I am tending to the belief that it is impossible to advance further with the continuum theory.

--- Albert Einstein.

From the quantum phenomenon it appears to follow with certainty that a finite system of finite energy can be completely described by a finite set of numbers (quantum numbers). This does not seem to be in accordance with a continuum theory and must lead to an attempt to find a purely algebraic theory for the description of reality. But nobody knows how to obtain the basis for such a theory.

--- Albert Einstein.
A publication of the INTERNATIONAL SOCIETY OF UNIFIED SCIENCE.
Devoted to advancing the Reciprocal System of Theory.

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THE INTERNATIONAL SOCIETY OF UNIFIED SCIENCE

13th Annual Convention

AGENDA

PLACE: MULTNOMAH COUNTY LIBRARY, Gregory Heights Branch, Meeting Room
7921 N.E. Sandy Blvd., PORTLAND, OREGON 97213

Friday, August 12, 1988

9:30 am  Introduction
Officers
Attendees
Registration

9:45 am  Dewey Larson: Outline of Reciprocal System

12:00  Lunch

2:00 pm  Papers/Discussion

3:30 pm  Business Meeting, Part I

7:00 pm  Conference Dinner and Party

Saturday, August 13, 1988

9:30 am  More Papers/Discussion

11:00 am  Dewey Larson: Questions and Answers

12:00  Lunch

2:00 pm  Business Meeting, Part II

7:00 pm  Conference Banquet

Note: To be accepted for presentation, a paper must extend the Reciprocal System to a new area or contain new comparisons of the theory with experimental or observational data or shed new light on difficult points. Purely philosophical papers or papers that simply rehash existing Reciprocal System theory will not be accepted.

For INFORMATION PARTICULARS about volunteering and serving in the Convention Program, please communicate with one of the following members of the Convention Program Committee:
Ronald Satz, Chairman; Rainer Huck and Robin Sims, ISUS, INC.,
1680 East Atkin Avenue, Salt Lake City, Utah 84106; (801) 467-3795.
R. Satz can be reached at (215) 495-6362.
ANNOUNCEMENT RE ACCOMODATION FOR THE ISUS CONFERENCE 1988

For the coming ISUS conference in Portland on August 12, 13 1988 a block of 10 rooms has been set aside for ISUS members use at the JADE TREE MOTEL.

The Jade Tree is a modern and very nice and clean motel with luxury rooms near both downtown Portland and Mr Larson's house. ISUS held a director's meeting there in 1985 and the directors were all very content with the accommodations. There are a number of good restaurants nearby and the motel is only a few miles from Portland airport.

The rooms set aside for us are:
* 5 rooms each with two twin beds @ $33.79 each per night. (inc. these twin rooms would be suitable for sharing for 2 persons thus reducing the cost to $16.90 each person).
* 4 rooms each with one double bed @ $33.79 each per night. (suitable for couples).
* 1 room with two double beds @ $42.50 per night. (suitable for two large persons sharing).

The Jade Tree has agreed to hold these rooms for us until they receive a deposit equal to the first nights stay, at which time the room will become reserved. After July 12 the rooms cannot be held so please send in your deposit as soon as possible and definitely before July 12.

Please send your deposit of one night's stay directly to the Jade Tree either by telephoning the Jade Tree and using your credit card or by mailing a check or money order directly to them. Their address is:
JAIDE TREE MOTEL, 3939 NE. HANCOCK ST. PORTLAND, OREGON 97212
PH (503) 288-6891 (the manager's name is Wanda)

We suggest you reserve a room for the nights of August 11,12,13.
The Jade Tree offers you a free night on Sunday August 14 if you wish to stay over after the conference. The conference will begin at 9.00 am August 12 and will end with the dinner banquet around 10pm August 13.

We are all looking forward to having a great conference in the home city of Mr Larson and we look forward to seeing you there.

Robin Sims
ISUS Board Director
Conference Program Committee
FOR BETTER TEACHING THE RECIPROCAL SYSTEM

President's Message

Our Thirteenth Annual ISUS, INC. Conference is taking place in Portland, Oregon, August 12-13, 1988. No better objective can be discovered for it than that we study and learn together how to share more effectively with all humankind the Reciprocal System of physics of natural science. This splendid theory of revalued and unified physics is superior in most essential ways to modern academic physics.

The international revolution in physics at the beginning of this century revalued classical optics, thermodynamics, electrodynamics and mechanics with relativity physics, statistical mechanics, quantum electrodynamics (QED) and quantum mechanics. However, the theories of quantum and relativity physics evidently have not revalued the science of physics enough. The two theories themselves do not at all form a coherent whole. Modern academic physics in 1988 remains every bit as much as classical physics a lot of more "bits and pieces that don't fit very well together". Anyone who still doubts this should have another good look at the branch of modern physics known as nuclear physic.

If not the only way, one of the best ways humankind can and does learn physics is from discovering the mistakes physicists make. We learn from history that the greatest physicists of the past, going from Aristotle through Copernicus and Newton to Einstein, corrected some but not all errors of their predecessors, making new errors in the very process of disclosing the old.

By postulating that space and time are inseparably related in a four-dimensional continuum, Einstein sought to correct Newton's scholia that absolute space and absolute time are absolutely unrelated. All the while Einstein and Newton disagreed with Aristotle that time is an aspect of motion and implicitly agreed with Isaac Barrow's unsupported conjecture that neither space nor time imply motion.

The Reciprocal System postulates that the universe is composed entirely of one component, discrete units of motion, motion at unit speed, existing in three dimensions. It defines motion as the relation between two uniformly progressing reciprocal quantities, space and time. It measures motion, so defined, by speed, the scalar magnitude of the relation between space and time.

The universe of motion postulate and the motion definition of the Reciprocal System exclude the four-dimensional space-time continuum postulate of the Einsteinian relativity theory from applicability to the physical universe, which exists independently of human perception.

The Reciprocal System definition of motion implies that motion involves the uniform progression of both space and time and further the three-dimensional scalar motion of physical locations. It defines a physical location in space to be a point, or segment, of the line of the space progression at a given time.

The Reciprocal System rejection of the four-dimensional stationary space-time continuum of relativity and quantum physics is a salutary, because a true correction of a persistent mistake of modern physics.
Perhaps the most startling and telling evidence is provided by two outstanding formulators of relativity physics that this proposed rejection is worthy of full consideration as warranted and justified by the evidence and in the interest of the search for physical truth. They are: Herman Minkowski and Albert Einstein. Also, with few exceptions, such as Paul Dirac, Richard Feynman, Edward Fredkin, etc., quantum physicists have contributed much to perpetuating the continuum mistake by stubbornly refusing even to consider whether motion, space and time are as quantized as light, electron and matter.

Unlike Einstein, Minkowski(1) anticipated and acknowledged that the invariances of the equations of Newtonian mechanics imply the scalar motion of physical locations. He remarked that only by disdaining logic may we with untroubled minds "overcome the difficulty of never being able to decide, from physical phenomena, whether space, which is supposed to be stationary, may not after all be in a state of uniform translation." In this state of uncertainty after the foregoing remark Minkowski chose to assume tentatively that space may be at rest, immovable, stationary. He thus missed discovering the physical fact of space-time progression, affirmed by the Reciprocal System, probably because of his allegiance to the four-dimensional continuum postulate.

However, in his later years Einstein(2) himself came to doubt and question his continuum postulate with respect to space-time. "I am tending to the belief that it is impossible to advance further with the continuum theory."

The continuum postulate implies that space and time are infinitely divisible rather than finitely divisible. On the contrary, the Reciprocal System, by reason of its definition of motion as a reciprocal relation between space and time, implies that the physical universe as a whole and in all its parts, is finitely divisible, including motion, space and time.

The foregoing report discloses briefly some of the way that the Reciprocal System constitutes a general revaluation and progressive unification of the science of physics.

In relation to modern academic physics, investigated and taught in the universities, colleges and schools of the U.S.A. and the U.S.S.R., the Reciprocal System of physics is 'the new kid on the block' that has been growing up perhaps too quietly during more than a quarter century.

After his unsuccessful attempt to unite theoretically the phenomena of electromagnetism with those of gravitation, Einstein issued two major memorable challenges concerning how to unify physics. The two challenges are repeated hereafter. Let all who desire to share in the creation of a true revalued and unified physics take up these challenges; investigate and carefully examine our ISUS claim that the Reciprocal System of physics, originated and authored by Dewey B. Larson, is the most general and only adequate physical theory presently available that can respond and has responded effectively to begin meeting the following two challenges of Einstein:
1. "From the very beginning there has always been present
the attempt to find a unifying theoretical basis for all these single
sciences, consisting of a minimum of concepts and fundamental relation-
ships, from which all the concepts and relationships of the single
disciplines might be derived by logical process. This is what we
mean by the search for a foundation of the whole of physics..... Some
physicists, among them myself, cannot believe that we must abandon,
actually and forever, the idea of direct representation of physical
reality in space and time." (3)

2. "From the quantum phenomenon it appears to follow with
certainty that a finite system of finite energy can be completely
described by a finite set of numbers(quantum numbers). This does not
seem to be in accordance with a continuum theory, and must lead to an
attempt to find a purely algebraic theory for the description of reality:
But nobody knows how to obtain the basis for such a theory." (4)

Oewey B. Larson has found and reported how to obtain the
basis of just such a theory and calls it the Reciprocal System. (5)

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Outline of the Deductive Development of the Theory of the Universe of Motion

Conceptual Fundamentals

This theory introduces two new concepts into physical science: the concept of physical location, and the concept of scalar motion.

The nature of these new concepts can be illustrated by a consideration of the "expansion of the universe" that is postulated in the astronomers' latest theory of the recession of the distant galaxies. As explained by Paul Davies, "The expanding universe is not the motion of the galaxies through space...but is the steady expansion of space." Since the galaxies, on this basis, are not moving through space, each galaxy remains in what we will call a physical location in space. This physical location is moving outward in the context of the stationary spatial reference system, carrying the galaxy with it. While only the galactic motion can be observed, all physical locations necessarily participate in the outward motion, irrespective of whether or not they are occupied by galaxies.

Inasmuch as all galaxies, and the physical locations that they occupy, are moving uniformly outward from all others, each is moving in all directions. A motion distributed uniformly over all directions has no specific, or inherent, direction; that is, it is scalar. Thus the expansion can be described as a positive scalar motion of all physical locations (represented as outward in the spatial reference system). Our new theory defines a universe of motion in which scalar motion of physical locations is not a unique phenomenon confined to the expansion recognized by the astronomers, but is the basic form of the motion from which all physical phenomena are derived.

Basic Premises

The basic premises of the theory consist of certain preliminary assumptions, a postulate, and a definition.
A. In order to make science possible, some preliminary assumptions of a philosophical nature must be made. We assume that the universe is rational, that the same physical laws apply throughout the universe, that the results of experiments are reproducible, etc. These assumptions are accepted by scientists as a condition of becoming scientists, and are not usually mentioned in purely scientific discourse.
B. We assume that the generally accepted principles of mathematics, to the extent that they will be used in this development, are valid.
C. We postulate that the universe is composed entirely of one component, motion, existing in three dimensions and in discrete units.
D. We define motion as the relation between two uniformly progressing reciprocal quantities, space and time.

Deductive Development

Each of the following statements is a deduction from the postulate and the preceding statements. The objective of the deductive development is to determine what can exist in the theoretical universe defined by the premises of the theory. In most cases it will be evident that the entity or phenomenon that theoretically can exist is identical with one that does exist in the actual physical universe, and there are no definite conflicts in any case. To the extent that the outline has been carried, the theoretical universe is thus a correct representation of the observed physical universe.
1. Motion, as defined, is measured in terms of speed, the scalar magnitude of the relation between space and time.
2. By reason of the postulated reciprocal relation between space and time, each individual unit of motion is a relation between one unit of space and one unit of time, a motion at unit speed.
3. We define the primary motions as those which can exist independently of the existence of motions of other types.
4. According to our definition, motion involves a uniform progression of both space and time. We define a point, or segment, of the line of the space progression at a given time as a physical location in space.

5. Inasmuch as we postulate that the universe is three-dimensional, we may represent the scalar progression of space by a line in a stationary three-dimensional spatial reference system, measuring the corresponding progression of time by means of a scalar device, a clock. In this reference system, a positive motion is represented as outward from a reference point, and a negative motion as inward. The terms “outward” and “inward” will be used in preference to “positive” and “negative” to avoid possible confusion with another use of the latter set of terms.

6. The initial point of the progression of an individual unit of motion is zero. As the distance between two points cannot be less than zero, it follows that the primary motions are necessarily outward: increasing the distances relative to the initial points.

7. The progression is scalar. It is simply outward without any inherent direction. Motion outward from the initial point of the progression is therefore outward from all points of reference.

8. From the foregoing, any two physical locations are progressing outward from each other at unit speed; that is, their separation is increasing at the rate of one unit of space per unit of time.

9. We define the natural system of reference as that system in which the primary motions do not cause any change in the positions of physical locations.

10. From (8), it follows that the natural system of reference is progressing outward at unit speed relative to the spatial system of reference.

11. We identify unit speed as the speed of light.
   (The various features of the theoretical universe emerge from the deductive development without labels. It is therefore necessary to identify the physical phenomena to which they correspond. The correlation is usually quite evident, as in this instance. In any event, it is self-verifying, as any error would quickly show up as a discrepancy in the subsequent development.)

12. Since the postulate specifies that nothing exists other than discrete units of motion, and the natural reference system is a direct consequence of the existence of the primary units, this reference system is the framework, or background, of the universe of motion, and does not represent any activity in that universe. The natural system of reference, as defined, is therefore the physical zero, or datum level, from which all physical activity extends.

13. We identify the outward progression of the natural reference system relative to the stationary system of reference as the “expansion of the universe” reported by the astronomers.

At this point we have arrived, by deduction from our basic premises, at an explanation of the general background of the physical universe that is essentially in agreement with the astronomers’ assumption. (Our derivation leads to a uniform outward speed, rather than a speed that varies with the distance, as produced by the kind of an expansion assumed by the astronomers, but this difference is easily accounted for, because there is a known force, gravitation, that acts against the outward motion, with a magnitude varying as an inverse function of the distance.)

The advantage of deriving this explanation of the universal background from a set of general premises, rather than merely assuming its existence, lies in the fact that further deductions can be made from these same premises. Instead of a single process involving the universe as a whole, the explanation that we have just derived from the premises of the theory of the universe of motion identifies the expansion as the result of outward scalar motions of individual physical locations. This opens the way for the existence of other scalar motions of the same physical locations, independent motions, as we will call them.
14. Once the primary units of motion are in existence, units of inward scalar motion can be superimposed on the outward units. The net magnitude of two such motions is zero, and the combination therefore has no physical properties in a spatial reference system, but it constitutes a base upon which other combinations can be formed.

15. As stated in our definition, motion is a progression. Thus it is not a succession of jumps, even though it exists only in discrete units. There is progression within the units, as well as unit by unit, simply because the unit is a unit of motion (progression). The significance of the discrete unit postulate is that discontinuity can occur only between units, not within a unit. But the various stages of the progression within a unit can be identified.

16. The continuity of the progression within the units enables the existence of another type of scalar motion of physical locations. This is a motion in which there is a continuous and uniform change from outward to inward and vice versa; that is, a simple harmonic motion. At this stage of the development only continuous processes are possible, but a continuous change from outward to inward and the inverse is just as permanent as a continuous outward or inward motion.

17. In the two-unit complete cycle of the simple harmonic motion the net change of the spatial position of the physical location is zero. As represented in the spatial reference system, the two-unit combination remains stationary in the dimension of the motion.

18. From (10), it follows that the physical location occupied by that motion combination (17) moves outward at the speed of light in a second dimension.

19. The path of the combined progressions then takes the form of a sine curve.

20. We identify such scalar motion combinations as photons. A system of photons is electromagnetic radiation.

(This derivation shows why radiation has the properties of a wave as well as those of particles. It is composed of particles (discrete units), but the motion (progression) of these particles is wave-like.)

21. The outward movement of physical locations due to the motion of the natural reference system relative to the stationary spatial system carries with it not only the photons but also any other physical entities that occupy such locations.

(In addition to the photons, there are certain other massless particles that have no known motion-producing mechanism, and must therefore remain stationary in the natural system of reference, unless acted upon by some outside agency. There are also objects—very distant galaxies—that do have a motion-producing mechanism (gravitation), but are so far away that the gravitational motion toward our location has been reduced to negligible levels. All of these objects behave exactly as required by the theory; that is, they move outward relative to the spatial reference system at the speed of light.)

22. There is no inherent relation between the time magnitudes involved in the two different dimensions of the photon motion. One is the time of the progression of the natural reference system. The other is independent of this progression. Thus the frequency of the radiation, the number of cycles per unit of the linear progression, can take any value, subject only to the capability of the process whereby the radiation is produced.

23. The postulate that the universe is three-dimensional means that three independent magnitudes are required for a complete definition of each of its basic quantities. Thus three dimensions of scalar motion are possible. In order to distinguish these purely mathematical dimensions of motion from the dimensions of space, which are geometrical, as well as mathematical, in the context of a spatial reference system, we will refer to them as scalar dimensions.

24. Only one dimension of motion can be represented in a three-dimensional spatial system of reference. Each motion shown in such a system is represented by a vector, a one-dimensional quantity having both magnitude and direction, and any combination of such motions can be represented by the vector sum, which is likewise one-dimensional.

25. A scalar motion has magnitude only, and no inherent spatial direction. It therefore has to be given a direction in order to be represented in a spatial reference system.
26. To give directions to the members of a system of scalar motions, it is necessary to couple some one of the moving locations to the stationary reference system in such a way that it is represented as motionless. The directions imputed to the other motions of the system are then determined by their relation to this assumed motionless reference point. (For example, if we designate our galaxy as A, the direction of the motion of distant galaxy X, as we see it, is AX. But observers in galaxy B see galaxy X as moving in a very different direction BX because they use a different reference point. This contrasts sharply with the directions of the motions of our ordinary experience—vectorial motions—which are the same regardless of the location from which they are being observed. In this vectorial case the direction is the property of the motion.)

27. From (25) and (26), it follows that the factors which determine the direction of a scalar motion are independent of those which determine the magnitude. The direction is a result of the nature and location of the coupling of the motion to the reference system. It may be a constant direction, as in the outward travel of the photons of radiation, or it may be a rotationally distributed direction, one that is continually changing.

28. From (27), the translational motion of a photon, instead of being unidirectional, as in (18), may be rotationally distributed in the reference system. The motion thus distributed, which we will call a scalar rotation, is a linear progression with a constant magnitude but a continually changing direction.

29. From (23), scalar rotation can take place coincidentally in three dimensions. From (24), however, it can be represented in a spatial reference system only on a one-dimensional basis. The magnitudes of the motions in the three dimensions are additive, and can be represented as a total, but the directions of the different distributions cannot be combined. The representation in the reference system therefore indicates the correct magnitude (speed) of the three-dimensional motion, but shows only the directions applicable to the one dimension of the motion that is parallel to the dimension of the reference system.

30. In the absence of any specific restrictive factor, rotationally distributed scalar motions are distributed over all spatial directions. The magnitude of such a motion toward a point in any given direction is therefore inversely proportional to the second power of the intervening distance.

(This is the origin of the "inverse square law.")

31. Inasmuch as the natural reference system progresses outward at unit speed relative to the spatial reference system, no further increment of outward speed is possible, because of the discrete unit postulate. The net total magnitude of a rotationally distributed motion must therefore be inward.

32. If the scalar rotation is less than three-dimensional, the basic photon will move outward as radiation in a vacant dimension, and the motion combination will disintegrate. In order to be stable, the rotationally distributed motion must therefore be three-dimensional.

33. The three-dimensional combination of vibrational and rotationally distributed motions appears in the reference system as an identifiable object moving inward in all directions. We identify such an object as an atom, or a sub-atomic particle. Collectively, the atoms and particles constitute matter.

34. We identify mass as a measure of the net magnitude of the rotationally distributed scalar motions of matter. We identify the observable inward-directed effects of this motion as gravitation. The magnitude of the gravitational effect is therefore directly proportional to the mass.

35. The inward gravitational motion of the atoms results in the formation of material aggregates of various sizes. In these aggregates the atomic motions (and masses) are independent and additive.

36. The outward motion due to the progression of the natural reference system always takes place at unit speed, regardless of the size of the aggregate or the distance that is involved (8). The net relative motion of any two gravitating objects with no additional motions is the algebraic sum of the unit outward motion and the inward gravitational motion.
37. At relatively short distances gravitation predominates, and the net motion is inward. Since the gravitational motion decreases with distance, while the outward progression remains constant, the opposing motions reach equality at some greater distance, which we will call the gravitational limit. Beyond this distance the net motion is outward, increasing with distance, and approaching unity (the speed of light) at extreme distances.

(This theoretical pattern of net speeds is verified observationally by measurements of the Doppler shift in the radiation received from the distant galaxies.)

38. The conventional spatial reference system in conjunction with a clock for measuring time represents a physical situation in which the space component of the progression of the natural reference system is neutralized by gravitation, while the time component proceeds at the full normal rate. In this reference system, the space progression, as indicated by the motion of a massless object, appears as a one-dimensional motion through the three-dimensional space.

39. Since we postulate a reciprocal relation between space and time, each of the deductions expressed in the foregoing numbered statements is also valid in the inverse form; that is, with space and time interchanged.

40. We identify the time component of the progression of the natural reference system as the "flow of time" registered on a clock.

41. It follows from (39) that motion in time takes place in three dimensions, in the same manner as motion in space. The time component of the progression of the natural reference system (clock time) is a one-dimensional outward motion through a stationary three-dimensional temporal system of reference, in which independent motions at different speeds and in different directions also take place.

42. Motion at unit speed causes unit change of position in both the spatial reference system and the temporal reference system. It is a motion in time as well as motion in space.

43. When motion takes place in time, the constant progression analogous to clock time is in space, and would be measured by some kind of a "space clock." But the rates of progression are the same, one unit of space and one unit of time per unit of motion. Thus the measurements relative to the "space clock" are identical with those relative to a clock that registers time, if expressed in the same units.

44. As noted in (2), the space–time ratio in the units of motion is fixed at unity by the reciprocal postulate. It follows that a reduction of speed—as, for instance, by an increase in the distance between gravitating objects—does not alter the ratio of space to time in the effective motion; it reduces the proportion of the total motion that is effective in increasing the spatial separation of the objects. This effective portion of the motion increases the separation by $x$ units of space per unit of clock time, where $x$ is a fraction, and because of the fixed relation between space and time in the individual units, also increases the separation in time by $x$ units.

45. Where only one motion is involved, the $x$ units of time are coincident with the time progression, and do not enter separately into the determination of the speed. But if two objects are both moving, their relative position in space may change at a rate exceeding unity by some quantity $x$. From (44), the change in the separation in time then also exceeds unity (clock time) by $x$. The speed is $(1+x)/(1+x) = 1$. Thus, if at least one of the two objects is a photon, or other object moving with unit speed, the relative speed is always unity. This agrees with statement (8).

(This is the explanation of the observed fact that the speed of light is independent of the reference system.)

46. Where motion at a speed greater than unity (motion in time) takes place under conditions that preclude actual changes of position in time, this motion acts as a modifier of the spatial motion; that is, as a motion in equivalent space. The spatial equivalent of a temporal magnitude $x$ is $1/x$.

47. Where scalar motion in space is three-dimensional, the speed in one of the dimensions may be greater than unity. But, as indicated in (29), the effective magnitude of a combination of motions is the net total of the scalar speeds, and because there are two low speed dimensions the net speed is less than unity. In this case, then, the motion in the high speed dimension
acts as a motion in equivalent space, and modifies the magnitude of the change of position in space, rather than causing a change of position in time.

48. We identify the material atoms with scalar rotation in equivalent space as the atoms of the electronegative elements.

49. We also encounter motion in equivalent space within the units of space. Here no modification of the normal progression of space can take place, because of the discrete unit postulate, but motion can take place in time. Inasmuch as this motion within the spatial unit does not alter the position in time of the unit of motion as a whole, the changes within the unit that result from the motion in time are observed in equivalent space rather than in actual time.

50. The existence of a spatial unit within which motion has properties quite different from those prevailing in the region outside the unit explains the discontinuity in physical properties at very short distances that has led to the development of the quantum theory.

51. The progression of the natural reference system relative to the spatial system of reference is always outward, but, as indicated in (10), the natural datum level, or physical zero, is at unity, rather than at the mathematical zero. Within a unit of space, outward from unity is toward zero. It follows that the progression within the unit, as seen in the spatial reference system, is inward.

52. From (31), the gravitational motion is inward. This direction, too, is inward relative to the natural datum, unity. Within a unit of space it is therefore outward in the spatial reference system.

53. No stable equilibrium between the atoms or aggregates of matter is possible at separations greater than one unit of space. The inward and outward motions are equal at the gravitational limit, but this equilibrium is unstable, as the change in separation due to any unbalance between the opposing motions increases the unbalance. Within a unit of space, where the directions of the basic motions, as seen in the spatial reference system, are reversed, the effect of a change in separation between atoms due to an unbalance of the opposing motions reduces the unbalance, and eventually results in the establishment of a stable equilibrium.

54. The positional equilibrium in equivalent space that is established within a unit of space accounts for the existence of the crystalline state of matter.

THE OUTLINE OF THE DEDUCTIVE DEVELOPMENT OF THE THEORY OF THE UNIVERSE OF MOTION can be most helpful to anyone interested in learning about the Reciprocal System of physics. It is not, however, a substitute for reading and studying the books listed on pages 30 and 31.
Outline of the Deductive Development of the
Theory of the Universe of Motion

Section Two

In the first section of this outline the general characteristics of the motion of which
the universe is constructed, together with additional information about the various
forms and manifestations of that motion, were deduced from the postulates of the
theory. With the benefit of this information we are now in a position to develop the
details of the individual phenomena in the various physical fields. We will begin by
identifying the possible combinations of scalar rotations (atoms and sub-atomic
particles) and their individual characteristics, including the properties that are
represented in the periodic table of the elements. As in Section I, each statement is
a deduction from the postulates of the theory or from one or more of the numbered
statements earlier in the outline.

Deductive Development—Continued

55. As noted in (12), the primary motions are the framework, or background, of
the universe of motion, and do not constitute any physical activity in that
universe. Physical activity—that is, meaningful change—in the physical
universe results from motions superimposed on the primary motions. We
will now want to examine the general considerations involved in such
combinations of motions. First we note that there are no restrictions on the
combination of motions of the same kind in different dimensions. For
instance, rotations in different scalar dimensions can combine by rotating
around the same central point.

56. The normal progression, both of the natural reference system and of the added
motions, is a continuous succession (rather than a combination) of units of
the same kind. As soon as one unit of the progression ends, another one
begins. But the units in a succession do not necessarily have to be identical.
For example, the two-unit cycle of simple harmonic motion has the same
initial and final points as a two-unit segment of unidirectional linear motion,
and therefore fits into the linear progression. We may generalize this
situation, and say that compatible units of a different kind of motion can
replace units in the normal progression.

57. It follows from (44) and (56) that compatible units of motion added in a
dimension of an existing motion will merge with this previously existing
motion, merely altering its magnitude. Formation of a compound motion, a combination that retains the distinction between its components, therefore requires the addition of an incompatible motion.

58. Except where outside forces intervene, the added motion must oppose the original in order to achieve stability. Otherwise there is nothing to hold the components together. The opposition reduces the net total magnitude of the motion, and since low numbers are more probable than higher numbers, this makes the combination more probable than independent existence of the components.

59. A numerical constraint on the combinations is imposed by the discrete unit postulate. Addition of two inward units of motion to the unit outward progression of the natural reference system produces one net inward unit, the limiting value. The maximum linear addition to a motion combination is thus two units.

60. Where the motion is n-dimensional, the maximum is two units in each dimension, a total of $2^n$ units.

61. Scalar motion is measured in terms of speed (or inverse speed). As we have seen, however, the natural datum level is at unity, not at zero. The natural speed magnitudes are therefore the deviations from unity. A deviation downward from unity, $\frac{1}{2}$, to $\frac{1}{4}$ has the same natural magnitude, $n-1$ units, as a deviation upward from $\frac{1}{2}$ to $\frac{3}{2}$. In dealing with the basic scalar motions we will therefore use the deviations rather than the speeds measured from zero. We will call these deviations "speed displacements," abbreviated to "displacements" where the meaning is clear.

62. Where quantities are reciprocally related, the choice as to which should be called "positive" is purely arbitrary. It will, however, be convenient to refer to the phenomena of our ordinary experience as positive. Since the speeds in our local environment are below unity, we will call a decrease in speed from $\frac{3}{2}$ to $\frac{1}{2}$ a positive displacement of n-m units, and an increase in speed from $\frac{3}{2}$ to $\frac{1}{2}$ a negative displacement of n-m units.

63. The photon, as defined in (20), is a vibrating unit that moves outward translationally at the speed of light. As noted in (22), the frequency of the vibration is limited only by the capacity of the production process. The atom defined in (33) is likewise a vibrating unit with an added linear (scalar) motion, but in this case the linear motion is rotationally distributed over all directions, and the rotational character of the added motion imposes some restrictions on the numerical magnitudes.

64. A one-dimensional scalar rotation (28) of the linear vibrational unit generates a two-dimensional figure, a disk. A scalar rotation of the disk around another axis generates a three-dimensional figure, a sphere. This exhausts the
available dimensions. The basic scalar rotation of the atom is therefore two-dimensional.

65. While no further rotation of the same kind (inward) is possible, the entire combination of motions can be given an outward scalar rotation around the third axis. This conforms to the requirements of (57)—it is a one-dimensional addition to a two-dimensional motion—and those of (58)—it is an outward motion added to an inward motion.

66. The vibrational speed displacement of the basic photon may be either positive (less than unity) or negative (greater than unity). For the present we will consider only those combinations in which the basic vibrational displacement is negative. We will call this system of combinations the material system. The system based on the positive photon speed will be called the cosmic system.

67. From (58) we find that where the vibrational displacement is negative the net total rotational displacement must be positive.

68. Where a one-unit positive rotational displacement is applied to a one-unit negative vibration, the net total speed displacement (a scalar quantity) is zero. This combination of motions has no effective deviation from unit speed (the physical datum), and therefore has no observable physical properties. We will call it the rotational base of the material system. A similar combination with positive vibration and negative rotation is the rotational base of the cosmic system.

69. For convenience we will represent the different motion combinations of this type by sets of numbers representing the speed displacements in the three scalar dimensions. We will specify only the effective magnitudes of the displacements, and we will use the letters M and C to indicate whether the combination belongs to the material or the cosmic system. The displacement magnitudes will be expressed in the form M a-b-c, where a and b are the effective displacements of the two-dimensional rotation, which we will call the magnetic rotation, and c is the effective displacement of the one-dimensional, or electric, rotation. Negative displacements will be enclosed in parentheses. On this basis the material rotational base is M 0-0-0, and the cosmic rotational base is C 0-0-0.

70. To the material rotational base we may add a unit of positive electric rotational displacement (that is, one unit of effective one-dimensional scalar rotation), producing M 0-0-1, which we identify as the positron. Or we may add a unit of negative electric displacement, producing M 0-0-(1), which we identify as the electron. These are the first members of a series of combinations that we identify as the sub-atomic particles of the material system.
71. Addition of a magnetic (two-dimensional) displacement unit to the material rotational base produces \( M^{1\mathcal{H}_1-1\mathcal{H}_0} \). There are no half units, but a magnetic unit occupies both dimensions, and we therefore credit half to each. We identify this combination as the massless neutron, a particle not currently distinguished observationally from the other massless particles.

72. At the unit level the magnetic and electric displacement units are numerically equal; that is \( 1^2 = 1 \). Addition of a unit of negative electric displacement to the massless neutron therefore produces a combination with a net total rotational displacement of zero. We identify this combination, \( M^{1\mathcal{H}_1-1\mathcal{H}_0-1} \), as the neutrino.

73. Geometrical considerations indicate that two photons in different scalar dimensions can rotate around the same central point without interference as long as the rotational speeds are the same, forming a double structure. Any rotational combination with two or more net units of rotational displacement can take the double structure.

74. This introduces a new situation: the existence of competing structures. The aim of our development of the consequences of the postulates of the theory of the universe of motion is to determine what can exist in that theoretical universe. Thus far we have been able to identify an existing feature of the observed physical universe corresponding to each of the entities and phenomena that we have found can exist in the theoretical universe. From now on we will have to consider the possibility that the existence of certain structures may preclude the existence of competing structures. The result of the competition in each case is a matter of relative probability. Where the probabilities are nearly equal, the structures may coexist. Otherwise, the structure that is most probable, in a given set of circumstances, is the only one that exists under those circumstances, other than momentarily.

75. The double rotational structure is more compact, and therefore more resistant to disruption than the equivalent single structures. This gives it a sufficient margin of probability to preclude the existence of any significant quantity of the competing single structures (unless external forces intervene).

76. We identify the double rotational combinations as atoms.

77. The combination \( M^{1\mathcal{H}_1-1\mathcal{H}_0-1} \) has a total net rotational displacement of 2, and is excluded by (75). The two-unit magnetic structure \( M^{1\mathcal{H}_1-1\mathcal{H}_0} \), and its positive derivative \( M^{1\mathcal{H}_1-1\mathcal{H}_1} \), which have net displacements of 2 and 3 respectively, are likewise excluded for the same reason. But the negative derivative \( M^{1\mathcal{H}_1-1\mathcal{H}_1-1} \) can exist as a particle, since its net displacement is only one unit. We identify it as the proton.

78. A double rotating system with only one net unit of displacement can be formed by a combination of a rotation of the proton type, \( M^{1\mathcal{H}_1-1\mathcal{H}_1-1} \), and 

17.1-15
rotation of the neutrino type, M $1^{1}{h}-1^{1}{h}$-(1). We identify this combination, M $1^{1}{h}-1^{1}{h}$-(2), as the mass 1 isotope of hydrogen. Since the second rotation has a net displacement of zero, the probability difference between this double structure and the equivalent single structure, the proton, is small. These structures therefore coexist under appropriate conditions.

79. If the cosmic neutrino type of rotation, C $1^{1}{h}$-(1)-1, is substituted for the material neutrino type of rotation in this double structure, the combination has net total displacements M $1^{1}{h}$-0. We identify it as the neutron.

80. Because of some significant differences between atoms and sub-atomic particles we will use a different system of notation in representing the atomic combinations. This notation will show the total speed displacement in each dimension (including the initial non-effective unit), will use a double unit, and will omit the letter symbols M and C, which are unnecessary when the initial unit is included.

81. To convert the rotational displacement of the mass 1 hydrogen atom from the sub-atomic notation, M $1^{1}{h}$-1-(2), to the atomic notation, we divide by 2, obtaining $1^{1}{h}$-(1), and then add the initial unit, the result being $1^{1}{h}$-1-(1). The net effective displacement, in terms of the double unit is $1^{1}{h}$.

82. An additional single unit of displacement brings the total to 2-1-(1). We identify this combination as the mass 2 isotope of hydrogen. This is the first of the complete two-rotation combinations (those with effective rotational displacement in both rotations). It is therefore given the atomic number 1.

83. One positive displacement unit (atomic basis) added to mass 2 hydrogen, 2-1-(1), neutralizes the negative electric rotation, and produces 2-1-0. We identify this combination as helium, atomic number 2.

84. Successive additions of units of positive electric displacement, or the equivalent, to the helium atom, produce the other members of a series of atomic combinations, the series of chemical elements.

85. Inasmuch as the two-dimensional (magnetic) rotation is the basic rotation of the atom, as indicated in (64), the magnetic rotation takes precedence over the electric rotation where both are possible. It follows that some of the additions to the atomic series involve magnetic displacement in lieu of electric displacement. If we let n represent the number of double magnetic units of displacement (units of atomic number), the corresponding number of single magnetic units is 2n. When acting jointly in a motion combination, x magnetic units are equivalent to $x^2$ one-dimensional (electric) units. The 2n single magnetic units are therefore equivalent to 4n² single electric units. Dividing by 2 to convert to the double units of the atomic system, we find that n magnetic displacement units in an atom are equivalent to 2n² electric displacement units.
86. Successive additions of magnetic displacement go alternately to the two magnetic dimensions, since small numbers are more probable than larger numbers. One magnetic unit added to helium, 2-1-0, produces 2-2-0, which we identify as neon.

87. Helium already has one effective magnetic displacement unit in each magnetic dimension. Thus the increase to 2-2-0 involves a second unit in one of the dimensions. From (85) this second magnetic unit is equivalent to $2 \times 2^2 = 8$ electric units. It should be noted that this is the electric equivalent of the second unit, not of the sum of the two units. The reason is that the progression in the region inside unit space takes place in time only, and the succession of values is $\frac{1}{n}, \frac{1}{n}, \frac{1}{n}... \frac{1}{n}$. The number of time units involved is $1, 2, 3... n$. Thus the value 2 applies to the second unit only, not to the total of the first two units.

88. The first four additions of electric displacement units to helium produce the following series of elements:

<table>
<thead>
<tr>
<th>Number</th>
<th>Displacements</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2-1-1</td>
<td>lithium</td>
</tr>
<tr>
<td>4</td>
<td>2-1-2</td>
<td>beryllium</td>
</tr>
<tr>
<td>5</td>
<td>2-1-3</td>
<td>boron</td>
</tr>
<tr>
<td>6</td>
<td>2-1-4</td>
<td>carbon</td>
</tr>
</tbody>
</table>

89. As long as the magnetic displacement, the major component of the atomic rotation, is positive, the electric displacement, the minor component, can be negative without violating the requirement (67) that the net total rotational displacement of a material atom must be positive. Carbon can therefore exist with the alternate displacements 2-2-(4). Here the neon type magnetic rotation with net displacement 10 is combined with 4 negative electric displacement units, for a net positive total of 6, the same as the net displacement of the 2-1-4 combination. The probability difference between these two combinations is small, and both are found observationally. Beyond carbon the probabilities favor the smaller negative electric displacement. The normal forms of the next three elements are therefore:

<table>
<thead>
<tr>
<th>Number</th>
<th>Displacements</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-2-(3)</td>
<td>nitrogen</td>
</tr>
<tr>
<td>8</td>
<td>2-2-(2)</td>
<td>oxygen</td>
</tr>
<tr>
<td>9</td>
<td>2-2-(1)</td>
<td>fluorine</td>
</tr>
</tbody>
</table>

90. Another group of eight elements follows, bringing the second magnetic dimension up to two effective displacement units at argon, 3-2-0. A further one-unit increase raises the effective displacement level to 3 units in one of the
magnetic dimensions. The third magnetic unit is equivalent to \(2 \times 3^2 = 18\) electric units. Two 18-unit groups of elements therefore follow, increasing the displacements first to 3-3-0 (krypton, element 36) and then to 4-3-0 (xenon, element 54). Finally, there are two groups of \(2 \times 4^2 = 32\) elements each. The first of these carries the series to 4-4-0 (radon, element 86). The second would reach 5-4-0 (element 118), but here another factor intervenes.

91. From (60), the maximum three-dimensional scalar rotation has a magnitude of eight units. The significance of this is that at a speed displacement of eight net units the rotationally distributed progression reaches the same scalar location, the end of the spatial unit, that a linear progression reaches in the same time interval. The next unit of the progression then begins without any limitation on the nature of the coupling to the reference system. In the absence of such a limitation, the motion takes the most probable form, a unidirectional linear progression. This means that at element 118, where the rotational displacements are 5-4-0, and there are a total of eight effective magnetic displacement units (four in each dimension), the rotational combination of motions disintegrates and reverts to the linear basis. The series of chemical elements therefore terminates at element 117.

92. Because the succession of speed displacements follows the definite pattern outlined in (84) to (91), each element can be characterized by a unique set of numbers (subject to some modification under special circumstances). These are the values that enter into the various equations which determine the magnitudes of the different properties of the elements and their combinations.

93. Each successive element in the atomic series adds one double unit of positive three-dimensional rotational speed displacement to the combination of motions (the atom). In (34), three-dimensional speed displacement, positive in the material system, was identified as mass. The atomic mass is expressed in terms of atomic weight, the unit of which is half the rotational mass corresponding to the atomic number. The rotational mass of an atom of atomic number \(n\) is thus \(2n\) atomic weight units.

94. When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called "dimensions." Since we postulate that the physical universe is composed entirely of units of motion, a relation between space and time, the dimensions of all physical quantities (in this sense of the term) can be expressed in terms of space and time only. From (34), the three-dimensional gravitational motion of the atoms of matter has the dimensions \(s^1t^1\), where \(s\) and \(t\) are space and time respectively.

95. In order to change the spatial position of an atom, or an aggregate of atoms, an outward motion must be applied against the inward scalar motion of the atom. That inherent inward motion then acts as a resistance to the applied
outward motion. In this capacity as a resistance, or inertia, the mass acts as the inverse of a three-dimensional speed, with the dimensions $t^1/s^3$. In practice, gravitation is measured in terms of force, a derivative of inertia, rather than in terms of speed. Both the gravitational and the inertial relations are therefore expressed in terms of the $t^1/s^3$ magnitudes.

(This explains why measurements of the "gravitational mass" and the "inertial mass" arrive at the same result.)

96. Having established the space-time dimensions of mass, we can now define the dimensions of the other physical quantities of the mechanical system. The product of mass and speed, momentum, is $t^1/s^3 \times s/t = t^2/s^2$. The product of mass and the second power of speed, energy, is $t^1/s^3 \times s^2/t^2 = t/s$.

Acceleration, the time rate of change of speed, is $s/t \times 1/t = s/t^2$. Force, the product of mass and acceleration, is $t^1/s^3 \times s/t^2 = t/s^2$.

97. Physical phenomena with the same dimensions have the same general status in physical interactions, and are interchangeable. For example, all phenomena with the dimensions $t/s$ are equivalent to energy, and can be converted to kinetic energy by appropriate processes.
INTRODUCTION

According to the Reciprocal System the main energy generation process in stars is by way of thermal destruction of the atoms the elements in the stellar core.

"....both the thermal energy of the matter in the star and its ionization energy are space displacements, and when the total of these space displacements reaches equality with one of the rotational time displacements of an atom, the opposite displacements neutralize each other, and the rotation reverts to the linear basis. In other words, both the ionization and a portion of the matter of the atoms are converted into kinetic energy. ..."

"....Inasmuch as the entire structure ... is fluid, the heavy elements make their way to the center. As the temperature in the central regions rises, successively lighter elements reach their destructive limits and are converted to energy;"[1]

THE DESTRUCTIVE LIMIT

The destructive limit $T_d$, that is, the temperature at which the neutralization of one of the two-dimensional displacements of the atom takes place can be worked out as follows. A temperature $T$ in Kelvin, when expressed in the natural units is given by

$$\frac{T}{T_{\text{nat}}}$$ \hspace{1cm} (1)

where $T_{\text{nat}}$ is the natural unit of temperature in the time-space region (that is, the three-dimensional spatial reference frame) expressed in the conventional units $^2$ as

$$T_{\text{nat}} = 7.20423 \times 10^{12} \text{ K}$$ \hspace{1cm} (2)

Since speed displacement is the deviation of the speed from the natural datum—the natural datum in the universe of motion being unity—the space displacement corresponding to a temperature $T$ is

$$\left(\frac{T}{T_{\text{nat}}} - 1\right)$$ \hspace{1cm} (3)

This, therefore, is the space displacement available per each rotational unit of the atom when it is at a temperature of $T$ Kelvin. If the net number of rotational units (the atomic number) of the atom is $Z$, the total space displacement available due to the thermal energy is

$$Z \times \left(\frac{T}{T_{\text{nat}}} - 1\right)$$ \hspace{1cm} (4)

The temperature of the atom is a linear (vibratory) motion in the time-space region while the rotational motion that constitutes the atom is in the time region (inside unit space). The total number of equipossible orientations for a unit of linear motion in the time-space region is shown to be 8 $^3$. As such, the portion
of the space displacement of the temperature that becomes effective in the time region is

\[ Z \times \left( \frac{T}{T_{\text{nat}}} \right) - 1 \right) / 8 \]  

(5)

Thermal destruction of the atom implies the neutralization of one of its two-dimensional time displacement units since the basic rotation constituting an atom is two-dimensional. The one-dimensional equivalent of a two-dimensional displacement of magnitude \( n \) being \( 2 \times n^2 \), where the atomic displacements are \( a - b - c \), the time displacement units need to be neutralized would be either \( 2 \times (a - 1)^2 \) or \( 2 \times b^2 \). Thus, we have, at the destructive limit \( T_d \),

\[ 2 \times n^2 = Z \times \left( \frac{T_d}{T_{\text{nat}}} \right) - 1 \right) / 8 \]  

(6)

where \( n \) = larger of \((a - 1)\) and \( b \).  

(7)

It must be pointed out, at this juncture, that though the space displacement of the electric ionization does add to that of the thermal motion in neutralizing a unit of the magnetic time displacement of the atom, its contribution is comparatively small—amounting to not more than a fraction of a percent of the temperature displacement. Hence, no appreciable error will be introduced by dropping the ionization displacement from consideration at the present stage.

In fig. 1 are shown plotted the values of the thermal destructive limit of the elements against \( Z \). As can be seen, this temperature increases as the atomic number decreases. But the most conspicuous feature of the curve is that, instead of being monotonous, it dips at several locations where there is a change in the displacement of the atom in one of the magnetic dimensions. These dips, occurring respectively at \( Z = 70 \), 27 and 6 are of paramount significance in determining the course of the stellar evolution as we will presently see.

THE INTRINSIC VARIABLES

Under normal stellar conditions, where there is no severe large-scale turbulence, gravitational segregation of the elements according to their masses would take place, the heavier ones migrating toward the core. Taking this gravitational segregation into consideration if we plot the thermal limit \( T_d \) of the material of the star at different radii we obtain a curve of the general nature shown in fig. 2. The distribution of the actual temperature \( T_s \) in the star at various radii is also shown plotted in the figure. We see at the center, \( P \), that the temperature is the same as the destructive limit of the heaviest element present. As such, this element gets thermally neutralized to yield the energy output of the star. We shall refer to this process as the 'regular burning' in order to distinguish it from the 'secondary burning' which we will presently explain.

As the element burning (that is, the thermal neutralization) continues, elements of lower \( Z \) (and with higher \( T_d \)) keep arriving at the center. At the same time
the stellar temperature gradually keeps on rising so that each of these lower Z elements reaches the thermal limit successively at the center. Thus, the $T_d$ vs. radius curve goes on shifting horizontally to the left in the diagram, while the $T_s$ vs. radius curve gradually keeps on rising, signifying higher stellar temperatures, as evolution progresses. Eventually the group of elements with $Z = 74$ to 70 arrives near the center. The state of affairs is now as shown in fig. 3. It can be seen that the stellar temperature curve now begins to intersect the $T_d$ curve at two points $P$ and $Q$. Therefore we find that while principally elements 74 and 73 are burning at the center $P$, at a location $Q$ slightly farther out, element 70 also arrives at its destructive limit. The consequent ignition of the element 70, however, upsets the prevenient equilibrium between the thermal and the gravitational forces, for three reasons.

Firstly, the element 70 is relatively more plentiful compared to the elements of higher Z and thus a potentially larger energy source is switched on, and swithed on suddenly, in addition to the existing source. This new source we shall refer to as the 'secondary source.' Secondly, this happens not quite at the center (where the regular source has been operating) but at a slightly larger radius $r_s$ (see fig.3), which we shall call the 'secondary burning radius', where there was no energy generation previously. Thirdly, the extent of the spherical area at radius $r_s$, where the thermal limit of the secondary fuel is reached, is comparatively larger than available to the regular fuel at the center, and in consequence the proportion of the secondary fuel that is ignited is very much more.

The additional energy thus released causes an expansion of the star. This drops the stellar temperature and acts as a negative feedback, shutting off the new energy source. Subsequent contraction repeats the cycle and we have the phenomenon of the intrinsic variable. In fact, the Cepheids could be identified as the stars burning elements around the Ytterbium-dip at $Z = 70$ (fig.1).

Larson proposes [4], in the context of the Reciprocal System, that in the regular course of the energy generation process, with elements of lower atomic numbers successively arriving at the center to be neutralized, the appearance of an element like Lead (Pb) with comparatively higher than normal abundance initiates the variability cycle. This might well be one of the causes of the variability and the long period variables seem to fall into this category. However, as the stellar mass (and consequently its temperature) increases, the ratio of the additional energy produced to the total stored energy decreases. As such, the variations become damped out and unobservable. In the case of the higher temperature stars, therefore, the principal cause for the variability could be attributed to the Yb-dip as explained in the foregoing.

The phenomenon of the intrinsic variable occurs whenever there is a cyclic

C 17.1-22
upsurge in the energy production. This also happens when the central temperature of a gravitationally contracting aggregate first reaches the destructive limit of the heaviest element present there. In fact, Larson identifies this category of stars as the long period variables [4].

THE MAIN SEQUENCE STARS

The phenomenon of the variable luminosity manifests only in case the accretion rate is high and the star follows the path AC shown in the Color-Magnitude diagram (see fig.6 of Reference [5]). The story of a main sequence star, with about the same surface temperature as that of the variable is somewhat different. This is primarily because when the stellar temperature arrives at the Yb-dip, the temperature gradients in the variable and the main sequence star are markedly different. In the variable the Yb-dip occurs much farther from the core as compared with the main sequence star. As shown in fig.4 (a) and (b) the temperature gradient in the core is much steeper in the main sequence star.

If \( dZ \) is the difference between the atomic number of the element currently burning at the center and that of the new arrival (the secondary source), the effect of the steep temperature gradient is to keep \( dZ \) to a small value (1 or 2). Therefore no marked difference in the magnitude of energy generation will result by the initiation of the secondary burning. Whatever little difference is there is successfully damped out by the larger heat capacity and the larger mass of the overlying material (in view of the smaller secondary burning radius \( r_s \)). Consequently the main sequence star of comparable surface temperature passes less conspicuously than the variable through this \( T_d \) dip. In the case of the variable the \( dZ \) is larger (4 or 5) (see fig.4(b)) which results in considerable amount of secondary energy production.

THE TYPE I SUPERNOVA

As the element-burning continues and the Cobalt-dip (at \( Z = 27 \)) arrives at the core while element 31 or 30 is burning at the center, a spectacularly different result ensues. Firstly, the secondary source triggered suddenly is proportionately very large—not just three or four times the regular, as in the case of the Yb-dip, but nearly a hundredfold bigger—owing to the much greater relative abundance of the Co-group of elements. Secondly, because of the large size of the dip in \( T_d \) at \( Z = 27 \) the secondary burning radius is appreciably large. As such, a large number of elements (with \( Z \) between 32 and 27), and in quantities more plentiful than the regular fuel now burning at the center, are present within the sphere of radius \( r_s \), waiting to be ignited but for their higher destructive temperatures.

The initial spate of the secondary energy released by the onset of the thermal destruction of Co at the radius \( r_s \) does two things: on the one hand, it ceases
the expansion of the overlying material and results in a drop in the temperature, which thereby acts as a negative feedback switching off the Co ignition. On the other hand, it compresses the material inside the radius \( r_s \). This sudden implosion raises the temperature in the region sharply and brings all the high-\( T_d \) material within the radius \( r_s \) catastrophically to its destructive limit. Consequently, a pilot explosion takes place in the core, liberating considerably large quantities of energy—greater nearly by a magnitude or two than was being released hitherto—in a short interval. This acts as a positive feedback and retriggers the burning of the Co-Fe group of materials at the radius \( r_s \) at a substantially high rate. This high rate of temperature rise raises the temperature of a large portion of the Co-group well above its destructive limit, culminating in the supernova explosion before the negative feedback of the drop in temperature owing to the expansion of the outer layers has time to operate. In fact, if the star is quite large, a few outer luminosity pulsations may be apparent before the core explodes activating the final cataclysm of the Cobalt explosion.

As Larson points out [6], the supernova explosion disperses the major portion of the Co-group out into space before it had a chance to get destroyed in the event. Hence their cosmic abundance keeps on building up unlike that of the other elements of higher \( Z \). The elements of \( Z = 28 \) through 30, which are inside the secondary burning radius, and are involved in the pilot explosion, also seem to share this good fortune to a limited degree by virtue of their higher destructive limits.

CONCLUSIONS

Highlighting the effect of the \( T_d \) dip on stellar evolution we summarize:

1) In the course of the regular burning in stellar core, the element that reaches the thermal limit next in the succession is that with \( dZ = 1 \) or 2. The effect of the dip is to activate a source with \( dZ = 4 \) or 5, with the concomitant larger difference between the relative abundances of the regular and the secondary energy sources. This is one of the causes of the variable luminosity.

2) The secondary energy source thus activated by the dip is an extra source, operating in addition to the regular source existing at the center.

3) The secondary source is located not at the center but at a larger radius called the secondary burning radius.

4) The long-period variables could be identified as the stars burning element Pb at the center or the ones that just started their energy production by thermal neutralization while the Cepheids the ones passing the Ytterbium-dip \( (Z = 70) \).

5) The Type 1 supernova explosion is the result of the Cobalt-dip \( (Z = 27) \) reaching the stellar core.
REFERENCES


5. Ibid., fig.6, p. 64

6. Ibid., p. 50

* * *

BASIC PROPERTIES OF MATTER

This volume is the second in a series of separately titled volumes of a revised and greatly enlarged edition of THE STRUCTURE OF THE PHYSICAL UNIVERSE, originally published in 1959. The other volumes now available are NOTHING BUT MOTION (Volume I) since 1979 and THE UNIVERSE OF MOTION (Volume III) since 1984. BASIC PROPERTIES OF MATTER (Volume II) is the third volume published actually since 1988. The nature of the subject matter covered in the present volume is indicated in the following Table of Contents:

Preface
1 Solid Cohesion
2 Inter-atomic Distances
3 Distances in Compounds
4 Compressibility
5 Heat
6 Specific Heat Patterns
7 Temperature Relations
8 Thermal Expansion
9 Electric Currants
10 Electrical Resistance
11 Thermoelectric Properties
12 Scalar Motion
13 Electric Charges
14 The Force Equations
15 Electric Storage
16 Electrostatics
17 Induction of Charges
18 Ionization
19 Magnetostatics
20 Magnetic Quantities and Units
21 Electromagnetism
22 Charges in Motion
23 Magnetic Materials
24 Isotopes
25 Radioactivity
26 Atom Building
27 Mass and Energy
Fig. 1 DESTRUCTIVE LIMITS OF THE ELEMENTS
Fig. 2 REGULAR BURNING

Fig. 3 ONSET OF SECONDARY BURNING

(a) Main sequence star  (b) Intrinsic variable

Fig. 4 EFFECT OF TEMPERATURE GRADIENT ON THE DIP