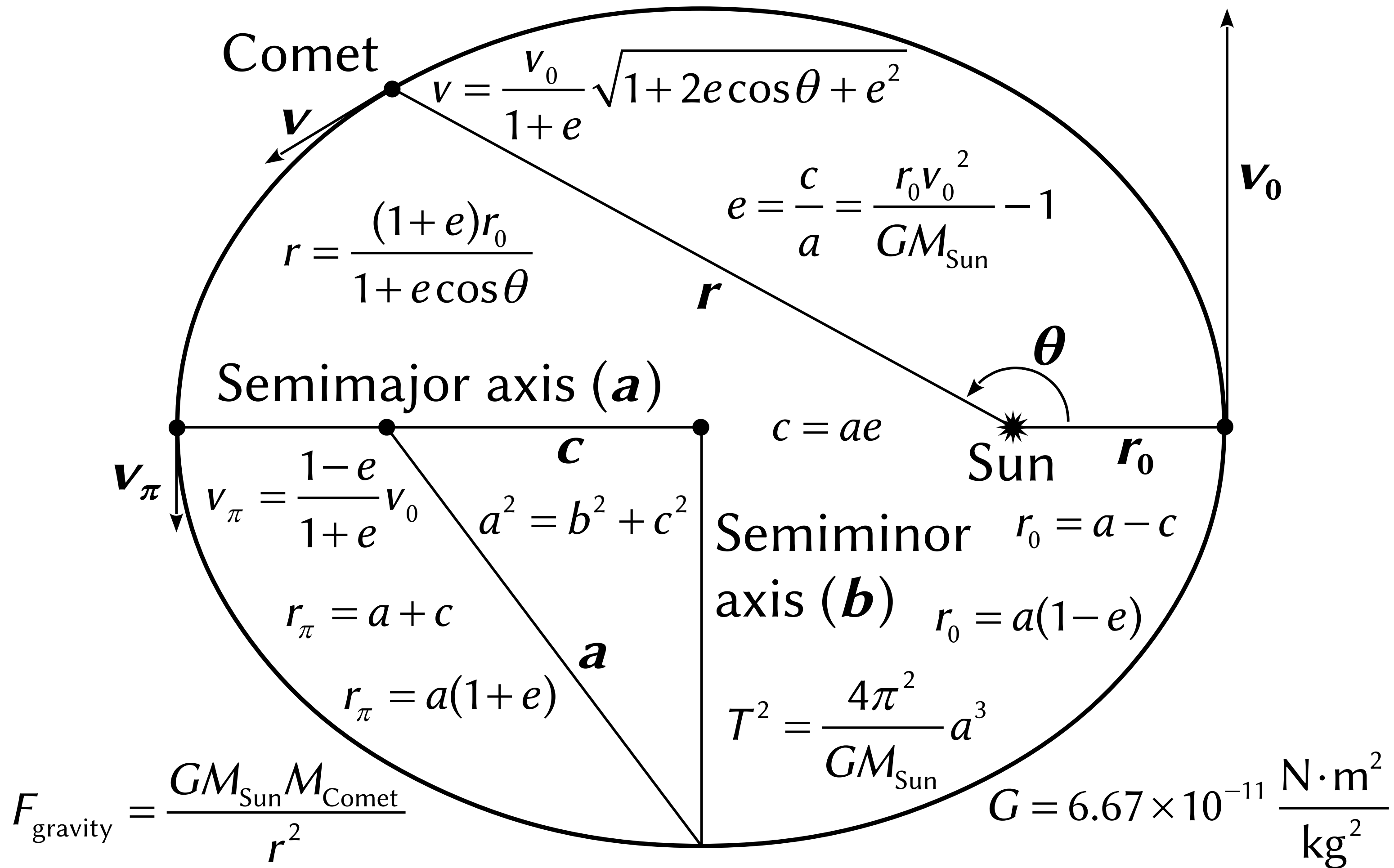


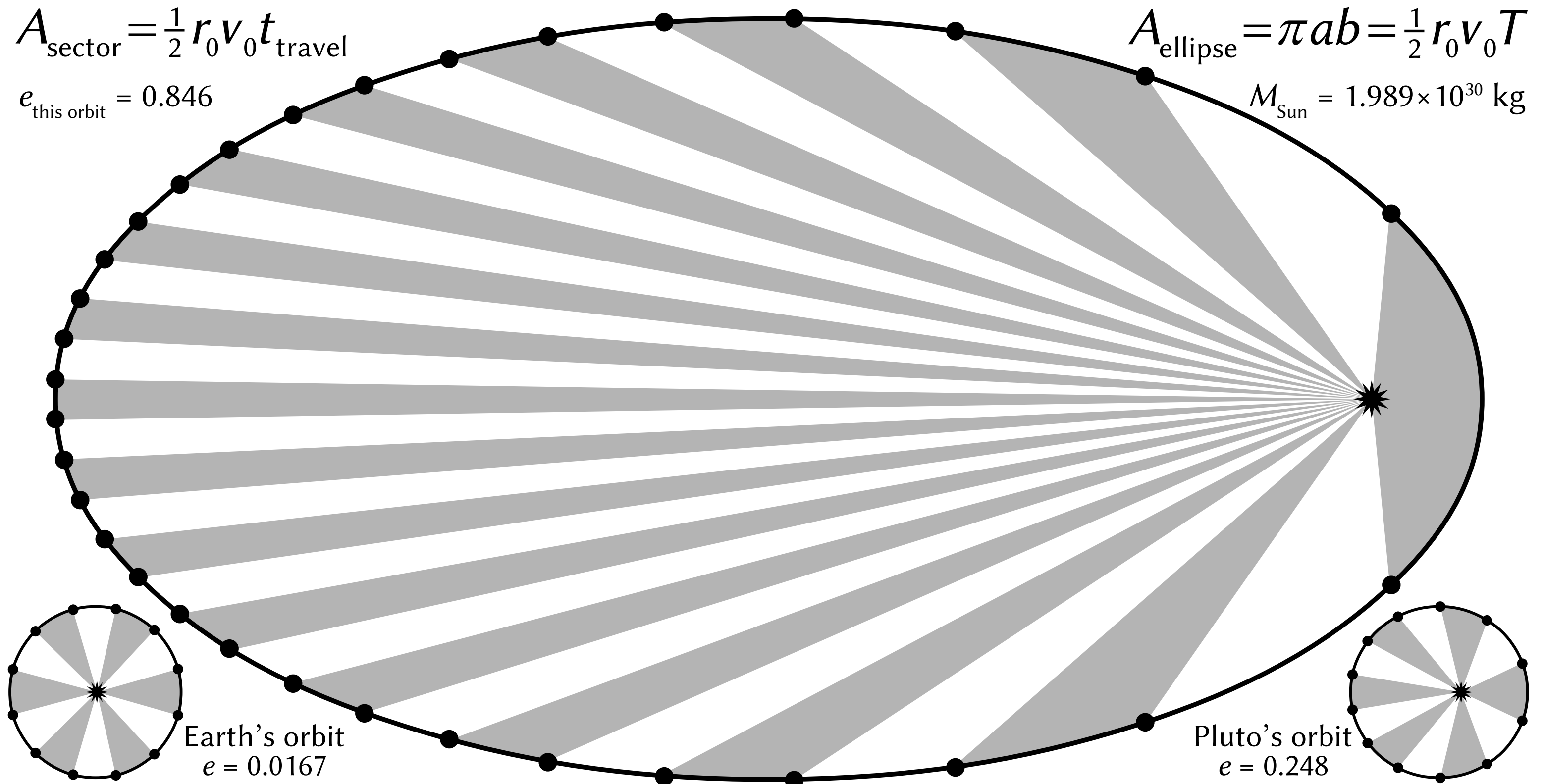


$$A_{\text{sector}} = \frac{1}{2} r_0 v_0 t_{\text{travel}}$$

$$e_{\text{this orbit}} = 0.846$$

$$A_{\text{ellipse}} = \pi ab = \frac{1}{2} r_0 v_0 T$$

$$M_{\text{Sun}} = 1.989 \times 10^{30} \text{ kg}$$



As an object orbits the sun, the line segment from it to the sun sweeps out equal areas in equal times. For each orbit shown, travel time is the same between any two adjacent dots. Sector areas are equal.

$$t_{\theta} = \frac{r_0}{v_0(1-e)} \left[2\sqrt{\frac{1+e}{1-e}} \tan^{-1} \left(\sqrt{\frac{1-e}{1+e}} \tan \frac{\theta}{2} \right) - \frac{e(1+e)\sin\theta}{1+e\cos\theta} \right]$$

$$P_{\text{ellipse}} = 2\pi a \left[1 - \left(\frac{1}{2} \right)^2 \frac{e^2}{1} - \left(\frac{1 \cdot 3}{2 \cdot 4} \right)^2 \frac{e^4}{3} - \left(\frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6} \right)^2 \frac{e^6}{5} - \dots \right]$$

$$e = \frac{c}{a} = \frac{\sqrt{a^2 - b^2}}{a} = \sqrt{1 - \left(\frac{b}{a} \right)^2} \qquad h = \left(\frac{a-b}{a+b} \right)^2 = \left(\frac{1 - \sqrt{1-e^2}}{1 + \sqrt{1-e^2}} \right)^2$$

$$P_{\text{ellipse}} = \frac{\pi(a+b)}{4} \left[4 + h + \left(\frac{1}{4} \right)^2 h^2 + \left(\frac{1 \cdot 3}{4 \cdot 6} \right)^2 h^3 + \left(\frac{1 \cdot 3 \cdot 5}{4 \cdot 6 \cdot 8} \right)^2 h^4 + \dots \right]$$

r_0 = distance from sun to closest point in orbit (perihelion)

r = distance from sun to current location

v_0 = velocity at perihelion v = velocity at current location

θ (theta) = angle from perihelion to current location

a = half of longest axis of orbit b = half of shortest axis

c = distance from center of orbit to a focus

e = eccentricity of orbit G = gravitational constant

t_θ = travel time from perihelion to current location

T = total travel time for an orbit F_{gravity} = force of gravity

M_{Sun} = mass of sun M_{Comet} = mass of comet

r_π = distance from sun when the angle is π (i.e., 180°)

v_π = velocity at farthest point from sun (aphelion)

A_{ellipse} = total area of orbit P_{ellipse} = perimeter of orbit

The LORD by wisdom
hath founded the earth;
by understanding hath he
established the heavens.

Proverbs 3:19