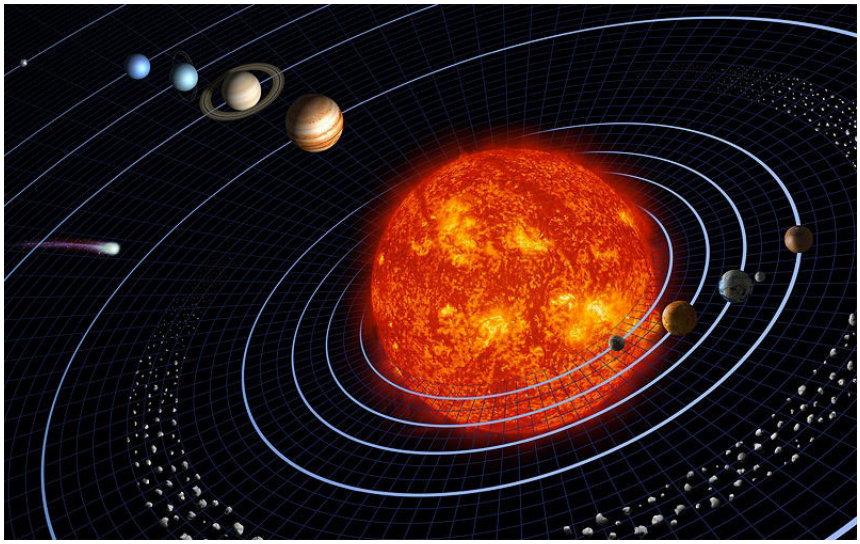
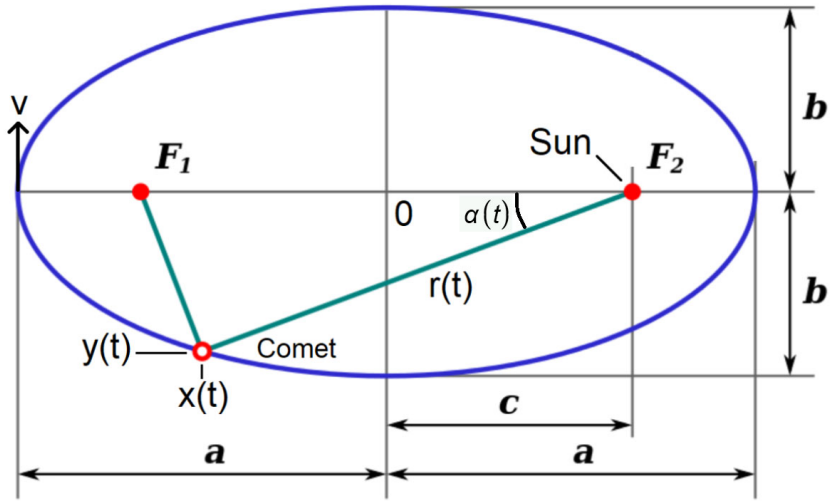
https://en.wikipedia.org/wiki/Great_Comet_of_1811





$G := 6.674 \cdot 10^{-11}\ N \cdot \frac{m^2}{kg^2}$ $AU := 150 \cdot 10^6\ km$ $m_s := 1.9885 \cdot 10^{30}\ kg$

$d := 30\ km$ $\rho := 500\ \frac{kg}{m^3}$ $m := \rho \cdot \frac{4}{3} \cdot \pi \cdot \left(\frac{d}{2}\right)^3 = (7.069 \cdot 10^{15})\ kg$ Comet

$a := 212.4\ AU$ $e := 0.995125$ $b := a \cdot \sqrt{1 - e^2} = 20.947\ AU$ $c := a \cdot e = 211.365\ AU$

$v := 100\ \frac{m}{s}$ $t_{end} := 3090\ yr$ $N := \frac{t_{end}}{yr} \cdot 12$

$\alpha(0\ s) = \pi\ rad$ $r(0\ s) = a + c$ $\alpha'(0\ s) = \frac{v}{a + c}$

$$\frac{m \cdot \alpha'(t)^2 \cdot r(t)^2}{r(t)} = G \cdot \frac{m \cdot m_s}{r(t)^2} \qquad m \cdot \alpha''(t) \cdot r(t) = 2\, m \cdot \alpha'(t) \cdot \alpha(t) \cdot r(t)$$

$$\begin{bmatrix} \alpha \\ r \end{bmatrix} := \text{Odesolve}\left(\begin{bmatrix} \alpha(t) \\ r(t) \end{bmatrix}, t_{end}, N\right)$$

$$\frac{m \cdot \alpha'(t)^2 \cdot r(t)^2}{r(t)} = G \cdot \frac{m \cdot m_s}{r(t)^2} \qquad v(t) = \alpha'(t) \cdot r(t)$$

$$\alpha'(t)^2 \cdot r(t) = G \cdot \frac{m_s}{r(t)^2} \qquad \alpha'(t)^2 = G \cdot \frac{m_s}{r(t)^3}$$

$$\sqrt{N \cdot \frac{m^2}{kg^2} \cdot \frac{kg}{m^3}} = 1 \frac{1}{s}$$

$$\alpha'(t)^2 = G \frac{m_s}{r(t)^3} \qquad m \cdot \alpha''(t) \cdot r(t) = 2\, m \cdot \alpha'(t) \cdot \alpha(t) \cdot r(t)$$