 2(4+6) \\ \text{A} \rightarrow \text{B wave ; B wave} \rightarrow \text{C wave ; C wave} \rightarrow \text{D wave ;} & & & \\ \text{or as } 2, 2 ; & 6, 6 ; & 10, 10 ; & \\ & & 2(6+8) \dots \dots \dots & \\ & & \text{D wave} \rightarrow \text{E wave ;} & \\ & & 14, 14 ; \dots & \end{aligned}$$

2(b) *Microspheric development and electronic structure of atomic configuration :*

Like the macrospheric development, there are three square relationships in the case of microspheric development also. It starts with 9 square units from the 25 square units of configuration of symmetry in one direction, in which there are 5 uncondensed and 4 condensed making the total whole as 3^2 . [Figs. 17(b), 20 and 21].

Progressively developing series in the microspheric case will be as in Table 6(a).

| Total whole square | Condensed | Uncondensed |
|--------------------|-----------------|-----------------|
| 3^2 | $= 4 \cdot 1^2$ | $+ 5 \cdot 1^2$ |
| 6^2 | $= 4 \cdot 2^2$ | $+ 5 \cdot 2^2$ |
| 9^2 | $= 4 \cdot 3^2$ | $+ 5 \cdot 3^2$ |
| 12^2 | $= 4 \cdot 4^2$ | $+ 5 \cdot 4^2$ |
| ... | ... | ... |

The roots of three square relationship in microsphere will be root of total whole square minus root of condensed whole square and is equal to root of uncondensed minus condensed square as shown in Table 6(b).

| Root of Total whole square | Root of Condensed whole square | Root of Uncondensed - Condensed square |
|----------------------------|--------------------------------|--|
| $\sqrt{9}$ | $= \sqrt{4}$ | $= \sqrt{5}$ |
| $\sqrt{36}$ | $= \sqrt{16}$ | $= \sqrt{20}$ |
| $\sqrt{81}$ | $= \sqrt{36}$ | $= \sqrt{45}$ |
| $\sqrt{144}$ | $= \sqrt{64}$ | $= \sqrt{80}$ |
| ... | ... | ... |

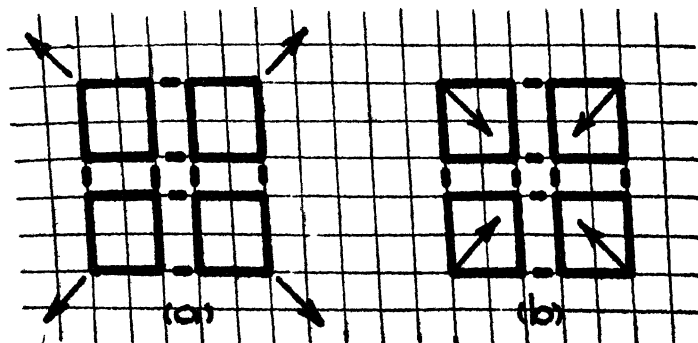
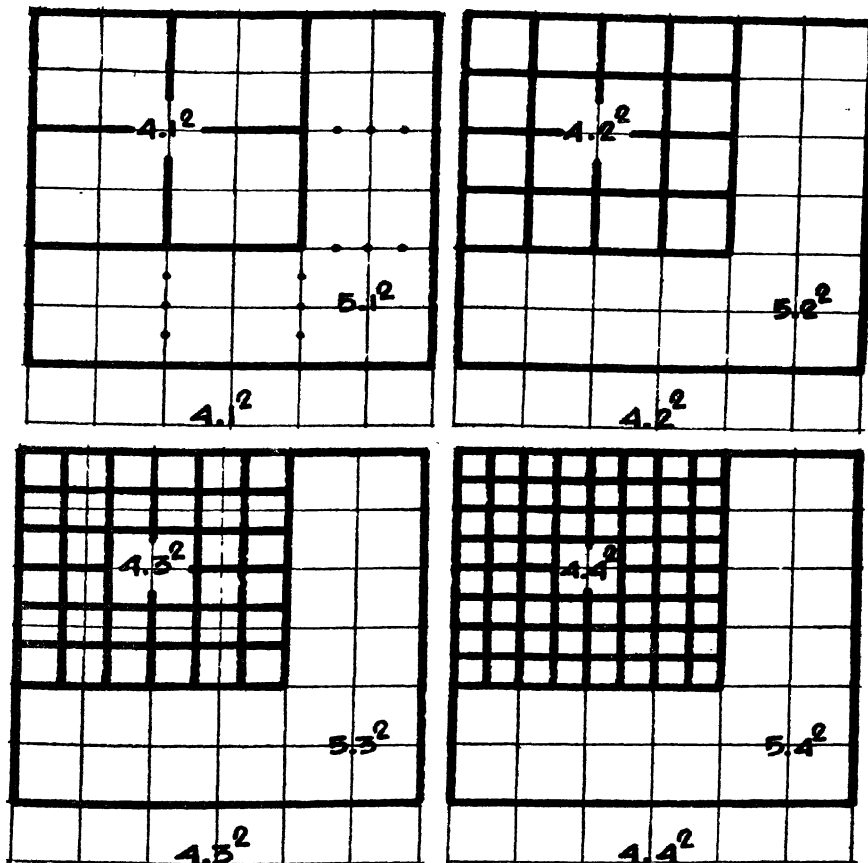


Fig. 17



MICRO SPHERE OF CONDENSED

Fig. 20

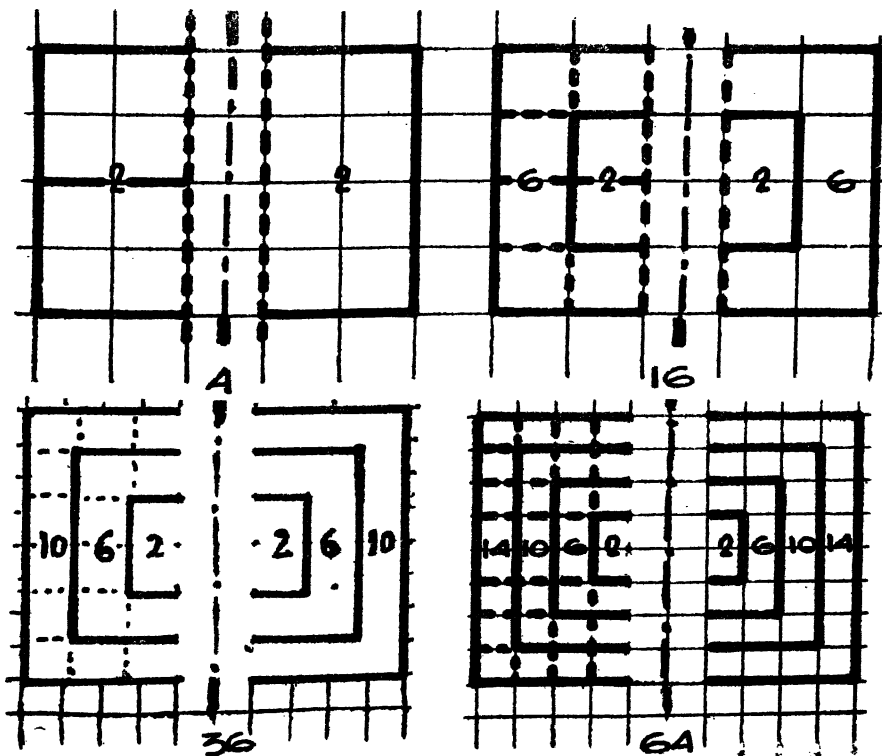


Fig. 21

There could be a valid question that while the macrosphere can develop indefinitely, there must be some scope available for microspheric development also—within a constant atomic configuration. That

this is so is illustrated by following relationship :

$$\frac{\text{Total whole square}}{\text{Uncondensed - Condensed square}} = \frac{3^2}{1^2}, \frac{6^2}{2^2}, \frac{9^2}{3^2}, \frac{12^2}{4^2} = 9$$

| ORBITS | | | a ₁ | a ₂ | b ₃ | a ₃ | b ₄ | a ₄ | c ₅ | b ₅ | a ₅ | c ₆ | b ₆ | a ₆ | d ₇ | c ₇ | b ₇ | a ₇ | d ₈ | c ₈ | b ₈ | a ₈ | | |
|-----------------------------|----------------|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--|--|
| MAXIMUM ELECTRONIC IN ORBIT | | | 2 | 2 | 6 | 2 | 6 | 2 | 10 | 6 | 2 | 10 | 6 | 2 | 14 | 10 | 6 | 2 | 14 | 10 | 6 | 2 | | |
| PERIOD | ELEMENT NUMBER | ELEMENT | | | | | | | | | | | | | | | | | | | | | | |
| 1st | 1 | H | 1 | | | | | | | | | | | | | | | | | | | | | |
| | 2 | He | 2 | | | | | | | | | | | | | | | | | | | | | |
| 2nd | 3 | Li | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| | 4 | Be | 2 | 2 | | | | | | | | | | | | | | | | | | | | |
| 3rd | 5 | B | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | |
| | 6 | C | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | |
| | 7 | N | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | |
| | 8 | O | 4 | 4 | 4 | | | | | | | | | | | | | | | | | | | |
| | 9 | F | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | | |
| | 10 | Ne | 6 | 6 | 6 | | | | | | | | | | | | | | | | | | | |
| | 11 | Na | 2 | 2 | 6 | 2 | | | | | | | | | | | | | | | | | | |
| | 12 | Mg | 2 | 2 | 6 | 2 | | | | | | | | | | | | | | | | | | |
| 4th | 13 | Al | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | |
| | 14 | Si | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | |
| | 15 | P | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | |
| | 16 | S | 4 | 4 | 4 | 4 | | | | | | | | | | | | | | | | | | |
| | 17 | Cl | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | | |
| | 18 | Ar | 6 | 6 | 6 | 6 | | | | | | | | | | | | | | | | | | |
| | 19 | K | 2 | 2 | 6 | 2 | 6 | 2 | | | | | | | | | | | | | | | | |
| | 20 | Ca | 2 | 2 | 6 | 2 | 6 | 2 | | | | | | | | | | | | | | | | |
| 5th | 21 | Sc | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | |
| | 22 | Ti | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | |
| | 23 | V | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | 24 | Cr | 4 | 4 | 4 | 4 | 4 | | | | | | | | | | | | | | | | | |
| | 25 | Mn | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | |
| | 26 | Fe | 6 | 6 | 6 | 6 | 6 | | | | | | | | | | | | | | | | | |
| | 27 | Co | 7 | 7 | 7 | 7 | 7 | | | | | | | | | | | | | | | | | |
| | 28 | Ni | 8 | 8 | 8 | 8 | 8 | | | | | | | | | | | | | | | | | |
| | 29 | Cu | 9 | 9 | 9 | 9 | 9 | | | | | | | | | | | | | | | | | |
| | 30 | Zn | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | |
| | 31 | Ga | 10 | 10 | 2 | 1 | | | | | | | | | | | | | | | | | | |
| | 32 | Ge | 10 | 10 | 3 | 1 | | | | | | | | | | | | | | | | | | |
| | 33 | As | 10 | 10 | 4 | 1 | | | | | | | | | | | | | | | | | | |
| | 34 | Se | 10 | 10 | 5 | 1 | | | | | | | | | | | | | | | | | | |
| | 35 | Br | 10 | 10 | 6 | 1 | | | | | | | | | | | | | | | | | | |
| | 36 | Kr | 10 | 10 | 6 | 2 | | | | | | | | | | | | | | | | | | |
| | 6th | 37 | Rb | 2 | 2 | 6 | 2 | 6 | 2 | 10 | 6 | 2 | | | | | | | | | | | | |
| | | 38 | Sr | 2 | 2 | 6 | 2 | 6 | 2 | 10 | 6 | 2 | | | | | | | | | | | | |
| 39 | | Y | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | |
| 40 | | Zr | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | |
| 41 | | Nb | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | |
| 42 | | Mo | 4 | 4 | 4 | 4 | 4 | | | | | | | | | | | | | | | | | |
| 43 | | Tc | 5 | 5 | 5 | 5 | 5 | | | | | | | | | | | | | | | | | |
| 44 | | Ru | 6 | 6 | 6 | 6 | 6 | | | | | | | | | | | | | | | | | |
| 45 | | Rh | 7 | 7 | 7 | 7 | 7 | | | | | | | | | | | | | | | | | |
| 46 | | Pd | 8 | 8 | 8 | 8 | 8 | | | | | | | | | | | | | | | | | |
| 47 | | Ag | 9 | 9 | 9 | 9 | 9 | | | | | | | | | | | | | | | | | |
| 48 | | Cd | 10 | 10 | 10 | 10 | 10 | | | | | | | | | | | | | | | | | |
| 49 | | In | 10 | 10 | 2 | 1 | | | | | | | | | | | | | | | | | | |
| 50 | | Sn | 10 | 10 | 3 | 1 | | | | | | | | | | | | | | | | | | |
| 51 | | Sb | 10 | 10 | 4 | 1 | | | | | | | | | | | | | | | | | | |
| 52 | | Te | 10 | 10 | 5 | 1 | | | | | | | | | | | | | | | | | | |
| 53 | | I | 10 | 10 | 6 | 1 | | | | | | | | | | | | | | | | | | |
| 54 | | Xe | 2 | 2 | 6 | 2 | 6 | 2 | 10 | 6 | 2 | | | | | | | | | | | | | |

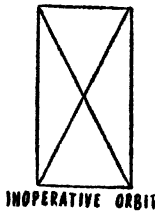


Fig. 22. Electronic structure of elements.

TABLE 7

| Temperature °F | Equilibrium Phases | | | | |
|-------------------|--------------------------------------|-----------------------------------|---------|--|---------|
| | Space | H ₂ O as permanent gas | | | |
| | | Sp. Vol. | Entropy | | |
| 1600 | | 0.3703 | 1.7080 | | |
| 1200 | | 0.2806 | 1.5742 | | |
| 1000 | | 0.2288 | 1.4874 | | |
| 900 | | 0.1981 | 1.4309 | | |
| 800 | | 0.1583 | 1.3508 | Liquid H ₂ O phase eliminated | |
| 705.4 | Vap-Liq Critical State | 0.0503 | 1.0580 | | |
| | | Vapour H ₂ O | | Liquid H ₂ O | |
| | | Sp. Vol. | Entropy | Sp. Vol. | Entropy |
| 705.4 | | 0.0503 | 1.0580 | 0.0503 | 1.0580 |
| 600 | | 0.2668 | 1.3307 | 0.0236 | 0.8131 |
| 450 | | 1.0993 | 1.4793 | 0.0194 | 0.6280 |
| 300 | | 6.466 | 1.6350 | 0.01745 | 0.4369 |
| 150 | | 97.07 | 1.8685 | 0.01634 | 0.2149 |
| (39.2°) | Solid liquid critical state | 2518 | 2.1620 | 0.01602 | 0.0142 |
| 32 | | 3306 | 2.1877 | 0.01602 | 0.0000 |
| Temp. °C | | | | Liquid H ₂ O super-cooled | |
| | | | | Den. gm/c.c. | Entropy |
| 0 | | 14810 | 2.3297 | (+4) 1.0000 | 0.01742 |
| -50 | | 249600 | 2.6028 | (0°C) 0.99987 | -0.3244 |
| -150 | | 935200 | 2.9503 | (-4) 0.99945 | 0.01735 |
| | | | | (-8) 0.99869 | -0.3758 |
| | | | | (-10°C) 0.99815 | 0.01720 |
| | | | | | -0.4266 |

Solid phase eliminated

Solid H₂O

Specific Vol. as Cft/lb Entropy as BTU/lb/°R

Data above 705.4°F are at constant pressure of 3206.2 lb/sq inch abs.

specific properties, namely, specific volume and entropy have been presented in Table 7. The solid/liquid critical state has been assumed near about 39.2°F or 4°C at which the liquid phase has the maximum density. No data is available about the property of ice between 0°C and 4°C. There must be appearance of solid ice phase between 4°C and 0°C.

At 705.4°F, the vapour/liquid critical state, the specific volume and entropy of both vapour and liquid are identical. At this state, liquid phase loses its identity from vapour phase. At temperatures above this critical state, vapour and liquid phase cannot exist, only H₂O as permanent gas can exist. Below this critical state, vapour and liquid co-exist in equilibrium combination. At 705.4°F, H₂O as permanent gas arrives at its least specific volume, from 0.3703 at 1600°F to 0.0503 and the entropy changes from 1.7080 at 1600°F to 1.0580. The properties of vapour phase and liquid phase in equilibrium combination, below their critical state, vary in opposite directions. The specific volume and entropy progressively increase in the vapour phase with decrease in temperature while in the liquid phase in combination, they change in opposite direction. The liquid H₂O phase starting with

0.0503 as specific volume and 1.0580 as entropy at 705.4°F progressively decreases to 0.01602 specific volume and 0 entropy at 32°F whereas in the vapour phase the specific volume starts with 0.0503 at 705.4°F and increases to 3306 at 32°F.

Below the solid/liquid critical state, the density of H₂O in the super-cooled liquid phase decreases from 1 at 4°C to 0.99815 at -10°C i.e., the increase of sp. vol. of super-cooled liquid with temperature occurs just in the same way as that of H₂O in vapour phase does with lowering of temperature in its phase combination with liquid above the solid-liquid critical state. The properties of solid H₂O in equilibrium with super-cooled liquid H₂O below solid-liquid critical state progressively change from 0.1742 in specific volume and -0.3244 in entropy at 0°C to 0.01720 in specific volume and -0.4266 in entropy at -150°C. It can be seen in this phase combination also that the super-cooled liquid phase progressively increases in specific volume while the solid phase progressively decreases in specific volume. The data for entropy in the liquid phase is not available but the nature of change of properties of phase combinations of H₂O which occur through the vapour/liquid critical state, identical

nature of change of properties also should occur through the solid-liquid critical state. It is significant that the liquid phase above the solid/liquid critical state possesses opposite characteristics of liquid phase below the solid/liquid critical state. The maximum density is at 4°C. Liquid phase below the solid/liquid critical state is not the identical liquid above the solid-liquid critical state. Above the solid/liquid critical state, 4°C, the phase of H₂O as ice cannot permanently exist just as liquid phase above the vapour-liquid critical state of 705.4°F cannot exist. Thus, the two critical states are similar in nature.

3(b) *Brief description of the nature of continuum :*

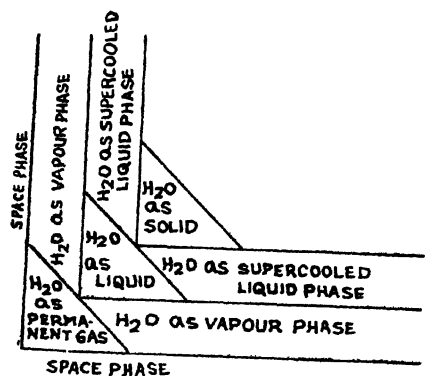
The essence of the whole picture of the nature of continuum in the evolutionary context is like progressive changes of twin phase combinations through critical states one after the other with respect to a change of magnitude of a critical dimension like critical temperature, velocity of light etc.

H₂O as permanent gas, vapour and liquid phases at vapour/liquid critical state of 705.4°F is in such a state of equilibrium that none of the phases is distinguishable. The critical state is an abstract state of existence wherefrom phenomenal nature starts. Starting from a temperature higher than the critical, as the temperature is progressively lowered down to the critical temperature, the permanent gas density progressively increases, till it becomes maximum at the critical state. Just below the critical temperature permanent gas becomes vapour in its continuity, having the maximum density and a new phase (liquid) with least density appears with which vapour is in equilibrium combination. The two phases in equilibrium combination possess opposite properties. With lowering of temperature, one phase (liquid H₂O) increases in intensive properties and the vapour decreases in intensive properties till the two in combination arrive at a temperature state where condensed phase increases to maximum intensity and the uncondensed phase, vapour, arrives at the minimum intensity. This temperature state is the second critical state wherefrom one phase (liquid) with maximum intensity transits in continuity to a phase of super-cooled liquid H₂O with maximum intensity and a new phase (ice) is generated in the new twin combination.

3(c) *Similarity between thermodynamic continuum and numerical continuum :*

The continuum of thermodynamic phases has been qualitatively shown in Fig. 23 which follows the same pattern as in the case of numerical continuum in Fig. 24.

Numerical continuum of fundamental unit and the digits in combination have been explained in Figs. 6, 7, 8 and 9. The ultimate fundamental is ONE. The digits vary from 1 to 9 within the framework of ONE. The unit and the digits in combination make the different frames of phases of



Evolution of Thermodynamic Phase Continuum of H₂O.

Fig. 23

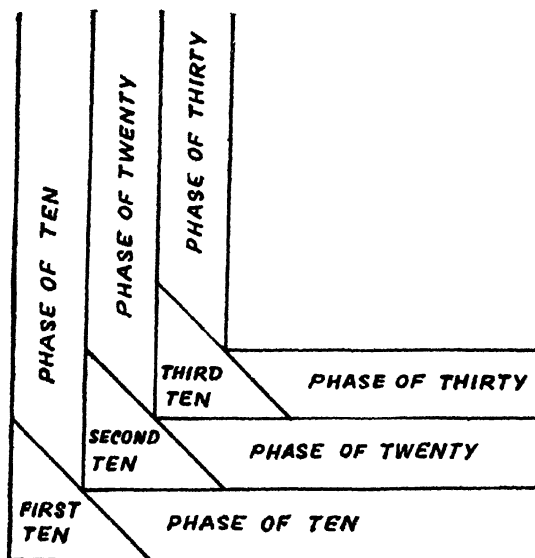


Fig. 24

numbers from 1 to 10, 11 to 20, 21 to 30 etc. The states 10, 20, 30 etc. are numerical critical states as shown in Figs. 8 and 9. The nature of association is obvious from the figure. The critical states through which the numerical phases change from previous to next are similar to the thermodynamic critical states.

The thermodynamic data of H₂O, available in Table 7 covering approximately three zones of phase combinations and two critical states, are in conformity with the configuration of symmetry of phase continuum.*

* ("Science Based on Symmetry," Chapter. 1 for detailed analysis)

TABLE 8—THERMODYNAMIC DATA OF H₂O ON TEMPERATURE, Sp. VOLUME, PRESSURE, ENTROPY, DENSITY AND HEAT OF VAPORIZATION etc., BETWEEN THE TWO CRITICAL STATES: 39.2°F AND 705.4°F (PERRY, HAND BOOK AND HODGMAN, HAND BOOK)

| Temp. °F | Vap. pressure (abs) lb/sq. inch | Specific volume | | Heat of vapourization BTU/lb | Entropy | | Density | |
|-------------|------------------------------------|------------------|------------------|---------------------------------|---------------------|---------------------|------------------|------------------|
| | | Liquid cft/lb | Vapour cft/lb | | Liquid BTU/lb/R° | Vapour BTU/lb/R° | Liquid lb/cft | Vapour lb/cft |
| 39.2 | 0.1217 | 0.01602 | 2518 | 1071.25 | 0.0162 | 2.1597 | 62.5 | 0.000997 |
| 50 | 0.1781 | 0.01608 | 1703.2 | 1065.63 | 0.0361 | 2.1264 | — | — |
| 100 | 0.9492 | 0.01618 | 350.4 | 1037.23 | 0.1295 | 1.9826 | 62.00 | 0.002884 |
| 200 | 11.526 | 0.01668 | 83.64 | 977.91 | 0.2938 | 1.7762 | (at 100.4°F) | (at 100.4°F) |
| 300 | 67.013 | 0.01743 | 6.466 | 909.11 | 0.4369 | 1.6350 | 60.1 | 0.03 |
| 400 | 247.3 | 0.01864 | 1.8693 | 826.03 | 0.5664 | 1.5272 | 57.47 | 0.1552 |
| 500 | 680.8 | 0.0204 | 0.6749 | 773.9 | 0.6887 | 1.4325 | (at 300.2°F) | (at 300.2°F) |
| 600 | 1542.9 | 0.0236 | 0.2668 | 548.5 | 0.8131 | 1.3307 | 53.28 | 0.598 |
| 700 | 3093.7 | 0.0369 | 0.0761 | 172.0 | 0.9905 | 1.1989 | (at 410°F) | (at 410°F) |
| 705.4 | 3206.7 | 0.0503 | 0.0503 | 0 | 1.0580 | 1.0580 | 49.02 | 1.486 |
| | | | | | | | 42.87 | 3.746 |
| | | | | | | | 27.1 | 13.14 |
| | | | | | | | 19.88 | 19.88 |

3(d) Variations of thermodynamic properties :

Following the principle enunciated in Section 1(f) it is intended to verify the validity of the four pairs of forms of transformations listed in Table 5 by adopting various changes in thermodynamic properties of H₂O with respect to change in temperature. Established data of different thermodynamic properties of H₂O between solid/liquid critical state at 39.2°F and vapour/liquid critical state at 705.4°F have been listed in Table 8.

Let $100 = C_1 \Delta T_c = C_2 \Delta P_c = C_3 \Delta D_c = C_4 \Delta S_c = C_5 \Delta Q_c = C_6 \Delta E_c$ etc. in which ΔT , ΔP , ΔS , ΔQ , ΔD and ΔE are changes in temperature, pressure, density, entropy, heat of vapourisation and energy intensity in vapour phase and ΔT_c , ΔP_c , etc. are their critical values respectively. The following procedure has been adopted to work out the various changes of properties with respect to the yard-stick of temperature.

Suppose we want to study the variation of changes of vapour pressure ΔP and heat of vaporization ΔQ with respect to changes of temperature ΔT .

(a) Take a square configuration of 100 units \times 100 units.

(b) Let the dimension temperature be taken, in terms of which relationships of changes of different properties will be studied. It should be emphasised that variation of those properties which undergo changes between the two critical states should be taken into consideration. That part of the properties which do not undergo change should be eliminated.

(c) Calculate the change in temperature between the two critical states. Let ΔT_c be the change in temperature between the two critical states. Let this temperature change ΔT_c be equal to 100 units of the side of the square configuration. The ΔT changes in temperature at lower levels will be calculated as follows: $\frac{100}{\Delta T_c} \times \Delta T$ units of side of this square.

(d) Let ΔQ_c be the critical change in latent heat of vapourization between the two critical states. The ΔQ at different temperature levels will be given by $\frac{100}{\Delta Q_c} \times \Delta Q$ units.

(e) Similarly ΔP will be given by $\frac{100}{\Delta P_c} \times \Delta P$ units.

(f) Plot ΔT units along the vertical axis AY in Fig. 25.

(g) Plot ΔQ units along the X-axis from AY towards XB at different temperature levels.

(h) Plot ΔP units from XB towards AY at different temperature levels.

From Fig. 25 we get

$$\frac{100}{\Delta Q_c} \times \Delta Q = \sqrt{\left(\frac{\Delta T_c}{\Delta T_c} \times 100\right)^2 - \left(\frac{\Delta T}{\Delta T_c} \times 100\right)^2}$$

$$= 100 \sqrt{\frac{\Delta T_c^2 - \Delta T^2}{\Delta T_c^2}}$$

$$\text{or, } \frac{\Delta Q}{\Delta Q_c} = \sqrt{\frac{\Delta T_c^2 - \Delta T^2}{\Delta T_c^2}} \quad \dots \text{ Eq. 5.}$$

Similarly,

$$\Delta P \times \frac{100}{\Delta P_c} = \frac{\Delta T_c}{\Delta T_c} \times 100 - 100 \sqrt{\frac{\Delta T_c^2 - \Delta T^2}{\Delta T_c^2}}$$

$$\text{or, } \frac{\Delta P}{\Delta P_c} = 1 - \sqrt{\frac{\Delta T_c^2 - \Delta T^2}{\Delta T_c^2}} \quad \dots \text{ Eq. 6.}$$

These transformation equations have the same forms as i(a) and i(b) in Table 5. The Eq. 5 has the form of Lorentz transformation for length (space) contraction and Eq. 6 is the present approach to time dilation.

The above equations can be written in terms of reduced states of the different dimensions.

$$\text{Thus } \Delta Q_r = \sqrt{1 - \Delta T_r} \quad \dots \text{ Eq. 7.}$$

$$\text{and } \Delta P_r = 1 - \sqrt{1 - \Delta T_r} \quad \dots \text{ Eq. 8.}$$

These can also be expressed in the forms :

$$C_5 \Delta Q = C_1 \sqrt{\Delta T_c^2 - \Delta T^2} \quad \dots \text{ Eq. 9.}$$

$$\text{and } C_2 \Delta P = C_1 \{\Delta T_c - \sqrt{\Delta T_c^2 - \Delta T^2}\} \quad \dots \text{ Eq. 10.}$$

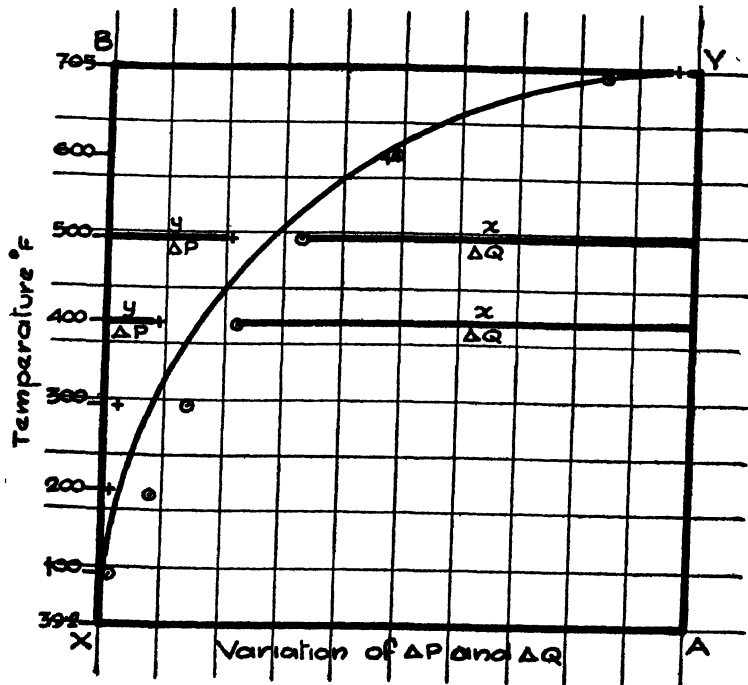


Fig. 25

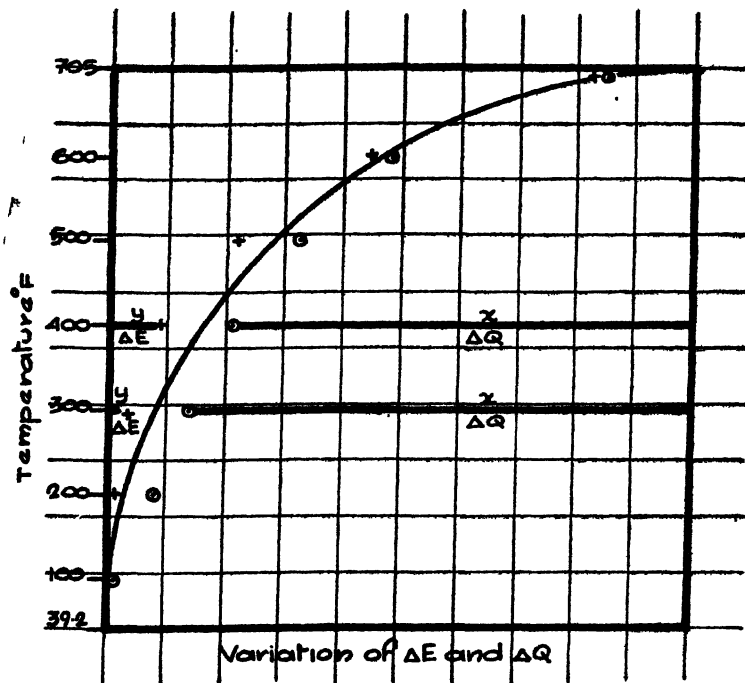


Fig. 26

The relationship of $\frac{\Delta P}{\Delta T}$ would be given by

$$\frac{100 \times \Delta P}{\Delta P_0} = \frac{100}{\Delta T_0} (\Delta T_0 - \sqrt{\Delta T_0^2 - \Delta T^2})$$

$$\frac{100}{\Delta T_0} \times \Delta T$$

or,
$$\frac{\Delta P}{\Delta T} = \frac{\Delta P_0}{\Delta T_0} \times \frac{1}{\Delta T} \times (\Delta T_0 - \sqrt{\Delta T_0^2 - \Delta T^2})$$
 ... Eq. 11.

Changes of heat of vapourization ΔQ and changes in energy intensity ΔE of vapour phase have been plotted against changes of temperature in Fig. 26

$$\Delta EC_6 = C_1(\Delta T_c - \sqrt{\Delta T_c^2 - \Delta T^2}) \quad \dots \text{Eq. 12.}$$

$$\frac{\Delta EC_6}{C_1} = (\Delta T_c - \sqrt{\Delta T_c^2 - \Delta T^2})$$

Substituting in equation 11 we have,

$$\frac{\Delta P}{\Delta T} = \frac{\Delta P_c}{\Delta T_c \Delta T} \times \Delta E \times \frac{C_6}{C_1} \quad \dots \text{Eq. 13.}$$

From this we get

$$\frac{\Delta P_r}{\Delta T_r} = \frac{C_6}{C_1 \Delta T} \times \Delta E \quad \dots \text{Eq. 14.}$$

Putting the values of C_6 and C_1

$$\frac{\Delta P_r}{\Delta T_r} = \frac{\Delta E}{\Delta E_c \Delta T_r} \quad \dots \text{Eq. 15.}$$

$$\text{Since } \Delta E = \frac{\Delta Q}{\Delta(V_v - V_l)} \text{ and } \Delta E_c = \frac{\Delta Q_c}{\Delta(V_v - V_l)_c}$$

we finally have

$$\frac{\Delta P_r}{\Delta T_r} = \frac{\Delta Q_r}{\Delta T_r \Delta(V_v - V_l)_r} \quad \dots \text{Eq. 16.}$$

This has the form of Clausius Clapeyron's famous equation correlating changes of vapour pressure with changes of temperature and latent heat of vapourization all expressed in their reduced states.

3(e) *Changes of entropy of vapour and liquid phases of H_2O :*

Following the same procedure, variation of entropy changes ΔS_v and ΔS_l in the vapour and liquid phases respectively have been calculated and the data have been plotted in Fig. 27. The figure

shows that the entropy changes vary between the two critical states maintaining conservation.

Thus, $\Delta S_v = (\Delta T_c - \Delta T)$ and $\Delta S_l =$

$$\Delta T_c - (\Delta T_c - \Delta T) \text{ and further } \frac{\Delta S_v}{\Delta S_{v_c}} = \frac{(\Delta T_c - \Delta T)}{\Delta T_c}$$

$$\text{and } \frac{\Delta S_l}{\Delta S_{l_c}} = 1 - \frac{(\Delta T_c - \Delta T)}{\Delta T_c} \quad \dots \text{Eq. 17.}$$

The forms of transformations follow iii(a) and iii(b) in Table 5.

A significant point may be noted is that variation of entropy changes in the two opposite phases in equilibrium combination maintaining conservation, goes against the famous postulate of Clausius namely, "Energy of the universe is constant, entropy tends to maximum". The relationship shows that entropy does maintain conservation.

3(f) *Changes of specific heats :* These are much more complicated than variations of changes of thermodynamic properties with respect to changes in temperatures. Some of the factors contributing to the apparent anomalies and complications are :

- (a) Many substances vary in specific volumes while in equilibrium existence comprising different phase combinations.
- (b) It may not be known in what phase a substance belongs to. Whether it is uncondensed or the condensed phase. Because in the present approach if a substance is a

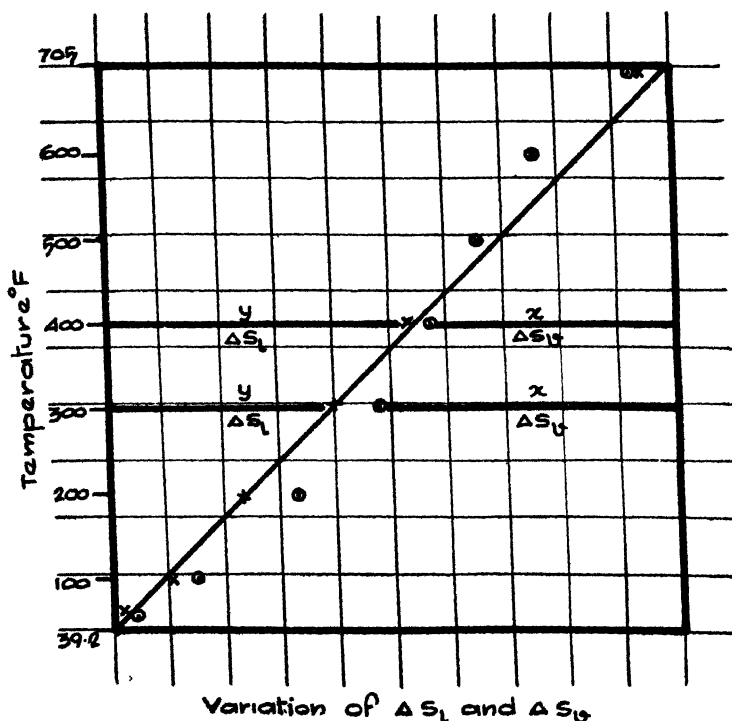


Fig. 27

condensed phase its specific heat should increase with temperature and if uncondensed, specific heat should decrease with temperature. For example, specific heats of super-cooled liquid H₂O, which is a uncondensed phase, decrease with temperature and specific heats of solid ice which is condensed phase increase with temperature.

- (c) A substance may be a mixture of both phases like a solid solution. Specific heat of solid Hg upto its melting point -36.7°C increases with temperature, behaving as a condensed phase. But at temperature above -36.7°C, the specific heats decrease with temperature. Liquid Hg is behaving here as uncondensed phase. Similarly, data on H₂O from 0°C to 34°C are anomalous. Specific heat of solid Pb from -270°C upto 360°C increases with temperature behaving like condensed phase. There are many other cases which require further study.

We shall deal with the variations in changes of specific heats of aluminium with changes of temperature following the same procedure. We are presenting in Fig. 28 the variation of changes in specific heats of aluminium with changes of

temperature. Einstein and Debye did extensive work on this and Debye's formula has been found to be near to the experimental data. Applying our method we got the following relationship from Fig. 28.

$$\frac{\Delta h}{\Delta h_c} = \sqrt{\frac{\Delta T_c^2 - (\Delta T_c - \Delta T)^2}{\Delta T_c^2}} \quad \dots \text{Eq. 18.}$$

where Δh is variable specific heats at different temperature levels and Δh_c is critical specific heat at 660°C which is the melting point.

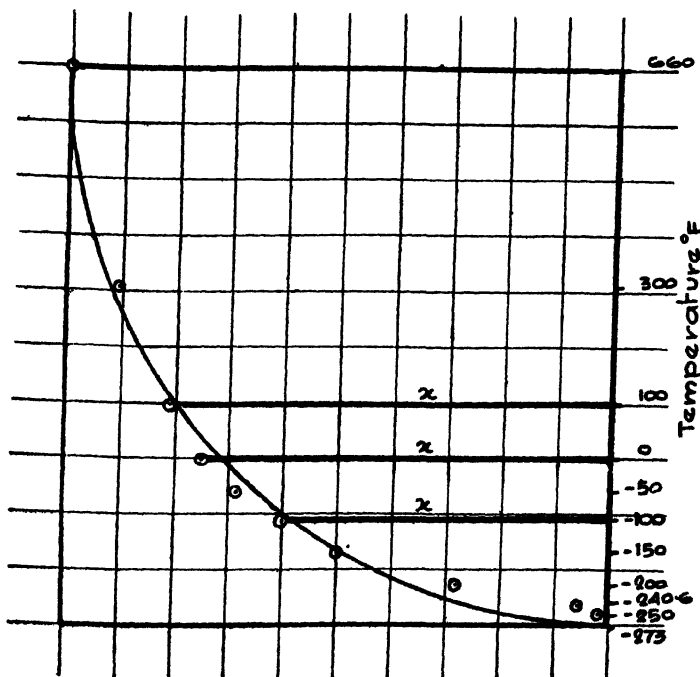
It should be noted that the form of transformation in this case is ii(a) of Table 5. This form of transformation is exactly opposite of Lorentz form.

3(g) Variation of specific heats of ice with temperature :

Variation in changes of specific heats of ice with changes of temperature have been plotted in Fig. 29. The relationship of the form of transformation is expressed as :

$$\frac{\Delta h}{\Delta h_c} = \frac{\Delta T_c - (\Delta T_c - \Delta T)}{\Delta T_c} \quad \dots \text{Eq. 19.}$$

This form corresponds to iv(a) in Table 5.



Variation of specific heats of Aluminium with temperature

Fig. 28

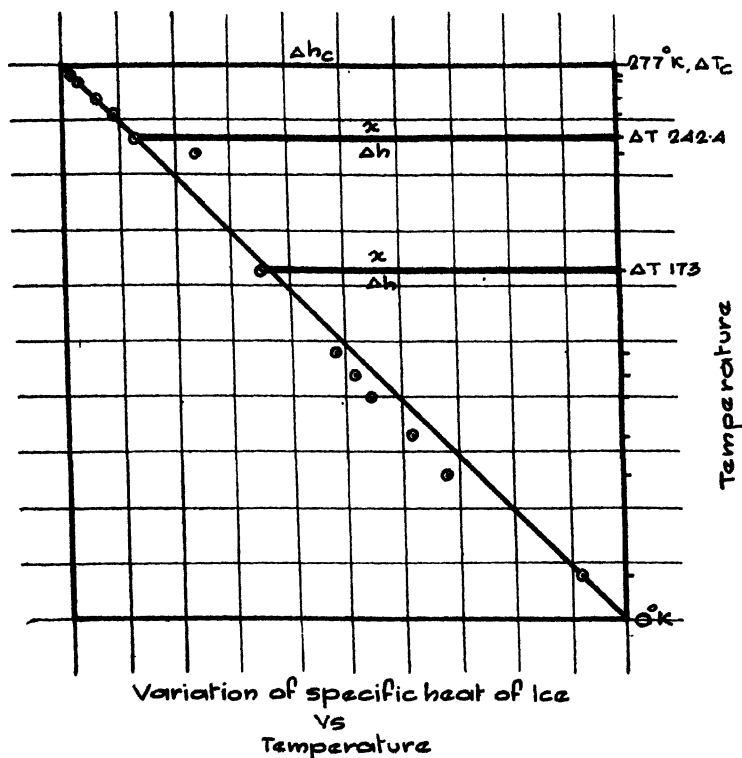


Fig. 29

Section 4

Application in Space and Time Transformations. Analysis of Motion along Circular path in a Plane

4(a) *Velocity components and their space and time contents along X and Y axes :*

Consider the velocity components along X and Y axes of an object in uniform motion along circular path in a plane. Let A be the starting position. In Fig. 30 the object moves in uniform motion along AA_1A_2BCD etc.

While the object is in uniform motion, at any instant in its own path, the space covered and time taken are intimately associated. Space and time move simultaneously with the object at various instants and positions in its own path. Thus space and time are inseparable with respect to the object in motion. In other words the total path described by the object is a measure not only of space but also equally of time. Both time and space are expressed in terms of space.

Let us divide the circular path between A and B in Fig. 30 into 3 equal parts viz., AA_1 , A_1A_2 , A_2B . Time and space for each of these three equal parts are identical.

It is intended to bring the space aspect as well as the time aspect in the configuration as they would be realised along the X and Y axes. As the motion (velocity) is uniform in circular path, space covered

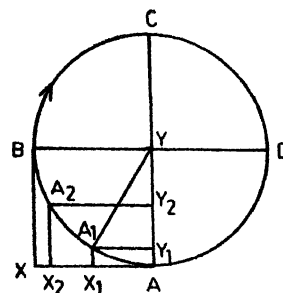


Fig. 30. Components along X and Y axes of uniform motion along circular path.

divided by time taken (which is velocity) from A to A_1 , A_1 to A_2 and A_2 to B are identical along the circular path of the motion along AA_1A_2B . But their components along X axis would be AX_1 , X_1X_2 and X_2X . Similarly along Y axis the corresponding components would be AY_1 , Y_1Y_2 and Y_2Y . It may be seen that the magnitudes of the components along the two axes vary in opposite manner. The velocity component along X axis progressively decreases in proportion to AX_1 , X_1X_2 and X_2X respectively. Along the X axis magnitude of space of each component progressively decreases while magnitude of time progressively increases (because the velocity component L/T progressively decreases along X axis). Similarly along Y axis magnitude of

space component progressively increases and magnitude of time component progressively decreases (because velocity component L/T progressively increases along Y axis). This should be expected because X and Y axes are opposites.

Following this method, one can visualise the consequences on space and time configurations and the relationships between the velocity components along X and Y axes for the complete motion of the object along the circular path.

For example Figs. 31(a) and (b) reveal the velocity components along X axis and Y axis respectively of the motion along the complete circular path. These velocity components have

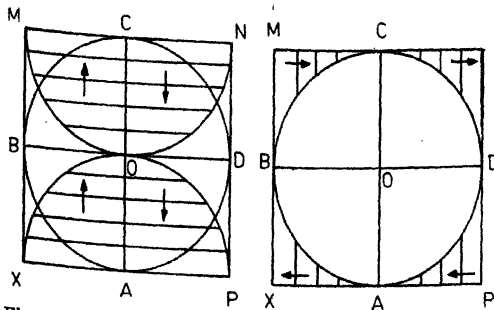


Fig. 31(a). Velocity of components along X axis for the complete circular path of motion.

Fig. 31(b). Velocity of components of Y axis for the complete circular path of motion.

been further split into space content and time contents of velocity components of motion along the complete path. Fig. 32 shows space and time contents of velocity components along X axis and Fig. 33 shows space and time contents of velocity components along Y axis. Rearranging, the total

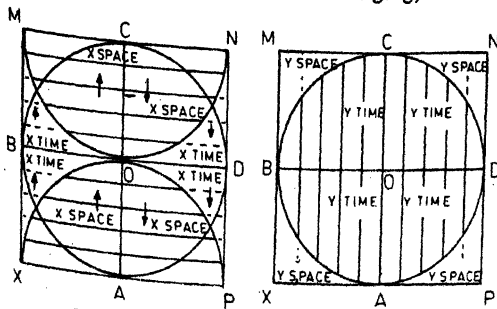


Fig. 32

Fig. 33. Space and time contents of velocity components along Y axis.

space contents of X and Y axes into one configuration is shown in Fig. 34(a) and total time contents along X and Y axes in Fig. 34(b).

The above geometrical analysis establishes conservation of velocity components. It also establishes not only conservation of space content

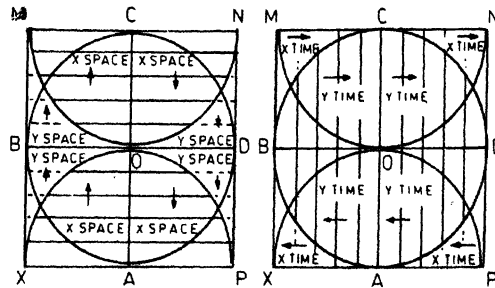


Fig. 34(a). Variation of X space and Y space along X axis.

Fig. 34(b). Variation of X time and Y time along Y axis.

and time content but also space time conservation, equivalence and interchangeability of space and time in the universal context. Another important point is that both space and time can dilate and contract depending on the course of motion. And all the space and time contents, of all varying velocity components along X and Y axes, undergo dilation or contraction according to the following forms of transformation equations :

$$(a) \quad l_2 = l_1 \sqrt{\frac{c^2 - v^2}{c^2}} \quad \text{and} \quad t_2 = t_1 \left[1 - \sqrt{\frac{c^2 - v^2}{c^2}} \right]$$

$$\text{and (b) } \quad l_2 = l_1 \sqrt{\frac{c^2 - (c-v)^2}{c^2}}$$

$$\text{and } \quad t_2 = t_1 \left[1 - \sqrt{\frac{c^2 - (c-v)^2}{c^2}} \right]$$

These forms have already been listed in Table 5.*

4(b) Geometrical configuration of Lorentz transformation : space can contract and dilate ; so also time :

The most important aspect of Lorentz's transformation is the factor $\sqrt{\frac{c^2 - v^2}{c^2}}$. When $v=0$, the

factor becomes unity, and when $v=c$, the factor becomes zero. These conditions are satisfied if the three dimensions viz., c , v and $\sqrt{(c^2 - v^2)}$ form the three sides of a right-angled triangle in which v varies, $\sqrt{c^2 - v^2}$ varies and c remains constant as hypotenuse [Fig. 35(a)].

In Fig. 35(a) v varies along Y axis. Its value at A is zero. $\sqrt{(c^2 - v^2)}$ varies along X axis which ranges in values from XA, where $v=0$, to zero at Y, where $v=c$.

Let a rod of length l_1 , in Fig. 35(b), be at rest along AX. This rod at velocity v will be l_2 following the relationship $l_2/l_1 = \sqrt{\frac{c^2 - v^2}{c^2}}$.

When $v=0$, the length is l_1 . If velocity approaches c , l_2 will be zero at Y_1 .

*"Science Based on Symmetry", Chapter 5, Section XVII and XVIII for details.

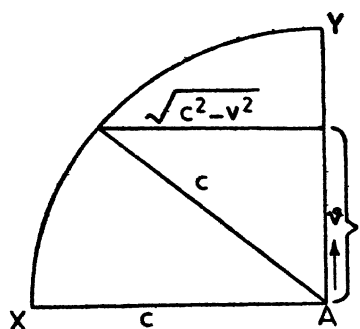


Fig. 35(a)

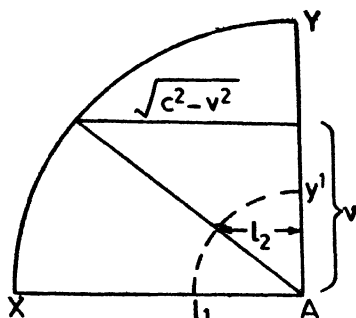


Fig. 35(b)

$$\frac{L_2}{L_1} = \sqrt{\frac{c^2 - v^2}{c^2}} = \sqrt{1 - \frac{v^2}{c^2}}$$

In order to find variation of magnitude of time, Lorentz's formula can be applied in an extended form as shown in Fig. 35(c).

In this approach if the area AXY is described by varying horizontal full lines (which are the space contents of velocity component) of magnitudes $\sqrt{c^2 - v^2}$ with velocity v varying from A to Y, the horizontal dotted lines in the area XBY will be described by time contents of the velocity component.

Fig. 35(c) shows that $c - \sqrt{c^2 - v^2} = t_2$ while the velocity v would increase from A to Y. If the velocity is equal to $c = AY$, the corresponding magnitude of l_1 at Y will be zero and the time magnitude will be $t_1 = BY$. This is the form of transformation for dilation of time.

The relationship is given by $t_2 = t_1 \frac{(c - \sqrt{c^2 - v^2})}{c}$.

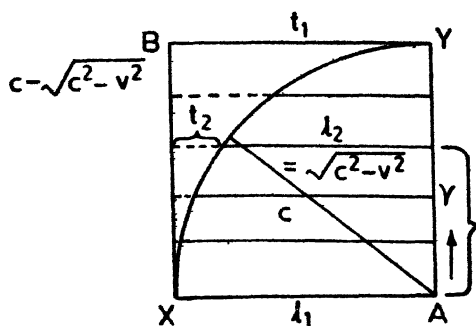


Fig. 35(c)

It should be noted that the forms of transformations of space and time contraction and dilation respectively follow same forms as deduced in Table 5. In the specific case under consideration space contraction and time dilation will obey the following forms:

$$l_2 = l_1 \sqrt{\frac{c^2 - v^2}{c^2}}$$

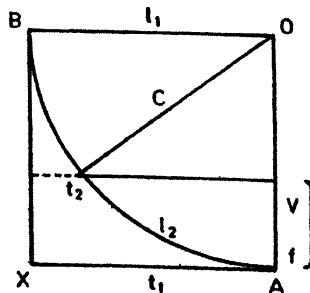
$$t_2 = t_1 \frac{(c - \sqrt{c^2 - v^2})}{c}$$

It must be emphasised that in the universal nature, contraction of space and dilation of time are not the only processes which work in phenomenal manifestations. There are processes in which space dilates and time contracts, following the forms of relationships, ii(a) and ii(b) in Table 5, as would be evident from Fig. 35(d) where

$$l_2 = l_1 \sqrt{\frac{c^2 - (c - v)^2}{c^2}} \text{ and}$$

$$t_2 = t_1 \left(1 - \sqrt{\frac{c^2 - (c - v)^2}{c^2}}\right).$$

In this case space dilates and time contracts with increase of velocity.



$$t_2 = t_1 \left(1 - \sqrt{\frac{c^2 - (c - v)^2}{c^2}}\right)$$

$$l_2 = l_1 \sqrt{\frac{c^2 - (c - v)^2}{c^2}}$$

Fig. 35(d). Reverse or opposite configuration of Lorentz's transformation which could lead to time contraction and length dilation with velocity increase.

We have already shown the application of this form in variation of changes in specific heats, numerous cases of analysis of space and time contents of velocity components of uniform motion along circular path as well as matter energy wave mechanism based on symmetry in our approach.

4(c) *Relativistic mass and matter energy relationship:*

In the special theory of relativity, conventionally, the variable mass M of a body moving with velocity v is given by

$$M = \frac{m_0}{\sqrt{c^2 - v^2}}, \text{ where } m_0 \text{ is rest mass.}$$

When $v=0$, $M=m_0$. At this state there is no kinetic mass or energy. This is a critical state, where all mass is rest mass, m_0 . When $v=c$, the magnitude of M becomes infinity and m_0/M becomes zero.

But in the case of variable length l of a body with l_0 as rest length the relationship is

$$\sqrt{\frac{c^2 - v^2}{c^2}} = \frac{l}{l_0}$$

by applying Lorentz form of transformation where l is variable length and l_0 is rest length.

With increasing v and decreasing value of the Lorentz factor the variable length l decreases, the limits of variations are zero and l_0 . But with a variation of the value of Lorentz factor in the same direction, the limits of variation of M is m_0 and infinity. Out of the eight forms of transformations, discovered in science based on symmetry, one of them, [(a), listed in Table 5], is Lorentz transformation. These forms of transformations have been successfully applied to numerous cases employing established data, in thermodynamics, specific heats, space and time contents of motion as well as mechanism of matter energy waves (based on our approach of concept of symmetry). In no case magnitudes of any changing property increase to infinity. Each and every varying property shows conservation, within finite limits between critical states. It is asserted that in the context of finite manifestations in the finite universe, (within limits of $v=0$ and $v=c$) a varying property tending towards dilation or increase in magnitude cannot involve infinity. By adopting appropriate form of transformation, variation towards dilation or increase of magnitude can be up to a finite maximum limit. For example, a dimension like time can dilate by adopting the following forms of transformation :

$$\frac{t}{t_0} = 1 - \sqrt{\frac{c^2 - v^2}{c^2}}$$

or

$$\frac{t}{t_0} = \sqrt{\frac{c^2 - (c-v)^2}{c^2}}$$

These show that time can dilate only up to maximum t_0 . One should not forget that variable mass M is in combination with matter coming out of rest mass m_0 with increasing velocity. When the two in opposite directions and maintain conservation. In relativistic form of equation there is no matter energy conservation.

At a critical state where kinetic mass or energy is zero at zero velocity, at that state, only m_0 remains. But when velocity is imparted to m_0 , generated kinetic energy forms with some mass from m_0 , a twin phase combination in which magnitudes of both phases must change in opposite directions with increasing v . Therefore, when M increases with velocity, m_0 must decrease to maintain conservation; m_0 cannot retain its original magnitude when $v=c$. All of m_0 at that

critical state becomes one with the medium in which everything possess velocity c . The changes of M and m_0 can vary according to any of the following forms :

- (a) $M = (c - \sqrt{c^2 - v^2})$... dilates with $v=c$.
- (b) $m_0 = \sqrt{c^2 - v^2}$... contracts with $v=c$.
- (c) $M = \sqrt{c^2 - (c-v)^2}$... dilates with $v=c$.
- (d) $m_0 = c - \sqrt{c^2 - (c-v)^2}$... contracts with $v=c$.
- (e) $M = c - (c-v)$... dilates with $v=c$.
- (f) $m_0 = (c-v)$... contracts with $v=c$.
- (g) $M = c - (c-v)$... dilates with $v=c$.
- (h) $m_0 = c - \{c - (c-v)\}$... contracts with $v=c$.

4(d) Relationship in matter and energy variation in vapour and liquid equilibrium of H_2O with temperature :

Established data on equilibrium variation of kinetic energy and potential energy, kinetic mass and potential mass with velocity or temperature between two critical states as such are not available to demonstrate matter/energy variation in our approach. We can, however, test our hypothesis on energy/matter variation in vapour and liquid in equilibrium between two critical temperature states from available data of H_2O .

We have to first ascertain what are the matter and energy significances of vapour and liquid phases. Energy significance as BTU/cft. of vapour phase can be represented by $E = \frac{Q}{v_0 - v_1}$, where Q , v_0 and v_1 are heat of vapourisation, Sp. vol. of vapour and Sp. vol. of liquid respectively. Similarly, matter significance as density d of liquid is $\frac{1b}{cft}$. The values of ΔE and Δd have been presented in Table 9.

We can examine from these the variation of energy of vapour with matter of liquid, since both the variables have a common denominator.

In terms of the critical maximum changes of these properties, namely, ΔT_c , ΔE_c and Δd_c , between the two critical states the values of ΔE and Δd at different temperature levels have been presented in Table 9.

| Temperature level °F | ΔE BTU/cft. of vapour | Δd lb/cft. of liquid | In terms of numbers of units of side of 100* | |
|----------------------|-------------------------------|------------------------------|--|----------------|
| | | | ΔE | Δd |
| 39.2 | 0 | 42.52 | 0 | 100 |
| 50 | 0.0006 | — | 0.01 | — |
| 100 | 2.540 | 42.19 (100.4°F) | 0.50 | 98.8 (100.4°F) |
| 200 | 28.6 | 40.22 | 0.59 | 94.5 |
| 300 | 140.5 | 37.59 (300.2°F) | 2.7 | 88.2 (300.2°F) |
| 400 | 447.4 | 33.40 (410°F) | 8.8 | 78.4 (410°F) |
| 500 | 1091 | 29.14 | 21.4 | 68.4 |
| 600 | 2265 | 22.49 | 44.3 | 52.8 |
| 700 | 4987 | 7.22 | 86.4 | 17 |
| 705.4 | 5090 | 0 | 100 | 0 |

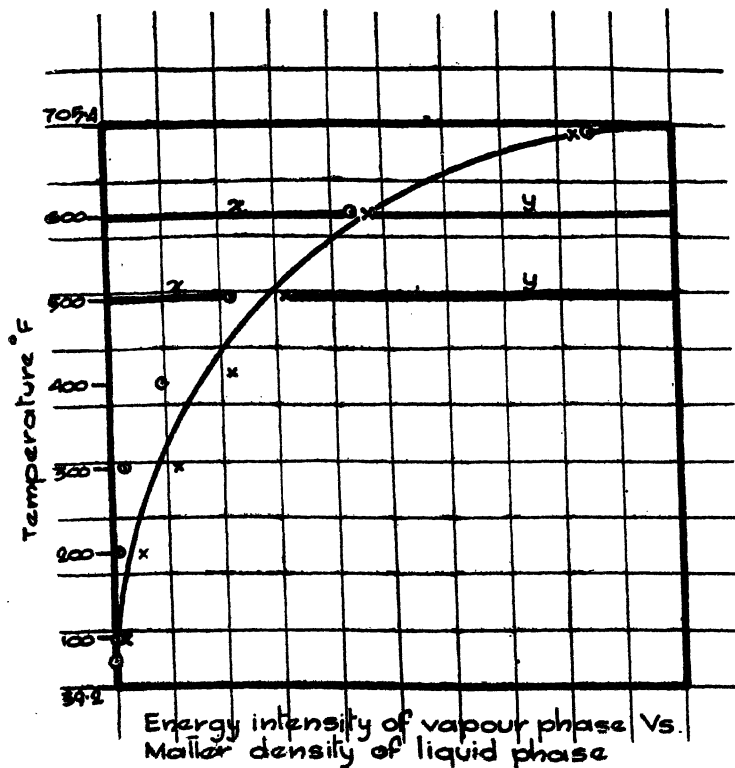


Fig. 86

The values of ΔE and Δd in terms of units of side of 100^3 have been presented in Table 9 and plotted at different temperature levels in Fig. 36, which gives the forms of transformation relationships for

$$\frac{\Delta d}{\Delta d_0} = \sqrt{\frac{\Delta T_0^3 - \Delta T^3}{\Delta T_0^3}}$$

$$\text{and } \frac{\Delta E}{\Delta E_0} = 1 - \sqrt{\frac{\Delta T_0^3 - \Delta T^3}{\Delta T_0^3}}$$

It may be seen that as expected, the relative variations of the changes of Δd and ΔE take place in opposite directions between the two critical states maintaining matter-energy conversation.

Section 5

Mechanism of Catalytic Chemical Reaction

Dynamic aspects :

In all changes involved in nature whether it is a chemical reaction or a phenomenal manifestation, for *equilibrium existence* two opposite components like condensed and uncondensed phases are necessary for generating resultant equilibrium. For example, an observed crystalline structure must have within it a component configuration vibrating between opposite phases so that the observed or perceived configuration of the crystalline structure is the resultant of these two opposites.

This can be illustrated by a simple example of a perceived cubic configuration, generated from a tetrahedron having its centroid position fixed, vibrating between two opposite phases (Fig. 37) ABCD and abcd, where 8 positions occupy 8 corners of a cube.

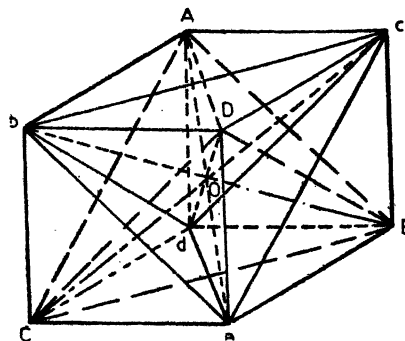


Fig. 87

Such a cubic crystal of equilibrium configuration, of course, does not have any vacant positions of the tetrahedron while vibrating between the two opposite states.

Similarly, when a tetrahedron vibrates between two opposite phases, with mid point of altitude fixed, result only six cognisable positions in the equilibrium configuration result, which appear in perception as an octahedron (Fig. 38).

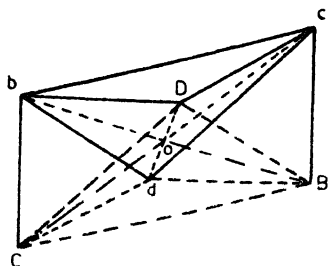


Fig. 38

The mechanism of catalytic chemical reaction has been put forward below according to this basic concept.

The entities which catalyze a reaction (catalysts) must have a configuration. The solid catalyst has a perceivable equilibrium configuration in the form of various crystalline structures. In these crystalline structures having different configuration, it may be that the perceived configuration corresponding to any crystalline structure may be only a portion of the actual equilibrium configuration in which the filled up positions are not amenable to function as catalyst while the unoccupied or unfilled or unsaturated positions can be active as catalyst.

The above illustrations provide the basis for the explanation of mechanism of catalytic reaction, particularly its dynamic aspects. It is possible that a catalytic substance is one in which an equilibrium crystalline configuration exists where all positions are not incorporated in the apparent configuration but some positions remain unoccupied or unassociated or unfilled, rendering the configuration incomplete. It is in these vacant positions that compounds as reactants are adsorbed or chemisorbed and then, because of oscillation of these positions between two opposite phases, namely reactant phase and product-phase, corresponding to condensed phase and uncondensed phase, they are oriented and transformed into products from the adsorbed reactants. To facilitate the maximum number of active positions available for the (poison free) reactants to be adsorbed, a catalyst may contain promoters, if required pretreatment like reduction, dehydration etc. may be necessary and

pressure and temperature are to be adjusted to the desired level to make the vibration not only optimum for rate of reaction but also for rendering the catalyst dynamic enough to establish optimum equilibrium between adsorption and desorption. The sequences in the mechanism of a catalytic reaction would be as shown in Fig. 39.

In Fig. 39 equilibrium configuration of the catalyst has been assumed to be constituted of component configuration, like a tetrahedron vibrating between two opposite phases, generating a resultant configuration like that of a cube or octahedron.

In a complete catalytic transformation process there will be three main steps of action in sequence in the direction of conversion of reactants to products :

(i) First action is conversion of the reactant positions to be adsorbed in the first phase of the catalyst configuration at suitable temperature, pressure, etc. This requires the reactant positions distributed in space to be brought to correct concentration (say by pressure adjustment) to suit distribution in the catalyst configuration in the first phase. The first action is likened to condensed phase such as liquified H_2O from vapour phase.

(ii) The second action is the change of orientation of the catalyst configuration from the first phase with reactant positions occupying the active positions to the second phase of the catalyst configuration, during which the reactants have been converted into products i.e. the reactants have undergone orientation in their combination. During this process the reactants, which were present in the first phase of the configuration associated with certain intensity of space (in this theory energy radiation is space) energy have also undergone change in the second phase, in which the products in the configuration associated with changed energy intensity of space, decide whether the reaction will be exothermic or endothermic.

(iii) The third action is the process of desorption or ejection of the product positions received from the second phase. The rate of desorption of the product positions formed in the second phase of the catalyst will be due to the difference in driving force between concentration of the product positions

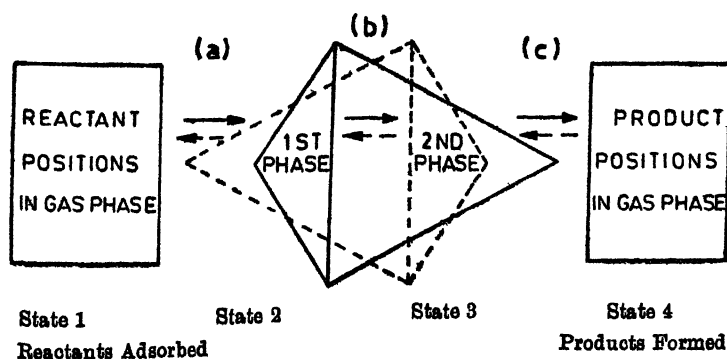


Fig. 39. Mechanism of catalytic reactions.

in the catalyst and their concentration in the gas phase. The third action is likened to vapourisation of liquid phase to vapour phase i.e. conversion of condensed phase into uncondensed phase.

Thus all the three steps or actions described above are factors which should be controlling the reaction.

The presence of a second or third entity mixed in the catalyst has direct effect in modifying the catalyst and its performance. They may help in generation of more active positions in the first state or they may start filling up the active positions themselves in the first state. These compounds act in two opposite ways ; they may function as promoters in the former case and as poison in the latter.

It should be noted that the physical structure of a catalyst need not be simple or elementary in nature like a tetrahedron oscillating between two

states giving the impression of a cube or octahedron. It can be a combination of a number of associated configurations oscillating between two opposite phases either resonating with the vibration of the main catalyst or just vibrate in opposite mode of the main catalyst and thereby stopping catalytic activity.

The most important factor in the suggested mechanism is the introduction of dynamicity between the states of chemisorption of reactants and desorption of products.

The above concepts not only render understanding of the mechanism and rate of reaction easy but also explain the effects of promoters and poisons and such other parameters as temperature, pressure and space velocity, and role of such processes as adsorption and desorption in chemical reactions. These concepts can also be utilized to explain the endothermicity or exothermicity in chemical reaction and establishing equilibrium.