1) 155(14) : Time Delay Calculation for Zero Deflection ($m = 0$, $M = 0$)

The basic integral is, in general:

$$t = \frac{1}{c}\int\left(1-\frac{r_0}{r}\right)^{-1}\left(\frac{1}{\ldots}-\left(1-\frac{r_0}{r}\right)\left(\frac{1}{a^2}+\frac{1}{r^2}\right)b^2\right)^{-1/2}dr \quad -(1)$$

$$-(2)$$

When: $m = 0$, $M = 0$

there is no deflection, and:

$$\boxed{t_0 = \frac{1}{c}\int\left(1-\frac{b^2}{r^2}\right)^{-1/2}dr = \frac{1}{c}\left(r^2-b^2\right)^{1/2}} \quad -(3)$$

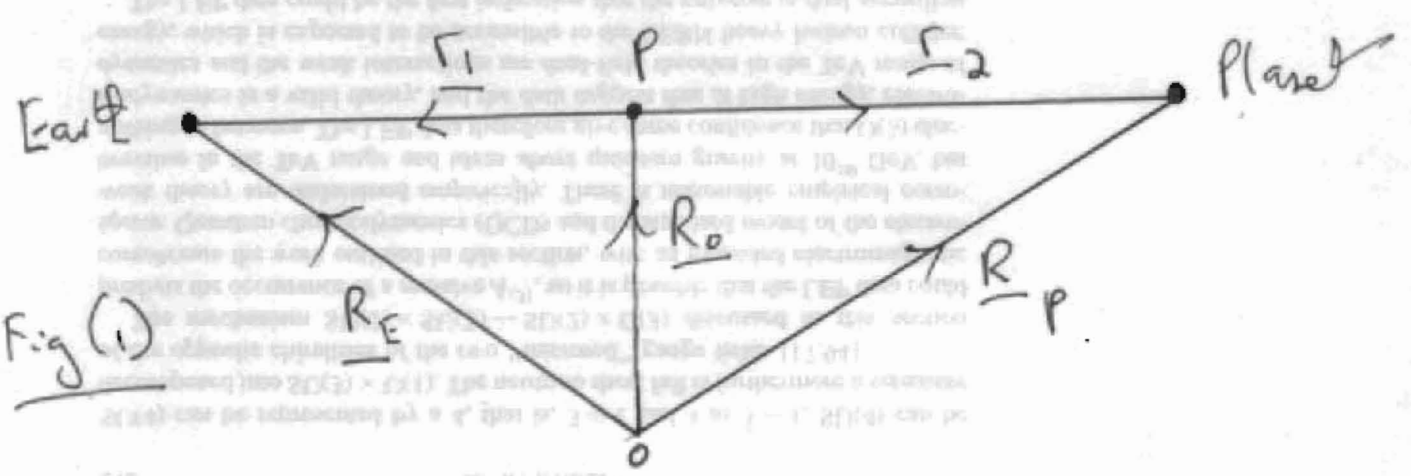


Fig (1)

From Fig (1): $\underline{R}_E = \underline{R}_0 + \underline{r}_1 \quad -(4)$

$\underline{R}_p = \underline{R}_0 + \underline{r}_2 \quad -(5)$

so: $\underline{r}_1 = \underline{R}_E - \underline{R}_0 \quad -(6)$

$\underline{r}_2 = \underline{R}_p - \underline{R}_0 \quad -(7)$

2) Therefore:

$$r_1^2 = R_E^2 - R_0^2 \quad \text{— (8)}$$

$$r_2^2 = R_p^2 - R_0^2 \quad \text{— (9)}$$

The time taken to go from the earth to point P is:

$$t_1 = \frac{1}{c}\int_0^{R_E}\left(1 - \frac{R_0^2}{r^2}\right)^{-1/2} dr$$

$$= \frac{1}{c}\left(R_E^2 - R_0^2\right)^{1/2} \quad \text{— (10)}$$

$$= \frac{r_1}{c}$$

The time taken to go from point P to the planet is:

$$t_2 = \frac{1}{c}\int_0^{R_p}\left(1 - \frac{R_0^2}{r^2}\right)^{-1/2} dr$$

$$= \frac{1}{c}\left(R_p^2 - R_0^2\right)^{1/2} \quad \text{— (11)}$$

$$= \frac{r_2}{c}$$

The time taken to go from earth to planet is:

$$\boxed{t_0 = t_1 + t_2 = \frac{1}{c}\left(r_1 + r_2\right)} \quad \text{— (12)}$$

The return trip takes twice as long, i.e. $2t_0$.

Therefore $\underline{b}$ is $\underline{R_0}$.