

PHYS233: Astronomy

Useful constants and formulas:

For Earth: $M_{\text{Earth}} = 5.972 \times 10^{24} \text{ kg}$, if spherical approximation: $R = 6370 \text{ km}$
If ellipsoid: $a = 6378137 \text{ m}$, $b = 6356752 \text{ m}$,

For Sun: $M_{\odot} = 1.989 \times 10^{30} \text{ kg}$, $R_{\odot} = 6.96 \times 10^8 \text{ m}$, $L_{\odot} = 3.9 \times 10^{26} \text{ W}$.

$G = 6.673 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$, $1 \text{ AU} = 1.49597870 \times 10^{11} \text{ m}$, 1 amu is $1.6604 \times 10^{-27} \text{ kg}$.

For calculating shortest distance between two points (φ_1, λ_1) and (φ_2, λ_2) on Earth's surface

$$\cos \Psi = \sin \varphi_1 \sin \varphi_2 + \cos \varphi_1 \cos \varphi_2 \cos(\lambda_1 - \lambda_2).$$

Distance = $R \Psi$, where Ψ is in radians and R is the radius of Earth. $R = 6370 \text{ km}$.

$$\cos A \cos B \pm \sin A \sin B = \cos(A \mp B)$$

$$\Theta = h + \alpha, \quad \text{escape velocity: } v_e^2 = \frac{2G(m_1 + m_2)}{R}$$

Conversion between Horizontal system to equatorial system:

$$\sin A \cos a = \sin h \cos \delta \qquad \cos A \cos a = \cos h \cos \delta \sin \phi - \sin \delta \cos \phi$$

$$\sin a = \cos h \cos \delta \cos \phi + \sin \delta \sin \phi$$

Conversion between Equatorial system to ecliptic system:

$$\sin \lambda \cos \beta = \sin \delta \sin \varepsilon + \cos \delta \cos \varepsilon \sin \alpha \qquad \cos \lambda \cos \beta = \cos \delta \cos \alpha$$

$$\sin \beta = \sin \delta \cos \varepsilon - \cos \delta \sin \varepsilon \sin \alpha \qquad \varepsilon = 23^\circ 26'$$

$$\text{Kepler's third law: } P^2 = \frac{4\pi^2}{G(m_1 + m_2)} a^3 \qquad \text{synodical period: } \frac{1}{P_{1,2}} = \frac{1}{P_1} - \frac{1}{P_2}$$

$$\frac{1}{2} v^2 - \frac{\mu}{r} = h, \quad h = -\frac{\mu}{2a} \text{ for ellipse}$$