NEW PARADIGMS IN PHYSICS

A New Paradigm: From Quantum Fields to the Planck Vacuum

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The current paradigm in fundamental physics assumes that Newton's gravitational constant G, Planck's (reduced) constant $\hbar$, and the fine structure constant α are primary constants — i.e., these constants are associated with something basic in nature and are thus not reducible to something more fundamental. This assumption leads, for example, to the conclusion [1] that quantum fields are the fundamental building blocks out of which the visible universe is constructed.

The Planck vacuum (PV) theory [2] derives the three constants

$$G = \frac{e_*^2}{m_*^2}\,, \tag{1}$$

$$\hbar = \frac{e_*^2}{c}\,, \tag{2}$$

$$\alpha = \frac{e^2}{e_*^2}\,, \tag{3}$$

where e_* is the bare electronic charge, m_* is the Planck mass, c is the speed of light, and e is the experimentally observed electronic charge. In effect, then, a new paradigm* has emerged where the PV is the source of the visible universe and its properties.

What follows is a brief survey of some equations that demonstrate how the current and new paradigms are related. The details leading to the equations are unimportant here and are left to the references. What is important is how the current primary constants on the left side of (1)–(3) are replaced by the new primary constants e_* and m_* on the right and in the equations to follow.

The Compton relation [3, p.433]

$$\lambda_c = \frac{h}{mc} \qquad \text{or} \qquad r_c mc = \hbar \tag{4}$$

associates a Compton wavelength λ_c (or a Compton radius $r_c = \lambda_c/2\pi$) with the particle mass m, while the de Broglie relation [3, p.81]

$$p = \frac{\hbar}{r_d} \tag{5}$$

relates the particle's relativistic momentum ($p = m\gamma v$) to its de Broglie radius $r_d = r_c/\beta\gamma$, where $\beta = v/c$ and $\gamma = 1/\sqrt{1-\beta^2}$. The PV theory explains these relations [2] [4] in terms of the magnitudes, mc^2/r and e_*^2/r^2, of the two distortion forces the particle exerts on the PV, the radius at which these two forces are equal being the Compton radius r_c. The calculations lead to the string of Compton relations

$$r_* m_* c = r_c mc = e_*^2/c\,, \tag{6}$$

where r_c is the Compton radius of any of the elementary particles, m is the particle mass, and r_* and m_* are the Compton radius and mass of the individual Planck particles making up the negative-energy PV state.

The Compton relations (6) yield the free-space permittivities [2]

$$\epsilon = \frac{1}{\mu} = \frac{e_*^2}{r_* m_* c^2} = 1\,, \tag{7}$$

while the static electric force between two charges e becomes

$$F_{el} = \frac{e^2}{r^2} = \alpha\,\frac{e_*^2}{r^2} \tag{8}$$

showing the fine structure constant α to be closely related to the PV polarizability.

The Heisenberg uncertainty relations

$$\Delta p \cdot \Delta q \geqslant \frac{\hbar}{2} = \frac{e_*^2/c}{2} \tag{9}$$

where p and q correspond to any two canonically conjugate operators, remain a wave-particle-duality mystery in the current paradigm. The PV theory explains these relations in the following manner: the so-called free particle interacts continually with the invisible PV continuum; as this continuum, like any continuum, can support wavelike disturbances, the reaction of the PV to the particle perturbations produces a wavelike reaction in the particle; then (9), which is currently ascribed to the particle, is actually a straightforward mathematical property of the perturbed continuum [3, p.105].

The gravitational equations of Newton and Einstein transform from the current paradigm to the new paradigm in the following way [5]:

$$F_{gr} = -\frac{mMG}{r^2} = \frac{(-mc^2/r)(-Mc^2/r)}{-m_* c^2/r_*} \tag{10}$$

and

$$G_{\mu\nu} = \frac{8\pi G}{c^4}\,T_{\mu\nu} \quad \rightarrow \quad \frac{G_{\mu\nu}/6}{1/r_*^2} = \frac{T_{\mu\nu}}{\rho_* c^2}\,, \tag{11}$$

*Merriam-Webster Online Dictionary, 2009. Paradigm: a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated.

where $c^4/G\,(=\, m_* c^2/r_*)$ and $1/r_*^2$ are the ultimate curvature force and Gaussian curvature sustainable by the PV, and ρ_* $(=\, m_*/(4\pi r_*^3/3))$ is the Planck-particle mass density of the PV.

Finally, the quantum vacuum consists of an electromagnetic (photon) component and a massive-particle ($k_c\, =\, 1/r_c$) component [4]. The energy densities of the two transform as

$$\frac{c\hbar}{2\pi^2}\int k^3 dk \quad \rightarrow \quad \frac{1}{8}\frac{e_*^2/r_*}{r_*^3} \tag{12}$$

and

$$\frac{c\hbar}{4\pi^2}\int k^2\left(k_c^2+k^2\right)^{1/2} dk \quad \rightarrow \quad \frac{1}{16}\frac{e_*^2/r_*}{r_*^3} \tag{13}$$

from the current to the new paradigm respectively.

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References

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