The Relativity Principle: Space and Time and the Planck Vacuum

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This short paper examines the Relativity Principle in light of the emerging Planck Vacuum (PV) theory and shows that Special and General Relativity are based physically on the Relativity Principle and the dynamics of the PV.

The idea that absolute motion through space is undetectable has been around for a long time, spanning the work of Galileo and Newton, and the Special and General theories of Relativity [1]. The Relativity Principle asserts that the cosmos is so constituted that it is impossible to detect absolute motion by any type of experiment whatsoever, or in more modern terms, that the equations of physics must be fundamentally covariant [2]. It is important to note, however, that this principle *does not* imply that a fundamental reference frame does not exist. In fact, the following discussion indicates that there may be a hierarchy of reference frames that are hidden from our view.

The PV theory views the cosmos as consisting of an omnipresent, negative-energy, degenerate collection of Planck particles known as the PV; *and* free space which is the void of classical physics [3]. Uniformly spread throughout this free space is the quantum vacuum [4] which consists of an omnipresent field of virtual photons and massive virtual particles whose source is the PV [5]. The free-space vacuum state is not empty, but as Davies puts it, "[this living vacuum] holds the key to a full understanding of the forces of nature" [6, p.104]. How the PV and free space manage to coexist is not known, but the equations of modern physics strongly suggest that some type of active vacuum state does indeed exist, when Newton's gravitational constant, Planck's constant, and the fine structure constant are replaced by their more fundamental counterparts

$$G = \frac{e_*^2}{m_*^2} \qquad \hbar = \frac{e_*^2}{c} \qquad \alpha = \frac{e^2}{e_*^2} \tag{1}$$

in those equations. The universality of this suggestion can be seen by combining the relationships in (1) to yield the string of equalities

$$m_*^2 G = c\hbar = \frac{e^2}{\alpha} \tag{2}$$

where e_* and m_* are the charge and mass of the Planck particles making up the PV. These equations imply that gravitational physics ($m_*^2 G$), quantum physics ($c\hbar$), and electromagnetics (e^2/α) belong to a *single physics*, and their arrangement in the string suggests the central position occupied by the quantum theory in uniting mass and charge. The latter suggestion is realized in the equality between the two particle forces that perturb the PV

$$\frac{mc^2}{r} = \frac{e_*^2}{r^2} \qquad \text{at } r = r_c \tag{3}$$

leading to the particle's Compton radius $r_c\,(= e_*^2/mc^2)$ [3], where mc^2/r and e_*^2/r^2 are the curvature force (a gravitational force) and the polarization force (an electrical force) the particle exerts on the PV. That mc^2/r is a gravitational type of force can be seen from Newton's expression for the gravitational force between two masses m and M separated by a distance r

$$\frac{mMG}{r^2} = \frac{(mc^2/r)(Mc^2/r)}{(m_*c^2/r_*)} \tag{4}$$

where $c^4/G = m_*c^2/r_*$ is used to remove G from the left side of the equation. The ratios mc^2/r and Mc^2/r are the curvature forces the masses m and M exert on the PV, while $m_*c^2/r_* = e_*^2/r_*^2$ is the maximum force sustainable by the PV. One of the e_*s in the product e_*^2 comes from the charge on the free particle and the other represents the charge on the individual Planck particles within the PV.

The reaction of the PV to the uniform motion of a free charge is such that an iterative process taking place between 'the magnetic and Faraday fields produced by the PV' and the charge results in the well known relativistic electric and magnetic fields commonly ascribed to the charge as a single entity [3, Sec. 4]. Since these magnetic and Faraday fields emerge from the PV, it is reasonable to suggest that the Maxwell equations themselves must owe their existence to a perturbed PV. If it is then assumed that the tensor forms of the Maxwell equations are *the* covariant equations for electromagnetics, the corresponding coordinate transformation that leaves these equations covariant is the coordinate transformation that satisfies the Relativity Principle. This will be the Lorentz transformation assuming the result is unique. With this transformation in hand, the constancy of the speed of light can be deduced and the Michelson-Morley experiments [7] satisfied. From that point on relativistic kinematics can be derived in the usual way [2, p.9]. Special Relativity is now based on (1) relativity and (2) the dynamics of the PV state, rather than the standard postulates including (1) relativity and (2) the constancy of the speed of light. In this PV formulation of Special Relativity the constancy of the speed of light is a *derived* result, not a postulate.

The presence of the PV in the kinematic picture causes a mix-up in the classical position and time coordinates (r, t), resulting in the differential interval

$$ds^2 = c^2dt^2 - dr^2 \tag{5}$$

between the two events in spacetime at (r, t) and $(r+dr, t+dt)$. However, with the PV in the picture: the mixing of space and time is no longer the mystery that it is in the pre-PV formalism where the equations in (1) are unknown; and (r, t) is still just the bookkeeping entry it is in pre-relativistic physics.

The mixing of coordinates and time in Special Relativity is necessarily carried over into the equations of General Relativity to insure covariance of those equations. But now the effects of a mass perturbing the PV show up in the equations. For a point mass the force perturbation is mc^2/r and the resulting differential-interval equation is the Schwarzschild line element [8]

$$ds^2 = (1 - 2n_r)\, c^2dt^2 - \frac{dr^2}{(1 - 2n_r)} \tag{6}$$

where

$$n_r \equiv \frac{mc^2/r}{m_*c^2/r_*} \tag{7}$$

is the relative curvature force the mass m exerts on the PV. If there were no perturbing mass ($m = 0$), the line element would reduce to that of the Special Relativity result in (5) as it should.

Expressing the Einstein field equation in the following way [9]

$$G_{\mu\nu} = \frac{8\pi G}{c^4}\, T_{\mu\nu} \qquad \rightarrow \qquad \frac{G_{\mu\nu}/6}{1/r_*^2} = \frac{T_{\mu\nu}}{\rho_*} \tag{8}$$

shows that it, and those equations like (6) that follow from it, owe their existence to the PV as implied by the presence of the Planck-particle Compton radius r_* $(= e_*^2/m_*c^2)$ and the energy density

$$\rho_* = \frac{m_*c^2}{4\pi r_*^3/3} = \frac{e_*^2/r_*}{4\pi r_*^3/3} \tag{9}$$

in the final equation of (8). The ratio $1/r_*^2$ in (8) is the Gaussian curvature of a spherical volume of the PV equal to $4\pi r_*^3/3$.

Although it is accepted knowledge that absolute motion through free space is undetectable, such motion is clearly suggested by the equations of modern physics as seen above. The assumed existence of the PV implies that extra-free-space (XFS) reference frames must exist, at least those reference frames that describe the dynamics taking place within the PV for example. From this point it is easy to speculate that some XFS frames might be associated with levels of reality more fundamental than both the free-space and the PV frames. Thus the picture emerges of a cosmos possibly occupied by successive sets of XFS reference frames, in addition to the free-space frames in which we live, that belong to deeper levels of reality yet to be discovered.

The coexistence of the free-space and PV reference frames on top of each other is easily seen in equation (4), where the Newtonian force on the LHS belongs to the free-space frame and the three PV-curvature forces on the RHS to the PV reference frame. The reference frame for both sides of equations (5) through (9) is the PV reference frame. The presence of the PV frame in the equations indicates that, although it may be impossible to detect an absolute frame experimentally, there is abundant evidence that at least XFS reference frames do exist.

Finally, it is worth noting that there may exist only one reference frame (the absolute frame) in which there are successively more complicated states of existence figuratively "piled on top of each other like the skins of an onion" with the free-space state at the top of the pile.

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