$$\tau = \frac{D}{c} = \frac{1}{c}\left[\sqrt{R^2+H_x^2} + H_x\cos i - R\cos\phi \sin i\right]$$

$$= \frac{GM_{\odot}m}{c^3}\left[\sqrt{r^2+h_x^2} + h_x\cos i - r\cos\phi \sin i\right]$$

$(\phi=0)$

$$\tau_l = \frac{D_l}{c} = \frac{GM_{\odot}m}{c^3}\left[\sqrt{r^2+h_x^2} + h_x\cos i - r\sin i\right]$$

$(\phi=\pi)$

$$\tau_t = \frac{D_t}{c} = \frac{GM_{\odot}m}{c^3}\left[\sqrt{r^2+h_x^2} + h_x\cos i + r\sin i\right]$$

$$A(r,\tau) = \begin{cases} \dfrac{2GM_{\odot}m\, r}{c^3\sqrt{(\tau-\tau_l)(\tau_t-\tau)}} & \tau_l<\tau<\tau_t \\ 0 & \text{otherwise} \end{cases}$$

$$\Delta B_\nu(R) = 4\pi\left\{B_\nu(T_{new}(R)) - B_\nu(T(R))\right\}$$

$$\Delta L(R) = \int_{\nu_{min}}^{\nu_{max}} \Delta B_\nu(R)\, d\nu$$

$$\frac{\partial \Delta L(\tau)}{\partial \tau} \quad \Psi(\tau) = \frac{GM_{\odot}m}{c^2}\int_{r_{in}}^{r_{out}} \Delta L(r) A(r,\tau)\, dr$$

choose suitable τ range and plot $\Psi(\tau)$ against τ