Abstract Submitted
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Transverse Gravitational Redshift ALEX MAYER, Jay Pritzker Fellowship — These two independently derived equations predict a relativistic redshift between two ideal clocks at identical gravitational potential separated by a constant distance (d). The general formula (1) includes an elliptic integral of the second kind ($E\ |2$). Here, b is the effective radius of the Earth ($\sim$6371km) and d the horizontal distance between two clocks at the altitude b. Eq. (2) is similar to the approximate formula $z \approx gh/c^2$ for the radial Einstein shift as both formulas are valid for small separation distances and both are readily derived from first principles. For a clock separation of 500 km at sea level, the two formulas yield the same prediction ($z \sim 10^{-12}$) to an accuracy of $\pm 1 \times 10^{-15}$. For 50 km, these formulas yield the same prediction ($z \sim 10^{-14}$) to an accuracy of $\pm 1 \times 10^{-19}$. This empirical prediction can be tested using modern atomic clocks and frequency transfer by fiber-optic cable.

$$z = \sec\left(\left[\frac{\sqrt{\frac{8GM\cos\phi}{bc^2}}\ E\left(\frac{\phi}{2}|2\right)}{\sqrt{\cos\phi}}\right]_{-\phi}^{+\phi}\right) - 1 \qquad \left[\phi = \frac{d}{2b}\right] \qquad (1)$$

$$z = \frac{\Delta f}{f} \approx \frac{4GM}{bc^2}\sin^2\left(\frac{d}{2b}\right) \qquad [d \ll b] \qquad (2)$$

Alex Mayer
Jay Pritzker Fellowship

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