High Energy Physics and the Reciprocal System

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> "…during times of crisis new theories arise… Meanwhile, adherents of the old paradigm in crisis fight to retain it against the revolutionaries who are outrageously explaining anomalies by treating nature as if she were a rabbit or squirrel instead of what every self-respecting scientist knows she is: a duck."
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> —J. P. Briggs and F.D. Peat, Looking Glass Universe, p. 28

Great advances in technology in the recent decades of this century have made it possible to amass a wealth of experimental data of unprecedented scope and variety. Theory in the areas of Particle Physics and Astrophysics has been subjected to repeated revisions to cope up with the observed facts. Especially in the field of High Energy Physics exciting things have been happening. The Orthodoxy is becoming more tolerant to wild, if not crazy ideas and inventions of thought. In this backdrop, it might be desirable to survey the vicissitudes of the physical theory, hoping that we might learn something from the history.

Little Fleas on Little Fleas on Little Fleas on…

Physicists recognize two revolutionary experiments in the 20th century that resulted in significant revision of the previous ideas about the fundamental particles. One was the Rutherford scattering experiment of 1911, which revealed that the atom was not a uniform solid object it was thought to be, but is largely hollow with a compact solid nucleus which is nearly five orders of magnitude smaller than the atom itself. Subsequent theory conjectured that the nucleus is made up of particles even more fundamental, namely, the protons and the neutrons. The second experiment was the electron-proton scattering experiment of 1968 at Stanford. With the probing energies scaled up to the MeV range the scattering pattern revealed that the proton and the neutron were not the solid compact objects they were thought to be, but are largely hollow with extremely compact, point-like objects inside. The theoreticians named these point-like particles the *quarks*.

Originally only three quarks ('u,' 'd' and 's') were invented to explain protons, neutrons and pions. But soon a theoretical inconsistency cropped up as the unstable hadron resonance known as Δ^{++} was experimentally discovered. According to the existing quark scheme this resonance has to be composed of three u-quarks in a configuration that is symmetric under interchange of any two quarks. This, however, was not in accordance with the well-established Pauli's Exclusion Principle, which states that no two fermions can be in the same quantum state. Therefore, instead of abandoning the quark model, the inconsistency was evaded by inventing purely *ad hoc*, a new quantum attribute—fancifully called the 'color' charge—which serves to distinguish the three u-quarks.

That now we have u, d and s quarks each in three color states is, of course, not the end of the story. The discovery in 1974 of the J or Ψ particle required the positing of a fourth quark (the 'c'), and in 1977 of the Upsilon particle necessitated another quark with a brand new quantum attribute (the 'b'). At the present time, we have as the fundamental particles six types of quarks, each in three different color states, along with equal number of antiquarks. In addition, the *Standard Model* (SM) propounds the existence of six *leptons*—particles which do not experience the 'strong' force. These are the electron, the muon and the τ- particle and their corresponding neutrinos ν_e, ν_μ and ν_τ along with, of course, the

antiparticles of all of these.

Problems in the Current Theory

Though the Standard Model is an eminently successful theory of the High Energy Physics and covers the 'weak,' the electromagnetic and the 'strong' interactions, its most flagrant shortcoming is the omission of gravitation. Physicists have come up with the characteristic length at which 'quantum gravity' is expected to manifest as nearly 10^{-35} m. This is seventeen orders of magnitude smaller than the characteristic length of the 'weak' interaction, namely, about 10^{-18} m. Such a stupendous scale difference is quite baffling to them.

It is an embarrassing fact that free quarks have never been observed. Consequently it is *theorized* that interactions between quarks must be extraordinarily strong and perhaps irrevocably *confine* them to their bound states. The theorists do not know whether quarks are truly fundamental entities or have further structure. Nor do they know if quarks are everlastingly stable or decay spontaneously. Further, the Standard Model contains many parameters, such as the masses of the quarks and leptons, the values of the fundamental charges etc. which cannot be derived from the theory but have to be taken as given. Then there is the *generation* problem: even though only two quarks (u and d) and two leptons (e^- and ν_e) occur preponderantly in nature, yet nature possesses two more copies (four more quarks and four more leptons) of this basic structure, which latter are assumed to be relevant, if at all, in the first few seconds after the so-called Big-bang.

Occurrence of infinities plagues the mathematics of the theory, at the various levels of the energy ranges. Solving one problem introduces new problems at the new levels. For instance, solving the mass problem of the 'weak' bosons, $W^{\pm}$ and Z^0, by Higgs mechanism involves the prediction of a new particle—the Higgs boson—the experimental discovery of which is an outstanding problem. The concept of *supersymmetry*—wherein all bosons have fermionic superpartners and *vice versa*—is invented to circumvent the infinities. However, in the bargain, a host of new particles are predicted, generating new ignorances at the same rate as developing new understanding.

Finally, the theorists are investing great hopes in the *superstring* theories, in which one-dimensional *singularities*, instead of point-like particles, are envisaged as the ultimate constituents of the universe. Supersymmetry is an essential ingredient of the theory. One of the problems besetting the superstring theory is the occurrence of several versions of it, without a clear hint of the actual one. The theory requires the superstrings to exist in large number of space-time dimensions (like 10). This requires figuring out ways of reducing the superabundance of the dimensions.

Vindication of these ideas comes from experimental confirmation and the future of High Energy Physics is threatened by a serious crisis. The range of energies that would be needed to test the new theories is 10^5 to 10^{19} GeV. The known acceleration technologies can take us up to the 10^4 GeV level in the coming decade. Beyond that, the veterans in the field fear that the High Energy Physics is near its end. The deepening crisis is making the physicists look for unconventional ideas, no matter how weird they might appear. Unfortunately, they are looking for these new ideas still within the ambit of the old paradigm only. They seem to be committing the mistake of the proverbial drunkard, who was found searching in the middle of the night, right under the street light, for something he lost in the darkness beyond! Recognition of the truth of the *Reciprocal System* of theory, which is based on a totally new basic paradigm, is getting procrastinated because it upsets some of our most cherished notions. But this is what a paradigm change at the most basic level is bound to do. Planck's discovery of the quantum nature of energy is a good example. It was greeted with indifference and disbelief, if not open hostility.

The Deepening Crisis

It is now apparent that applying iteratively the program that '*particles are built out of more fundamental particles'* has resulted in the proliferation of 'fundamental' particles and led us from complex theory to more complex theory. The situation is reminiscent of the accumulation of epicycles in the Ptolemaic system. Once again it might be pointing out to us, if we are able to take the hint, that the basic paradigm underlying the whole edifice of the High Energy Physics has been wrong.

Particle physicists have innovated the concept of force, which was originally defined as acceleration × mass. The idea of *action-at-a-distance* was repugnant to the modern scientist who thought it was spooky and belonged to the dark era of scientific ignorance. He rather believed in the *localness* of interaction: a force could be passed on from A to B only if A is physically touching (contiguous in space to) B, or through some other thing touching both. This belief logically led him to the idea of 'exchange force,' that when two entities are separated in space a force could be transmitted between them only through the *intermediary* of a particle—the field quantum—*propagating in space.* This is part of the paradigm on which the superstructure of modern physics has been erected. The physicists have even disregarded factual information from their own field and subscribed unstintingly to this paradigm. For example, there is no empirical evidence that gravitation is propagated at finite speed or that it is propagated at all. But current Orthodoxy presumes that gravitation has a field quantum, the graviton, and that it propagates at the speed of light.

Meanwhile a new factor has emerged into the situation. Carefully conducted experiments in the recent decades have established beyond doubt that quantum *non-locality* is a fact—particles widely separated in space are able to influence each other, without the need for any medium or intermediary and without any effects of attenuation by distance, even when they are beyond each other's *light cone.* Since this is a factual finding, it must be incorporated into whichever theory of physics that might come into ascendancy if it has to be a true theory.

Notwithstanding these developments High Energy Physics has continued on its program of building particles out of more fundamental particles, postulating at each structural level the existence of 'carriers of interaction'—the mesons, the 'intermediate vector bosons,' the gluons and the like. Now the question arises whether there is a way to build physical theory basing on established facts including non-locality without having to re-introduce the unacceptable spooky action-at-a-distance? Well, this is exactly what Larson has accomplished!

The New Paradigm

Larson has laid out, in his published works[1,2,3,4,5,6] the general outline of his theory, covering all the physical fields. All of the phenomena whose origin is a mystery in the current theory—like that of the high-energy cosmic rays—come out as logical deductions from his Fundamental Postulates about the characteristics of motion. He has carried out the development far enough to establish a *prima facie* case for a general theory. However, considerable amount of theoretical work still needs to be done to extend the application of the Reciprocal System to greater detail.

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1 Dewey B. Larson, *The Case Against the Nuclear Atom*, North Pacific Publishers, Portland, Oregon, 1963
2 Dewey B. Larson, *Beyond Newton*, N. P. P., 1964
3 Dewey B. Larson, *Nothing But Motion*, N. P. P., 1979
4 Dewey B. Larson, *The Neglected Facts of Science*, N. P. P., 1982
5 Dewey B. Larson, *Universe of Motion*, N. P. P., 1984
6 Dewey B. Larson, *Basic Properties of Matter*, International Society of Unified Science, Salt Lake City, Utah, 1988

Following the lead given by observational facts, and not based on speculations, Larson has endeavored to review the entire physical situation and come up with a new structure of physical theory, which has come to be called *The Reciprocal System* of theory. Larson's principal finding is that the physical universe is composed entirely of discrete units of motion. Space and time occur only as the two reciprocal aspects of motion and are quantized. In the new paradigm, space-time plays the role of the *content* of the physical universe, instead of that of the *container* or framework in which the physical universe exists. A consideration of the relations between the characteristics of space and time leads him logically to the development of a truly general theory, in which every aspect of the physical universe turns out to be a modification of the one fundamental component, namely, motion—in fact, *scalar motion*.

Larson points out that the reason why previous thinkers, like Eddington and Hobbes, who attempted to build a general theory based on motion as the fundamental constituent failed is that they did not recognize that this basic constituent is *scalar motion*, and not vectorial motion.

In the short space of an article it is impossible to delineate the complete theoretical development. We shall therefore limit ourselves to highlighting certain of its findings that are relevant to the present subject matter. We have already described elsewhere[7] how the phenomena of non-locality manifest logically in the Reciprocal System. Further, since all the physical phenomena are different manifestations of motion, and that occurs in discrete units of finite size, the Reciprocal System is intrinsically free from singularities.

New Insights

From the two Fundamental Postulates of the theory Larson finds that there is no need to break away from the original definition of force, as an aspect of motion, and that all known interactions—gravitation, electricity, magnetism etc.—are different aspects of the basic scalar motions of the physical universe. The continual expansion of space, apparent to us as the recession of the distant galaxies, comes out as the first corollary of the properties of scalar motion. There is no need for the *ad hoc* assumption of a big bang. The ubiquitous expansion of space (actually, space-time) acts as an *outward* force, in opposition to the *inward* force of gravitation and accounts for facts such as the unexplained stability of the Globular Clusters and the large-scale structure of the aggregates of matter.

Atoms come out as *rotational displacements* in the three scalar dimensions of motion. Larson repudiates the iterative dogma 'particles are built out of more fundamental particles,' cutting it out at the first iteration itself: he finds the atom to be a unit of compound motion and without parts. All the observed features of gravitational fields (alluded to earlier) follow as logical deductions, including the apparent action-at-a-distance.

Larson calls the region of the physical universe in which the possible speeds (space/time) range from zero to unity (unit speed being identified as the speed of light in the natural reference frame of the theory) *the material sector*, and the region in which they range from unity to infinity (or equivalently, the *inverse speeds* (time/space) range from zero to unity) *the cosmic sector.* The theory shows that while the phenomena of the material sector could be depicted in the three-dimensional spatial reference frame, those of the cosmic sector could be truly depicted only in a three-dimensional temporal reference frame. The speeds beyond the unit speed, which pertain to the cosmic sector, do not manifest to us as motion in space: they are actually *motion in time* (not, of course, the 'time travel' of science fiction).

7 Nehru KVK., "Non-Locality in the Reciprocal System," *Reciprocity* XXXI, Number 1, Spring 1997, pp. 7-14

Powerful Type II stellar explosions are energetic enough to propel part of the matter into ultra-speed range (beyond the unit speed). The consequent expansion takes place in coordinate time rather than in coordinate space. By virtue of the reciprocal relation between space and time, this *expansion* in coordinate time manifests to us as *contraction* in space and results in ultra-high density product. While the low speed component appears as a Red Giant (with a matter density on the order of 10^{-6} that of water), the ultra-speed component appears as a White Dwarf (with a matter density on the order of 10^{6} that of water) or a Pulsar (even denser). In addition, these ultra-speed phenomena account for the peculiar characteristics of the galactic cores, Seyferts, Radio Galaxies and the observations being mistakenly attributed to the purely hypothetical black holes. The peculiar characteristics of scalar motion, brought to light by Larson's research, show that it is totally unnecessary to resort to non-Euclidean geometry as the Relativists do.

By virtue of the symmetry between the characteristics of space and time and their reciprocal relation to motion, we find that all the phenomena of the material sector are duplicated in the cosmic sector with the roles of space and time interchanged. The atoms of the cosmic sector, *the c-atoms*, are the rotational inverses of the material atoms. They comprise the *antimatter*, but with this difference that they are the multiplicative inverses of matter—not the additive inverses as envisioned in the conventional theory. While gravitation in the material sector pulls atoms inward in space, the gravitation of the cosmic sector pulls the c-atoms inward in three-dimensional time to form c-stars, c-galaxies etc. Even though c-matter is as plentiful as the ordinary matter, the reason why we do not encounter it normally is that it forms aggregates in three-dimensional time, not in three-dimensional space. Moreover, while ordinary matter is moving outward in time, c-matter is moving inward in time and the chance encounters between the two types of atoms do not last longer than one natural unit of time ($\sim 10^{-16}$ s).

Radiation moves at unit speed (= unit inverse speed) and is therefore at the boundary between the two sectors. We actually observe the radiation from the c-stars. But since it enters our sector from a region not localized in three-dimensional space it appears absolutely uniform and isotropic—*the cosmic microwave background* (CMB). Its blackbody nature and temperature could be derived. Since in the conventional cosmological theory the CMB is taken to have arisen from the material aggregates, it has been a difficult problem to reconcile the perfect isotropy of the CMB with the lumpiness of the material aggregates. In the Reciprocal System this difficulty does not arise.

Larson identifies explosive processes operating at galactic cores that directly impart greater than unit speeds to matter. Quasars turn out to be the ejecta of such ultra-speed explosion processes. The excess speed in the explosion dimension shows up as the non-cosmological redshift. These objects eventually reach the limiting speed of the material sector and leave it altogether, entering the cosmic sector. Similar state of affairs holds good in the cosmic sector and mature c-quasars, on reaching the limiting (inverse) speed of that sector exit it and emerge into our sector. Once again, as the c-atoms (of the c-quasars) are coming in from a region not localized in three-space, they emerge uniformly and isotropically throughout the expanse of three-dimensional space. These, of course, are the original *cosmic ray particles*. They tunnel through the unit-speed boundary and manifest to us at near-light speeds. The most abundant c-element in them is c-hydrogen. Though c-atoms do not have mass in the conventional sense, they possess the equivalent of *inverse mass*. While the mass of a material atom is given by A (the atomic weight), the mass equivalent of the corresponding c-atom would be a function of 1/A. In fact it is given by

$$\left(G+\frac{4}{A_c}\right)\times 931.15\,MeV$$

where A_c is the atomic weight of the c-atom and G is the number of units of material *gravitational charge* (a component of mass arising out of oscillatory rotational motion in the theory, which is also responsible for radioactive decay). Table 1 lists Larson's identification of the cosmic ray decay particles along with the theoretical masses. There are several collateral factors, which influence the mass calculation but are omitted from consideration in this preliminary treatment. In spite of this, the agreement between the calculated and the observed values is striking.

Table 1: Larson's Identification of the Cosmic Ray Decay Sequence

			Mass (MeV/c^2)	
Name	**c-Isotope**	**Gravitational Charges**	**Calculated**	**Observed**
Ψ′	c-H^2	2	3710	3695
Ψ	c-He^3	2	3104	3105
Ω	c-Li^5	1	1676	1675
Ξ	c-B^{10}	1	1304	1314
Σ	c-N^{14}	1	1197	1197
Λ	c-Ne^{20}	1	1117	1116
π	c-Si^{27}	0	137.95	139.57
μ	c-Ar^{35}	0	106.42	105.66

In the case of the cosmic rays, since the incoming c-atoms possess extremely high energy—both rotational and translational—they give this up through the decay and the fragmentation processes. On the other hand, Larson points out that in the high-energy environment of the particle accelerators the reverse processes of consolidation and building take place. Starting with the production of c-atoms of high atomic number, the *aufbau* process results in c-atoms of progressively lower atomic numbers. Larson was able to identify the c-atoms that correspond to the known Resonances. Examples of the Sigma Series of the Baryon Resonances and the Meson Resonances are listed in Table 2 and Table 3 respectively.[8] They should serve to demonstrate how a true theory can bring order into the welter of high energy particles, without the need to make *ad hoc* assumptions *ad infinitum.*

Conclusion

As we approach the end of this century we find the rank and file of the physics profession openly acknowledging the impending crisis in the High Energy Physics. They are frantically looking for promising alternative ideas in theory and experimental techniques. We suggest that the reason why the physical theory has been becoming more and more complex is that it has to make up for a wrong basic paradigm on which it is built.

We submit that the *Reciprocal System* of physical theory, originated by Dewey B. Larson, is a true, complete and easily understandable general theory, founded on a new fundamental paradigm. The present view is that the phenomena of the physical universe *exist in* a framework of space and time. In contrast, the Reciprocal System asserts that scalar motion or speed, i.e. space/time, is the *content* of the physical universe—the sole content. It should be realized that this is a conceptual innovation of unprecedented nature throughout recorded history. No matter what conceptual changes the previous thinkers have introduced into the physical theory, including the latest efforts, they have all been, without exception, based on this age-old paradigm of viewing the phenomena as existing *in* space and *in* time. Therefore it must be recognized that the Reciprocal System is not just another theory, but one

8 Dewey B. Larson, *Nothing but Motion*, *op. cit.*, pp. 205 & 208

that is based on a totally new paradigm which no previous thinker could ever divine.

Larson discovers that there are several speed (motion) regions of the physical universe, which cannot be legitimately represented, in the conventional three-dimensional spatial reference frame. In all the cases where theory is encountering serious difficulties, the trouble arises because of the Procrustean attempts to fit all physical processes into the limited three-dimensional spatial frame. There is a conjugate sector of the universe, *the cosmic sector*, which can only be represented in the analogous three-dimensional *temporal* reference frame. Most of the mysterious astronomical phenomena that have no proper explanation in the conventional theory turn out to be the normal cosmic sector phenomena as they appear to us. High energy Cosmic Rays, Cosmic Microwave Background and Gamma Ray Bursts are typical examples. Larson identifies that some of the cosmic sector processes have wider implications to life sciences too. Then he also finds that there is a large segment of the physical universe, *the scalar zone* that cannot legitimately be depicted either in the three-dimensional spatial frame or in the three-dimensional temporal frame. All the bizarre aspects of the quantum phenomena follow from the discrete nature of space and time. The Reciprocal System offers an easily understandable picture of the reality underlying the quantum phenomena, which the Quantum Theory fails to provide.

Larson has covered a large ground in his work—truly immense for a single individual to have done—from the atomic to the astronomical, and developed theory far enough to establish that it is truly general. It is time that a concerted international effort is directed to evaluate the truth and merit of the Reciprocal System by open-minded members of the scientific community. Sooner or later, the mounting pressure of the crisis in the High Energy Physics is itself going to bring this to happen. But if a Foundation or Trust dedicated to mankind's betterment through science and technology can sponsor such a project to evaluate the Reciprocal System, it would save enormous amount of funds and human resources from further getting squandered on unfruitful scientific enterprises based on the wrong paradigm.

Table 2: Baryon Resonances (Sigma Series)

c-Element	Gravitational Charges	Inter-stage	Mass (MeV/c^2) Theoretical	Observed
c-N^{14}	1		1197	1190
c-Be^{8}	1		1397	1385
c-Be^{7}	1		1463	1480
c-Li^{6}	1		1552	
		a	1604	1620
c-Li^{5}	1		1676	1670
		a	1728	1750
		b	1779	1765
		c	1831	1840
		d	1882	1880
c-Kr^{72}	2		1914	1915
c-Ar^{36}	2		1965	1940
c-Mg^{24}	2		2017	2000
c-Ne^{20}	2		2048	2030
c-F^{18}	2		2069	2070
c-O^{16}	2		2095	2080
c-N^{14}	2		2128	2100
c-B^{10}	2		2234	2250
c-Li^{6}	2		2483	2455
c-Li^{5}	2		2607	2620
c-Ne^{20}	3		2979	3000

Table 3: Meson Resonances

c-Element	Gravitational Charges	Inter-Stage	Mass (MeV/c^2) Theoretical	Observed@
c-Li^6	0		621	
		a	673	700
c-Li^5 *	0		745	(760)
		a	797	784
		d	952	(951)
c-Kr^{72} *	1		983	(986)
c-Ar^{36} *	1		1034	(1031)
c-Mg^{24}	1		1086	(1090)
c-Ne^{20} *	1		1117	1116
c-O^{16}	1		1164	(1165)
c-N^{14} *	1		1197	1197
c-C^{12}	1		1241	(1240)
c-C^{11}	1		1270	(1274)
c-B^{10} *	1		1303	1310
c-B^9	1		1345	
c-Be^8	1		1397	
c-Be^7 *	1		1463	(1455)
		a	1515	1516
c-Li^6	1		1552	1540
		a	1604	(1623)
c-Li^5 *	1		1676	(1674)
		b	1779	(1773)
		c	1831	(1840)
c-Kr^{72} *	2		1914	1930
c-O^{16}	2		2095	2100
c-B^{10} *	2		2234	2200
c-B^9	2		2276	2275
c-Be^8	2		2328	2360
c-Be_7 *	2		2394	2375
c-Kr^{72} *	3		2845	2800
½ c-Kr	1½		1423	(1427)

* Decay sequence; @ Average values in parentheses