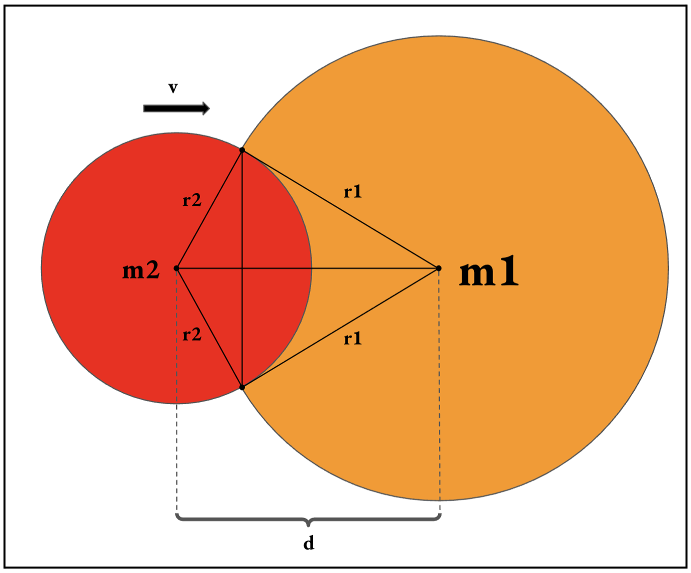
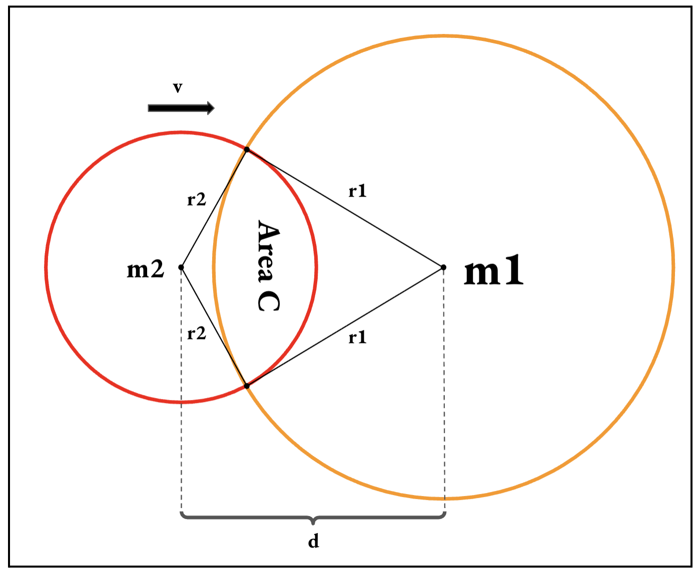
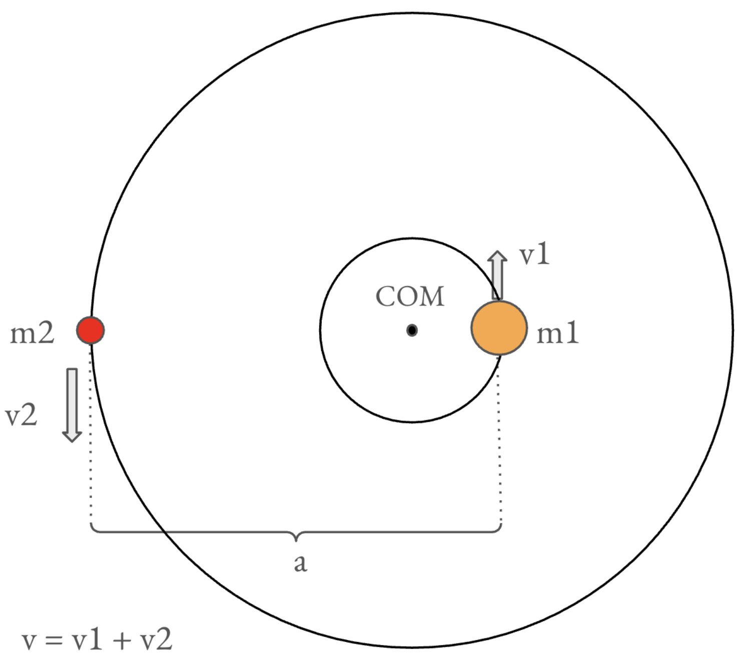
(1) Major Assumptions:

- Uniform Luminosity Distribution (No limb darkening, luminosity/projected area = const)
- Circular Orbit (e = 0)
- Orbital Inclination is 90 deg
- Distance to System >> Orbital Radii
- Celestial bodies m1 and m2 is perfectly spherical with projected areas being perfect circles







$$v_{rel} = \sqrt{\frac{G\left(m_1 + m_2\right)}{a}} = \left|\vec{v}_1\right| + \left|\vec{v}_2\right|$$

$$v_1 = \frac{m_2}{m_1 + m_2}\sqrt{\frac{G\left(m_1 + m_2\right)}{a}}, \quad v_2 = \frac{m_1}{m_1 + m_2}\sqrt{\frac{G\left(m_1 + m_2\right)}{a}}$$

$$Tangential\,Velocity = v(t)$$

$$v(t) = v_{rel}cos(\omega t - \phi), \qquad \omega = \frac{2\pi}{P}, \qquad \phi = arcsin\left(\frac{r_1 + r_2}{a}\right)$$

Eclipse begins at $t = 0$

$$x(t) = \int v(t)dt = \frac{v_{rel}}{\omega}sin(\omega t - \phi)$$

$$\Rightarrow x(t) = \frac{v_{rel}}{\omega}sin(\omega t - \phi) + \left(r_1 + r_2\right)$$

$$d(t) = \left|\left(r_1 + r_2\right) - x(t)\right| = \left|-\frac{v_{rel}}{\omega}sin(\omega t - \phi)\right|$$

$$2r_2 = \frac{v_{rel}}{\omega}sin(\omega t - \phi) + \left(r_1 + r_2\right)$$

$$r_2 - r_1 = \frac{v_{rel}}{\omega}sin(\omega t - \phi)$$

$$\frac{arcsin\left(\left(r_2 - r_1\right)\frac{\omega}{v_{rel}}\right) + \phi}{\omega} = t_1$$

$$2r_2 + \left(2r_1 - 2r_2\right) = \frac{v_{rel}}{\omega}sin(\omega t - \phi) + \left(r_1 + r_2\right)$$

$$r_1 - r_2 = \frac{v_{rel}}{\omega}sin(\omega t - \phi)$$

$$\frac{arcsin\left(\left(r_1 - r_2\right)\frac{\omega}{v_{rel}}\right) + \phi}{\omega} = t_2$$

$$2r_1 + 2r_2 = -\frac{v_{rel}}{\omega}sin(\omega t - \phi) + \left(r_1 + r_2\right)$$

$$\frac{arcsin\left(\left(r_1 + r_2\right)\frac{\omega}{v_{rel}}\right) + \phi}{\omega} = t_3$$