1)

155(16): Equation for Photon Mass due to Gravitational Time Delay.

The time delay is:

$$\Delta t = t_1 - t_0 \quad -(1)$$

where:

$$t_1 = \frac{2}{c}\left(\int_{R_0}^{R_E} f(r)\,dr + \int_{R_0}^{R_p} f(r)\,dr\right) \quad -(2)$$

and

$$f(r) = \left(1 - \frac{r_0}{r}\right)^{-1}\left(1 - \left(1 - \frac{r_0}{r}\right)\left(\frac{1}{a^2} + \frac{1}{r^2}\right)R_0^2\right)^{-1/2}. \quad -(3)$$

Here:

$$t_0 = \frac{2}{c}\left(\int_{R_0}^{R_E}\left(1 - \frac{R_0^2}{r^2}\right)^{-1/2} dr + \int_{R_0}^{R_p}\left(1 - \frac{R_0^2}{r^2}\right)^{-1/2} dr\right) \quad -(4)$$

$$= \frac{2}{c}(r_1 + r_2)$$

where $r_1 = \left(R_E^2 - R_0^2\right)^{1/2}$, $r_2 = \left(R_p^2 - R_0^2\right)^{1/2}$. $-(5)$

Here $a = \left(\frac{\hbar\omega}{mc^2}\right)R_0$ $-(6)$

where m is the photon mass. In this notation:

R_E = near orbital radius of the earth.
R_p = near orbital radius of a planet.
R_0 = distance of closest approach of radar beam to the sun.
$r_1 + r_2$ = distance of earth to planet
$\hbar\omega$ = quantum of energy of one photon in the radar beam