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RAC Examples 1 2013

1) $$L_{Total} = \int_0^\infty \frac{L}{4\pi r^2} \times n \times 4\pi r^2 \, dr$$

$$= nL \int_0^\infty dr = \infty.$$

If objects in front block those behind, every L.O.S. still terminates on a star.

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2) $$z = \frac{1}{\sqrt{1 - \frac{r_s}{R_{emitted}}}} - 1 = \frac{1}{\sqrt{1 - \frac{2r_g}{r_{em}}}} - 1$$ ← Schwarzschild

$$= \frac{1}{\sqrt{1 - \frac{2GM}{rc^2}}} - 1$$

$$\approx 1 + \frac{1}{2}\frac{2GM}{rc^2} - 1 = \frac{GM}{rc^2} = \frac{1}{2}\frac{r_s}{r}$$ ← Newtonian

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a) Earth: $M = 6 \times 10^{24}$ kg

$r = 6 \times 10^3$ km $= 6 \times 10^6$ m

$$r_s = \frac{2 \times 6.67 \times 10^{-11} \times 6 \times 10^{24}}{9 \times 10^{16}} = 9 \times 10^{-3} \text{ m}$$

$$z = \frac{1}{2} \times \frac{9 \times 10^{-3}}{6 \times 10^6} = 7 \times 10^{-10}$$

b) Sun: $M = 2 \times 10^{30}$ kg

$r = 7 \times 10^8$ m

$$r_s = \frac{2 \times 6.67 \times 10^{-11} \times 2 \times 10^{30}}{9 \times 10^{16}} = 3 \times 10^3 \text{ m}$$

$$z = \frac{1}{2} \times \frac{3 \times 10^3}{7 \times 10^8} = 2 \times 10^{-6}$$