Part III

Six-Dimensional Universe

1. Where Do High-Energy Cosmic Rays Come From? [1]

"I think there should be a law of Nature to prevent a star from behaving in this absurd way!" Arthur Eddington (on black holes)

A well-known result of the Theory of Relativity is that space and time can be interchanged.[2] This result is rather puzzling: how can the continuously flowing, one-dimensional time-coordinate be interchanged with the stationary three-dimensional space? Another strange result is that tachyons exist, particles of imaginary mass which are always faster then light. A related puzzling result is that a total gravitational collapse results in time-like space and space-like time.

The first two results tell the following: the tachyons are complementary physical matter (that will be denoted 'matter') for which space is macroscopically one dimensional and flows continuously and time is three dimensional and stationary. The whole universe is six-dimensional and the two different kinds of physical matter are propagated in it in two mutually orthogonal ways. Macroscopically, matter occupies continuum of three-dimensional space and one-dimensional ever-flowing time, while 'matter' occupies continuum of three-dimensional time and one-dimensional ever-flowing space. All the properties of 'matter' are analogous to the corresponding properties of matter, and each of the two different kinds of physical substance cannot be detected, in principle, by the other. 'Matter'

[1] A version of this section has been published in *Speculations in Science and Technology* 21 (1999), 345-346.

[2] Time in this part appears in its customary sense—time-coordinate.

and the ‘photons’ emitted by it constitute an unobservable complementary universe. The above conjecture is raised to the status of a postulate:

Principle of Cosmological Pair
The whole universe is constituted of two interchangeably-orthogonal universes.

“Interchangeably-orthogonal” stands for the special relations described above. That the time-coordinate is necessarily a line in a three-dimensional continuum is in fact a direct consequence of the relativity of simultaneity: The geometrical description of the relativity of simultaneity is that different world-lines are not necessarily parallel and do not necessarily lie in the same plane. That geometrical description implies that the time-coordinate continuum is three-dimensional.

Principle of Cosmological Pair, together with the prediction of time-like space and a space-like time in a total gravitational collapse, and together with the fundamental assumption that the principles of nature *never* break down give rise to the following conjecture. *In extreme states of gravitational collapse, physical substance can be converted to its interchangeably-orthogonal form. The conversion process reduces the mass-density of regions that approach space-time singularity and helps to prevent it. ‘Particles’ which have been converted appear in the observable universe as cosmic rays.*

The ability of Pauli Exclusion Principle to prevent space-time singularity is limited to neutron stars of less than about two and a half solar masses. Conversion of matter in neutron stars of more than two and a half solar masses is not necessarily continuous. Conversion is an auxiliary anti-singularity measure; the ultimate anti-singularity measure is controlled gravitation. Controlled gravitation, when used as an anti-singularity measure, prevents too-intensive cosmic rays showers, which can be fatal to life. Conversion of matter and controlled gravitation complement each other: Conversion of matter results in cosmic rays, which fuel the “furnaces” of living planets (see Part IV), have a role in the biological evolution, and provide an observable evidence for the existence of the unobservable complementary universe. Controlled gravitation guarantees that singularity never occurs independently of the magnitude of physical substance conversion. The process of preventing space-time singularity is coordinated by Nature in accordance with Principle of Supreme Design.

A star/'star' in which physical substance is converted into its complementary form will be called a hole/'hole'; it constitutes a "hole" in its universe through which physical matter leaks to its complementary universe. Holes/'holes' are definitely not singular and not necessarily "black." Conversion of physical matter takes place also in gravitationally collapsing stars which emit radiation that is observable from large distances (see below about pulsars). Particles which have been converted into 'particles' appear as 'cosmic rays' in the complementary universe. Since matter is propagated in space-time in an essentially different way from 'matter', no 'source' for those 'rays' can be identified. It remains a riddle until someone there, in the complementary universe, postulates the existence of a complementary unobservable universe.

Conversion of physical substance to its complementary form is actually the conversion of all the physical quantities which characterize the converted particles. This includes, of course, the universal function. The close-to-singularity state occurs mainly at the end of the life-conditions phase, when stars are out of nuclear fuel and collapse under their own weight. At that stage the time-density is very high. Thus many cosmic rays are at much denser time-density than the current matter on our planet. Denser time-density implies higher gravitational potential; a particle which is at high gravitational potential is a high-energy particle relative to matter at significantly lower gravitational potential (Eq. II.7). This time-effect is the major generator of high-energy cosmic rays. Based on the measured energies of high-energy cosmic rays an approximation of the minimal value of the variant speed of light can be evaluated, this can be added to the extrapolation of the universal function, based on observations of the past, to obtain a better description of this function. Secondary reasons for the high-energy of cosmic rays are the 'high-accelerated fall' of 'matter' into the 'holes' and the extreme 'temperature' and extreme 'pressure' there. The time effect is reinforced by these extreme energetic factors.

The binary pulsar **PSR**1913+16, is an indirect experimental demonstration of the existence of gravitational waves, and in the same time it is also an indirect experimental demonstration of matter conversion. The observed diminution in period of this pulsar is consistent with calculated energy loss through gravitational radiation (Taylor, 1979). However, as explained in Part II, gravitational waves result of disappearance/appearance of gravitational mass. Gravitational waves are geometric waves they do not carry energy, and the energy loss is due to the conversion of matter. The observed diminution in the period of **PSR**1913+16 is due to conversion of matter into 'matter' at a rate that is equivalent to calculated energy loss through gravitational radiation.

Conversion of 'matter' takes place mainly at close to maximal 'gravitational potential'. The gravitational potential of Earth, as long as it is in the life conditions phase, increases continuously. Thus, if high energy of cosmic rays is a time-effect, a process of reduction in the average energy of these rays should be detected during long term observations.

In conclusion, a gravitational collapse never results in singularity. Cosmic rays are an indirect observable demonstration of the existence of the complementary universe, in particular the existence of 'holes'. Matter does not necessarily accumulate in holes and cosmic rays can appear anywhere anytime apparently from nowhere. It is highly desirable to put the last prediction to test with a device that can follow considerable intervals of the paths of cosmic rays. As explained in Part IV, cosmic rays fuel the "furnace" of living planets. Thus the device should orbit Earth in a variable orbit larger than the moon's orbit. Observations of high-energy cosmic rays which appear from nowhere inside such device can confirm that high-energy cosmic rays have no observable source.

2. Wave-Functions—Split Particles

Principle of Cosmological Pair enables to attribute a direct physical reality to wave-functions. It can be that the phase of a wave-function describes a rotating vector in the orthogonal space. Due to this line of thought, a quantum particle between interactions with other particles is nothing but a time-vector field in which all the physical information about the particle is coded. A wave-function of a particle is a superposition of partial wave-functions which coexist simultaneously. At one absolute present, one of the partial wave-functions is "**full**" and the other partial wave-functions are "**empty**." The **full state** is distributed among the partial wave-functions according to their probability of occurrence which is proportional to the squared modulus of their time-vector.

When a partial wave-function of another particle is present in the same six-dimensional region where the full partial wave-function happens to be and the directions in time (phases) of the two wave functions in that region coincide up to certain tiny angel, $i\Delta\alpha$ – there are two possible outcomes:

1. An **empty interaction**: the other partial wave-function is empty. That empty partial wave-function collapses completely, and the wave function of that particle, immediately after that event, is the superposition of its rest partial wave-functions. The full wave-function involved in an empty interaction is not affected at all. Empty interactions account for the empirical fact that interference effects disappear when it is possible to know, even in principle, which partial wave-function has been "traveled."

2. An interaction: the other partial wave-function is also full. In this case the entire wave-functions, of the two particles, collapse. The observable quantities, due to this interaction, are only those coded in the two full partial wave-functions. The other physical information coded in the empty partial wave-functions is lost, and for each particle a new superposition evolves according to its state after the interaction.

Of the two partial wave-functions involve in an interaction, one is of the smaller spatial volume and one is of the smaller time volume. The smaller is that spatial volume, the lesser is the uncertainty in position and the bigger is the uncertainty in linear momentum (of the interaction). The smaller is that time-volume, the lesser is the uncertainty in the time-coordinate and the bigger is the uncertainty in energy (of the interaction). The product of each complementary pair of uncertainties is never less than the limit given by the Heisenberg Uncertainty Principle.

Empty partial wave-functions pass each other entirely undisturbed. In macroscopic matter, full partial wave-functions at any direction in time are highly frequent. Particles in macroscopic matter very frequently undergo interactions, and their wave functions collapse before any significant superposition is developed.

Let us discuss a simple example: a photon splits up when it incidents on a half-silvered mirror. The photon, after splitting, is two spatially separated partial wave-functions between which the full state alternates evenly. When a detector is put on one of the two routes and the corresponding partial wave function, when arriving at the detector, is full, the photon is absorbed by the detector and immediately from that absolute present will not be found on the other route. But when an empty partial wave-function arrives at the detector it instantaneously collapses and the photon, from that absolute present, is certainly on the other route. The two partial wave-functions can also be brought to be reunited. The photon after reunification is a superposition of many beams arranged in a conic structure. Due to the reunification, the time-vector along each beam is of a periodically evolving magnitude. This implies small full volumes in the neighborhood of the vanishing points and an observable interference pattern.

Wave-functions of matter consist of rotating time-vectors. Wave functions of 'matter' consist of rotating space-vectors. This is why interactions between matter and 'matter' are impossible.

3. Contact Interactions—the Gold Foil Experiment

A Quantum Modification of the Rutherford Atomic Model

All the wave-functions of the constituents of an atom/subatomic particle are at one quanta of space; they differ in their quantum numbers, in their masses, in their electric charges, and in their *three-dimensional w-components*. Spatial structure is very significant at the molecular level and upward. But at the atomic level and downward phenomena which apparently result from spatial substructure actually result from w-substructure. For example: polarization of atoms, which results in Vander Waals forces between them, are not due to any sub-position of electrons in the spatial quanta of atoms, but due to the positions of electrons' wave-functions in the w-space. When alpha particles incident on a gold foil, the x-components of the gold atoms' wave-functions (each occupies one flexible quanta of the three-dimensional x-space) deform and let the wave-functions of the energetic alpha particles pass among them. With respect to interactions with external particles, the electrons of a gold atom do not create a unified wave-function, while the nucleons of the atom do create such a wave-function (it is definitely not a matter of position in space). The rotating w-vectors of the nuclei of the gold atoms have a spatial wavy pattern such that when the rotating w-vector of an alpha particle coincides with the rotating w-vector of a nucleus of a gold atom with which is in direct contact, it does not at the same time coincide with the rotating w-vectors of the nuclei of its other direct neighbors (a reaction can occur only with the direct neighbors, not with any other atoms of the gold foil). When and only when the above rotating vectors coincide a reaction takes place—the outcome depends on the w-components of the two wave-functions involved. Rutherford's description of the atom actually essentially describes the w-component of the atom's wave-function. The w-component of the wave-function of an atom occupies a volume of about one cube additional Angstrom. In this volume the w-component of the nucleus occupies some partial volume. Orbiting the w-component of the nucleus are the w-components of the electrons. The w-component of the wave-function of an alpha particle occupies some volume which is typical for nuclei (its x-component occupies a volume of about one cube Angstrom). When the rotating w-vectors of an alpha particle and of a direct neighbor nucleus coincide, the outcome reaction is determined by the relative position in the w-space between the two corresponding w-components.