The Planck Vacuum and the Schwarzschild Metrics

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The Planck vacuum (PV) is assumed to be the source of the visible universe [1, 2]. So under conditions of sufficient stress, there must exist a pathway through which energy from the PV can travel into this universe. Conversely, the passage of energy from the visible universe to the PV must also exist under the same stressful conditions. The following examines two versions of the Schwarzschild metric equation for compatability with this open-pathway idea.

The first version is the general solution to the Einstein field equations [3, 4] for a point mass m at $r = 0$ and consists of the infinite collection ($n = 1, 2, 3, \cdots$) of Schwarzschild-like equations with continuous, non-singular metrics for all $r > 0$:

$$ds^2 = \left(1 - \frac{\alpha}{R_n}\right) c^2 dt^2 - \frac{(r/R_n)^{2n-2}\, dr^2}{1 - \alpha/R_n} - R_n^2 \left(d\theta^2 + \sin^2\theta\, d\phi^2\right), \tag{1}$$

where

$$\alpha = \frac{2mc^2}{m_* c^2/r_*} = 2rn_r\,, \tag{2}$$

$$R_n = (r^n + \alpha^n)^{1/n} = r(1 + 2^n n_r^n)^{1/n} = \alpha(1 + 1/2^n n_r^n)^{1/n}, \tag{3}$$

and

$$n_r = \frac{mc^2/r}{m_* c^2/r_*}\,, \tag{4}$$

where r is the *coordinate* radius from the point mass to the field point of interest, and m_* and r_* are the Planck particle mass and Compton radius respectively. The n-ratio n_r is the relative stress the point mass exerts on the PV, its allowable range being $0 < n_r < 1$ which translates into $r > r_*$. The original Schwarzschild line element [5] corresponds to $n = 3$.

The magnitude of the relative coordinate velocity of a photon approaching or leaving the point mass in a radial direction is calculated from the metrics in (1) (by setting $ds = 0$, $d\theta = 0$, $d\phi = 0$) and leads to

$$\beta_n(n_r) = \left|\frac{dr}{c\,dt}\right| = \left(\frac{g_{00}}{-g_{11}}\right)^{1/2} = (1 + 2^n n_r^n)^{(1-1/n)} \left(1 - \frac{2n_r}{(1 + 2^n n_r^n)^{1/n}}\right) \tag{5}$$

whose plot as a function of n_r in Figure 1 shows β_n's behavior as n increases from 1 to 20. The vertical and horizontal axes run from 0 to 1. The limiting case as n increases without limit is

$$\beta_\infty(n_r) = \begin{cases} 1 - 2n_r, & 0 < n_r \leqslant 0.5 \\ 0, & 0.5 \leqslant n_r < 1\,. \end{cases} \tag{6}$$

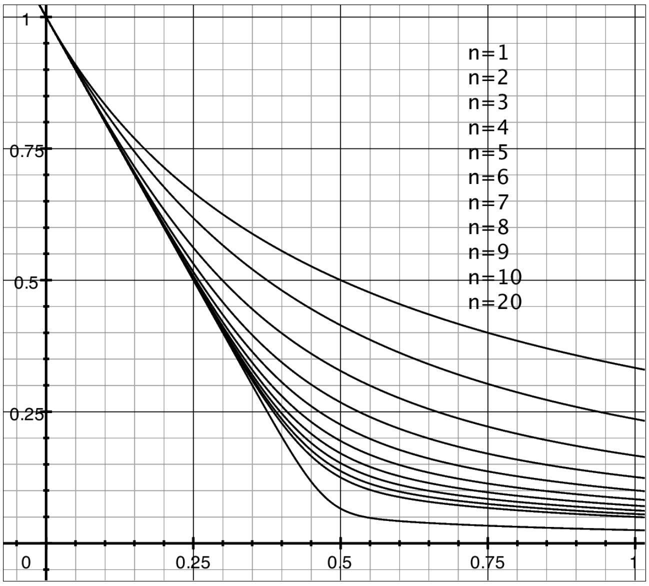

Fig. 1: The graph shows the relative photon velocity $\beta_n(n_r)$ plotted as a function of the n-ratio n_r for various indices n. Both axes run from 0 to 1. The limiting case $n \to \infty$ yields $\beta_n(n_r) = 1 - 2n_r$ for $n_r \leqslant 0.5$.

That is, the photon does not propagate ($\beta_\infty(n_r) = 0$) in the region $0.5 \leqslant n_r < 1$ for the limiting case. So if photon propagation is expected for n_r in this range, i.e., if energy transfer between the stressed PV and the visible universe is assumed, then the "$n = \infty$" solution must be discarded.

The second version of the Schwarzschild line element [6, p. 634]

$$ds^2 = (1 - 2n_r)\, c^2 dt^2 - \frac{dr^2}{(1 - 2n_r)} - r^2 \left(d\theta^2 + \sin^2\theta\, d\phi^2\right) \tag{7}$$

is the standard black-hole line element universally employed to interpret various astrophysical observations, where $2n_r = 1$ leads to the so-called Schwarzschild radius

$$R_s = \frac{2mc^2}{m_* c^2/r_*} = 2rn_r \tag{8}$$

the interior ($r < R_s$) of which is called the black hole. Within this black hole is the naked singularity at the coordinate radius $r = 0$ where the black-hole mass is assumed to reside—hiding this singularity is the event-horizon sphere with the Schwarzschild radius. It should be noted that this version is the same as the previous version with $n \to \infty$ except that there the coordinate radius is restricted to $r > r_*$ as $n_r < 1$. Equations (1) and (7) are functionally identical if one assumes that $R_n = r$, this being the assumption (for $n = 3$) that led to the standard version of the Schwarzschild equation.

The photon velocity calculated from (7) is the same as (6). That is, there is no energy propagation ($\beta = 0$) in the region $0.5 \leqslant n_r < 1$; so the standard Schwarzschild solution to the Einstein equation is not compatible with the assumed existence of the PV as a source for the visible universe, and thus must be discarded in the PV scenario.

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References

1. Daywitt W. C. The Planck vacuum. *Progress in Physics*, 2009, v. 1, 20.
2. Daywitt W. C. The source of the quantum vacuum. *Progress in Physics*, 2009, v. 1, 27.
3. Crothers S. J. On the general solution to Einstein's vacuum field and its implications for relativistic degeneracy. *Progress in Physics*, 2005, v. 1, 68.
4. Daywitt W. C. Limits to the validity of the Einstein field equations and General Relativity from the viewpoint of the negative-energy Planck vacuum state. *Progress in Physics*, 2009, v. 3, 27.
5. Schwarzschild K. Über das Gravitationsfeld eines Massenpunktes nach der Einsteinschen Theorie. *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften*, 1916, 189–196 (published in English as: Schwarzschild K. On the gravitational field of a point mass according to Einstein's theory. *Abraham Zelmanov Journal*, 2008, v. 1, 10–19).
6. Carroll B. W., Ostlie D. A. An introduction to modern astrophysics. Addison-Wesley, San Francisco — Toronto, 2007.