The Inter-Regional Ratio

Prof. K.V.K. Nehru, Ph.D.

1 Introduction

The Inter-regional ratio is an important concept discovered in the development of the Reciprocal System of theory. The works of Larson—notably, *Nothing But Motion* and *The Structure of the Physical Universe*—are to be referred to for an explanation of the origin and significance of this ratio. This paper only attempts to clarify the factors involved in its calculation, as applied to the basic properties of matter.

At the outset, I feel that the word "orientation" that we have been using in this context does not seem to be too fitting, because of its strong connotation of direction in space. The word "possibility" seems more appropriate. In evaluating the Inter-regional ratio we are inquiring as to how many total possibilities are there for a motion unit to exist—the intrinsic existential possibilities, we might say. Another word that comes to mind is "eigenstate." But "degrees of freedom" seems very much suitable, providing we refrain from smuggling in some of its spatial connotations.

The Reciprocal System shows that there are several types of regions or domains in the structure of the physical universe and that there are interactions across the regional boundaries. During the interactions it is not always the case that the effect of a unit of motion transmitted across the boundary is also *one* unit. For example, if there are *f* number of equipossible alternatives within the region for a unit of motion, then by probability laws we know that there is $1/f^{th}$ chance of the unit effect getting transmitted, or what is tantamount, only $1/f^{th}$ part of the unit motion gets transmitted. The number of possibilities or degrees of freedom, f, is called the Inter-regional Ratio.

2 Rotational Degrees of Freedom In Three-dimensional Time (or Space)

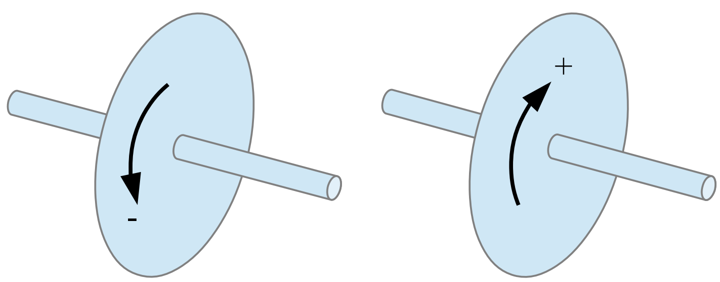

Figure 1: The Two Possibilities of a One-dimensional Rotation

Let us examine rotation in space in order to draw conclusions that are equally applicable to rotation in time. When we say 'one-dimensional' rotation we mean that one magnitude (or parameter) is required to fully specify the rotation. A one-dimensional rotation occupies two-dimensional space. Similarly, a two-dimensional rotation requires two magnitudes for its full specification and occupies three-dimensional space. Now a unit of one-dimensional rotation has two possible directions, +1 and -1, within the framework of the three-dimensional space, as shown in Figure 1.

As a result, the total number of possibilities—the degrees of freedom, as we will call them—in a three-dimensional space with two possibilities in each dimension is 2 × 2 × 2 = 8. Notationally we can express the eight possibilities as:

$$\begin{gathered}(+1,+1,+1),(+1,+1,-1),(+1,-1,+1),(-1,-1,+1),\\(-1,-1,-1),(-1,+1,+1),(+1,-1,-1),(-1,+1,-1)\end{gathered} \tag{1}$$

In fact, if n is the number of (vector) dimensions and p the number of possibilities per dimension, then f, the number of degrees of freedom available in the n-dimensional (vectorial) space (or time), is given by:

$$f=p^n \tag{2}$$

As such, an unit of one-dimensional rotation has eight degrees of freedom (that is, intrinsic existential possibilities) in three-dimensional space (or time).

It is often questioned that do not the two possibilities in each of the three dimensions make up a total of six instead of eight. This would indeed be true if we are considering three one-dimensional spaces instead of one three-dimensional space. If the three dimensions are independent, then the total possibilities are:

$$2\vee 2\vee 2=2+2+2=6 \tag{3}$$

In fact, this is what we have in the case of space-time dimensions—the dimensions of scalar motion—in distinction to the dimensions of space (or time), which we have called the vector dimensions. Since the three space-time dimensions, being scalar, are independent, the possible number of degrees of freedom *is* six.[1] So if n is the number of scalar dimensions and p the number of possibilities per dimension, we can write down the formula for the number of degrees of freedom available in the scalar dimensions as:

$$f=n\times p \tag{4}$$

On the other hand, if the three dimensions are interrelated, the total number of degrees of freedom, as given by Equation (2) is:

$$2\wedge 2\wedge 2=2\times 2\times 2=8 \tag{5}$$

The other question that is also sometimes raised is why not two possibilities per dimension and three dimensions imply $3^2 = 9$ possibilities instead of $2^3 = 8$. But it is not difficult to see that this would be the case only if we have three possibilities in each of a two-dimensional motion and not otherwise.

As the degree of complexity of the motion increases, the existential states possible to it decrease. The two-dimensional rotation, it is already remarked, requires two magnitudes to specify it fully. So the possible degrees of freedom for a two-dimensional rotation in three-dimensional space (or time) are 8/2 = 4. This can easily be understood with the help of the diagrams shown in Figure 2:

1 Larson, Dewey B., *The Neglected Facts of Science*, North Pacific Publishers, OR, 1982, p. 84.

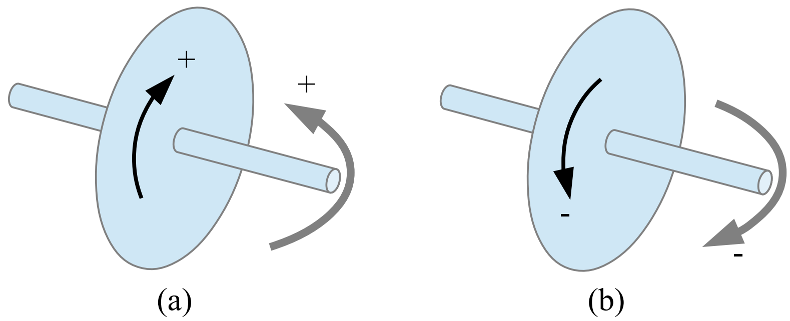

Figure 2: The Degeneracy of a Two-dimensional Rotation

The two-dimensional rotation is a *coupled* rotation of two one-dimensional rotations. This coupling causes a 'degeneracy.' In Figure 2(a), the directions of the two component rotations are indicated by two plus signs. The characteristic of the two-dimensional rotation is that if the directions of both the one-dimensional rotations are reversed, as in Figure 2(b), the net effect is to leave the sense of the two-dimensional rotation unchanged.

This is in view of the fact that:

$$\begin{gathered}(+1)\times(+1)=(-1)\times(-1)\\ \textit{and}\ (+1)\times(-1)=(-1)\times(+1)\end{gathered} \tag{6}$$

Due to this feature the eight possibilities listed in Statement (1) above reduce to four, for the case of the two-dimensional rotation, because each of the possibility listed in the upper line of Statement (1) turns out to be the same as the one listed immediately below it, in the second line. For example, for the coupled rotation:

$$(+1,+1,-1)\equiv((+1,+1),-1)\equiv((-1,-1),-1)\equiv(-1,-1,-1) \tag{7}$$

Therefore, if d is the vector dimensionality of the motion, then Equation (2) is modified to give f, the number of degrees of freedom available in vector space (or time) as:

$$f=\frac{p^n}{d} \tag{8}$$

We finally arrive at the total number of degrees of freedom available for a unit of motion in the atom which comprises of two two-dimensional (magnetic) and one one-dimensional (electric) rotations, as

$$\left(\frac{2^3}{2}\right)\times\left(\frac{2^3}{2}\right)\times\left(\frac{2^3}{1}\right)=4\times4\times8=128 \tag{9}$$

There is another point of relevance that needs to be mentioned at this juncture before turning attention to the inquiry of the vibrational degrees of freedom. We have already distinguished between the dimensions of space-time (the scalar dimensions) and the dimensions of space (or time) (the vector dimensions). If we have an instance of motion existing in two or three space-time dimensions, then motion in only *one* of these space-time dimensions can be represented in either three-dimensional space (or time).[2] This is depicted in Figure 3.

2 *Ibid.*, p. 19.

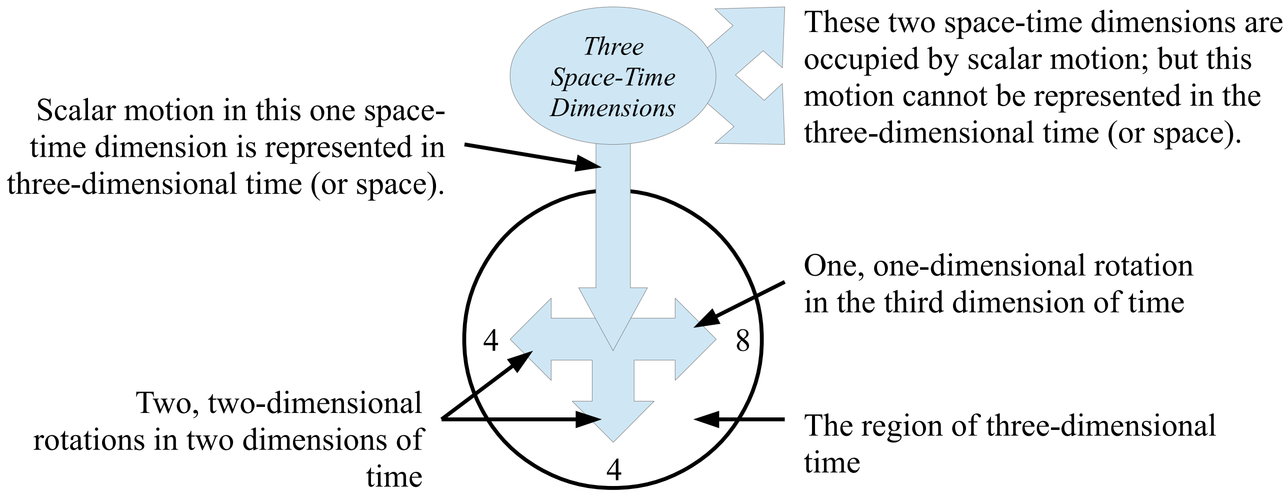

Figure 3: The Limitations of Three-dimensional Time

Gravitation (atomic rotation) is three space-time dimensional. The two space-time dimensions which can not be represented in three-dimensional time (or space) are fully occupied by scalar motion and therefore leave no more degrees of freedom than calculated by Equation (9).

3 Vibrational Degrees of Freedom in Three-dimensional Time

We note that while a one-dimensional rotation has two possibilities (clock-wise and counter-clockwise, as shown in Figure 1), a one-dimensional vibration has only one possibility, since both the directions (forward and backward) in any dimension constitute one oscillation. This is true of both one-dimensional linear and rotational vibrations.

In view of this, the possible number of degrees of freedom of a one-dimensional vibration in three-dimensional time (or space), as calculated by Equation (2), with p=1 and n=3, is:

$$f = 1^3 = 1 \tag{10}$$

However, this is not all: there is an additional factor that increases this number. This is the freedom available in the space-time dimensions, of which there are three. The single unit of photon vibrational motion can occupy only one out of these three space-time dimensions. This leaves the remaining two space-time dimensions vacant (unlike in the case of atomic rotation). Consequently the one unit of vibrational motion has three possible choices as far as the space-time dimensions are concerned. Notationally we can list these possibilities as

$$(1,0,0),(0,1,0),(0,0,1) \tag{11}$$

Thus the number of degrees of freedom of the one-dimensional vibrational unit becomes, by Equation (3) or (4):

$$1^3 \vee 1^3 \vee 1^3 = 1+1+1=3 \tag{12}$$

At this juncture we remind that what we are interested in finding out is not the degrees of freedom available to the one-dimensional vibration on its own right, but rather the additional degrees of freedom, if any, that this one-dimensional vibration makes possible to the rotational unit that is built on it. Since the atomic rotation is a time-displacement while the basic photon vibration is a space-displacement, both belong to different 'regions.' As a result, by applying probability laws, we see that *N* degrees of freedom of the space-displacement of the photon is equivalent to $1/N^{th}$ degree of freedom from the point of view of the time-displacement of the rotation.

The three degrees of freedom as calculated by Equation (12) are specifically applicable to the case of a one-dimensional rotation founded on a one-dimensional vibration, giving the rotational unit an additional $1/3^{rd}$ degree of freedom. But, the rotation basic to the atomic or subatomic structure is two-dimensional and not one-dimensional.[3] Therefore, with p=3 and n=2, by Equation (2), we obtain the total vibrational degrees of freedom from the point of view of the two-dimensional rotation as:

$$3^2=9 \tag{13}$$

This means that for every rotational degree of freedom in three-dimensiona1 time there is an additional 1/9th degree of freedom made possible by the underlying vibration.

However, we recall that the atomic structure consists of *two* two-dimensional rotational systems. (This, of course, is what distinguishes atom from the subatomic particles: the latter has only one two-dimensional rotational system) in its structure.)

Consequently, the additional degree of freedom made possible by the vibrational contribution is $2/9^{th}$ (being $1/9^{th}$ for each of the rotational systems) in the case of atoms, whereas it is only $1/9^{th}$ in the case of sub-atoms. The Inter-regional ratio, which is simply the number of total degrees of freedom is:

$$128+\left(128\times\frac{2}{9}\right)=156.4444 \tag{14}$$

in the case of atomic rotation, and is:

$$128+\left(128\times\frac{1}{9}\right)=142.2222 \tag{15}$$

in the case of subatomic rotation.

4 Summary

1) Scalar motion (that is space-time) can at maximum be three-dimensional. These dimensions of scalar motion are referred to as 'scalar dimensions.'
2) The scalar dimensions are independent. If there are *n* number of scalar dimensions and *p* number of degrees of freedom per dimension, the total degrees of freedom, *f*, are $n \times p$.
3) The stationary reference frame we call space is three-dimensional, these being called the 'vector' dimensions.
4) If a multi-dimensional scalar motion exists, motion in only one of these multiple scalar dimensions can be represented fully in a three-(vector) dimensional space or time.
5) The three vector dimensions of space (or time) are not independent but interrelated. If there are *p* number of possibilities per dimension, then the total number of degrees of freedom, *f*, in the three-dimensional vector space (or time) is given by: $f=p^3$.

3 Larson, Dewey B., *Nothing But Motion*, North Pacific Publishers, OR., 1979, p.124-125.

6) That the maximum number of degrees of freedom in three-dimensional space or time is p^3 does not mean that a particular motion can have p degrees of freedom. If the number of dimensions of this motion (as against the number of dimensions of the vector space (or time) in which it exists) is d, then the available number of degrees of freedom for this motion is: $f = p^3/d$.