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Pound-Rebka Experiment

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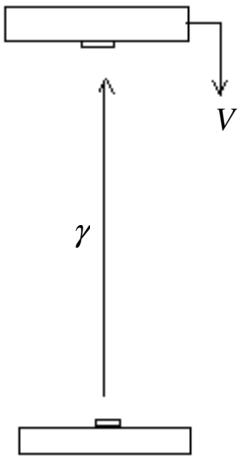
The real general relativity calculations are very simple.

In this experiment a gamma ray is emitted from the ground to the top of a tower and the gravitational redshift of the ray is cancelled in the detector with a Doppler shift due to the speed V. So, the speed V is a measure of the gravitational redshift when the frequency is the same.



$$x_0 = 8.61\times10^{-11} m \quad ; \quad \Delta R = h = 22.6m$$

$$V = \Delta V = 7.36\times10^{-7} ms^{-1}$$

Gravitational redshift:

$$x = x_0\sqrt{1-v^2/c^2} \quad \Leftrightarrow \quad \Delta x = x_0\frac{v}{c^2}\Delta v$$

And $$v = \sqrt{\frac{2GM}{R}} \quad \Leftrightarrow \quad \Delta v = \sqrt{2GM}\left(-\frac{1}{2}\right)R^{-3/2}\Delta R$$

$$\Leftrightarrow \quad \Delta x = -\frac{x_0}{c^2}\frac{GM}{R^2}\Delta R \quad \Leftrightarrow \quad \Delta x = -x_0\frac{gh}{c^2}$$

(G – gravitational constant; M – earth mass; R – earth radius; $g = 9.8ms^{-2}$)

$$\underline{\Delta x = -2.12\times10^{-25}}$$

Doppler effect:

$$x = x_0\frac{c+V}{c} \quad \Leftrightarrow \quad \Delta x = \frac{x_0}{c}\Delta V \quad \Leftrightarrow$$

$$\underline{\Delta x = +2.11\times10^{-25}}$$