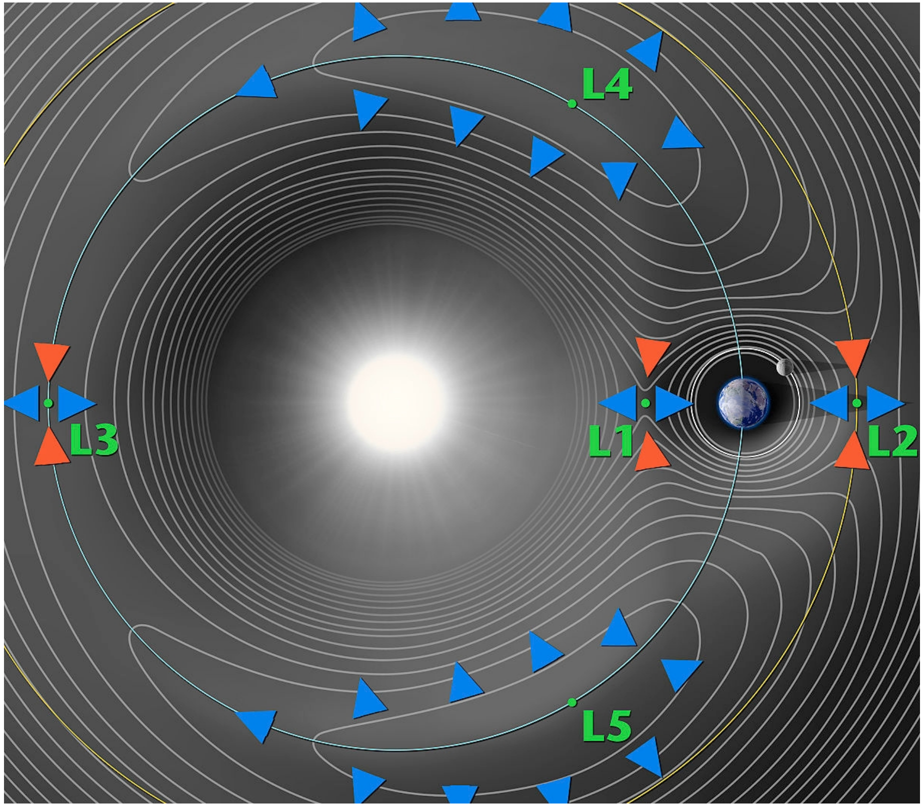
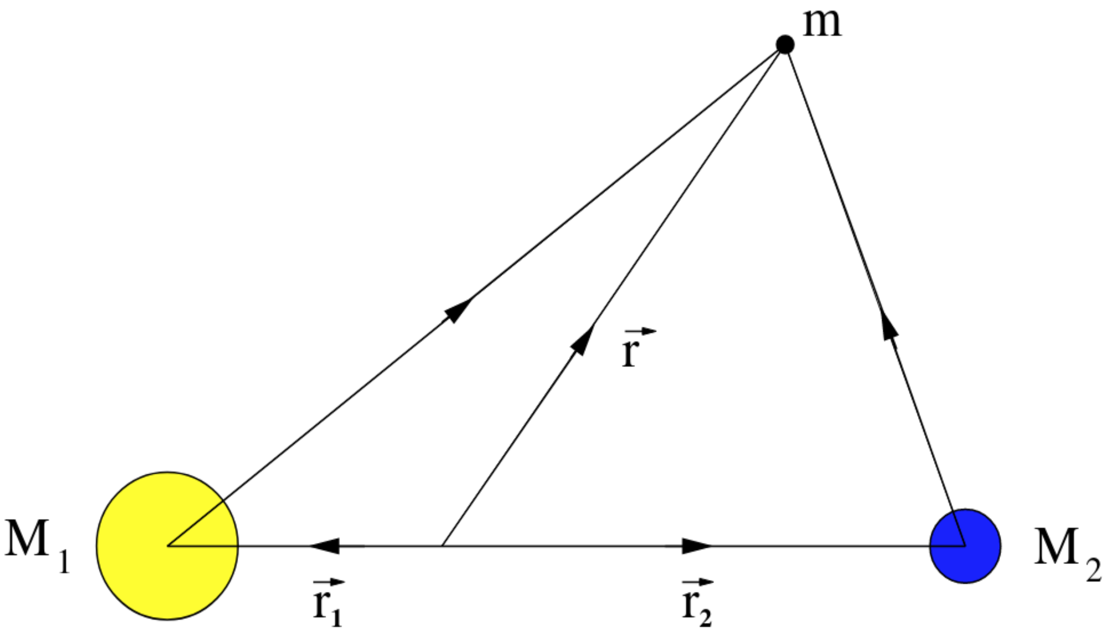
# Lagrange points



# Equations of motion




$$\vec{F}(t) = m\frac{d^2\vec{r}(t)}{dt^2} \qquad \vec{F} = -\frac{GM_1m}{|\vec{r}-\vec{r_1}|^3}(\vec{r}-\vec{r_1}) - \frac{GM_2m}{|\vec{r}-\vec{r_2}|^3}(\vec{r}-\vec{r_2})\,.$$

# Co-rotating reference frame

$$\vec{F}_\Omega = \vec{F} - 2m\left(\vec{\Omega} \times \frac{d\vec{r}}{dt}\right) - m\,\vec{\Omega} \times (\vec{\Omega} \times \vec{r})\,.$$

$$U_\Omega = U - \vec{v} \cdot (\vec{\Omega} \times \vec{r}) + \frac{1}{2}(\vec{\Omega} \times \vec{r}) \cdot (\vec{\Omega} \times \vec{r})\,,$$

$$\ddot{x} - 2\dot{y} - x = -\tfrac{(1-\mu)(x+\mu)}{d^3} - \tfrac{\mu(x-1+\mu)}{r^3}$$

$$\Omega* = \tfrac{1-\mu}{d} + \tfrac{\mu}{r} + \tfrac{x^2+y^2}{2}$$

$$\ddot{y} + 2\dot{x} - y = -\tfrac{(1-\mu)y}{d^3} - \tfrac{\mu y}{r^3}$$

$$\ddot{z} = -\tfrac{(1-\mu)z}{d^3} - \tfrac{\mu z}{r^3}$$

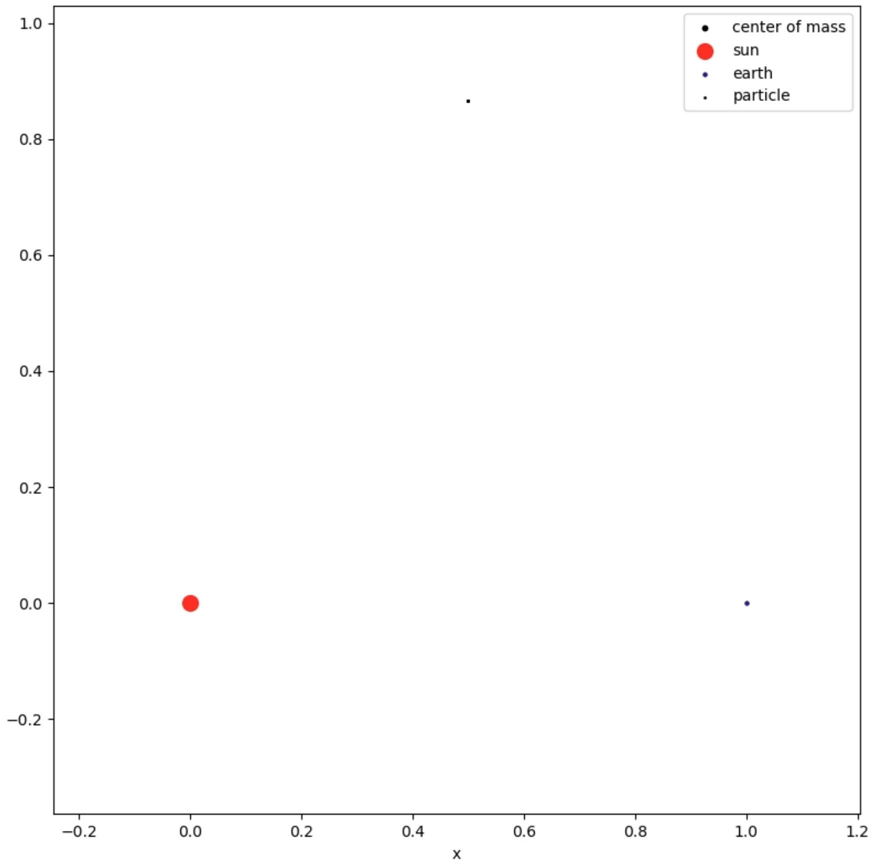
$$L1: \quad \left(R\left[1 - \left(\frac{\alpha}{3}\right)^{1/3}\right], 0\right),$$

$$L2: \quad \left(R\left[1 + \left(\frac{\alpha}{3}\right)^{1/3}\right], 0\right),$$

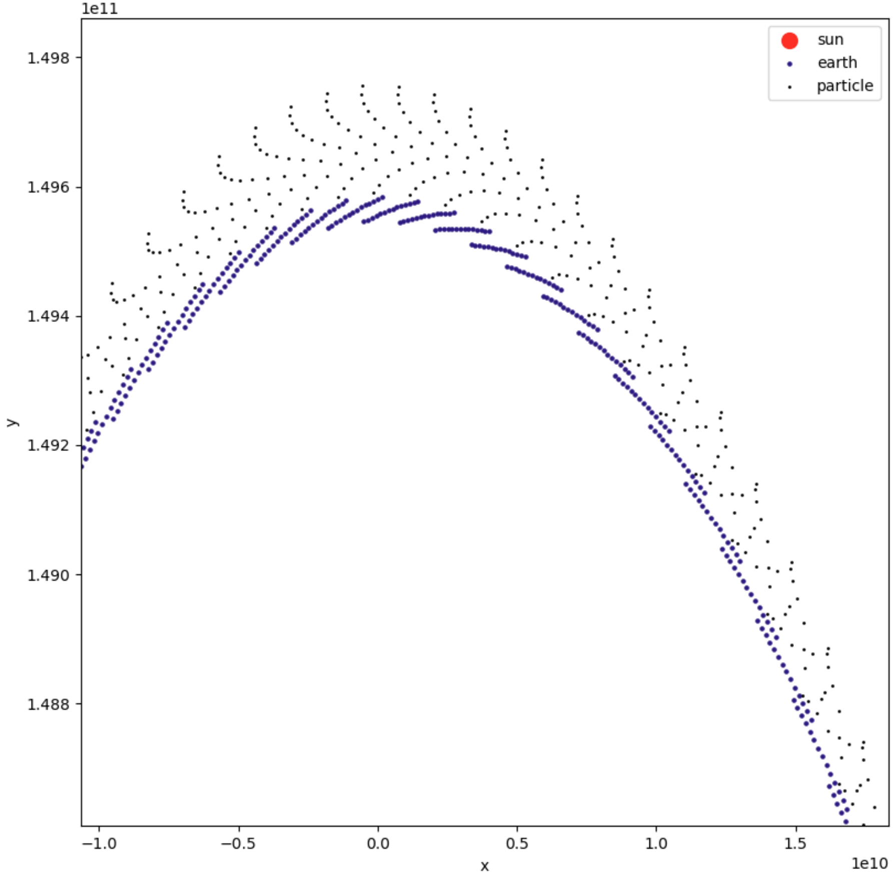
$$L3: \quad \left(-R\left[1 + \frac{5}{12}\alpha\right], 0\right).$$

$$L4: \quad \left(\frac{R}{2}\left(\frac{M_1 - M_2}{M_1 + M_2}\right), \frac{\sqrt{3}}{2}R\right),$$

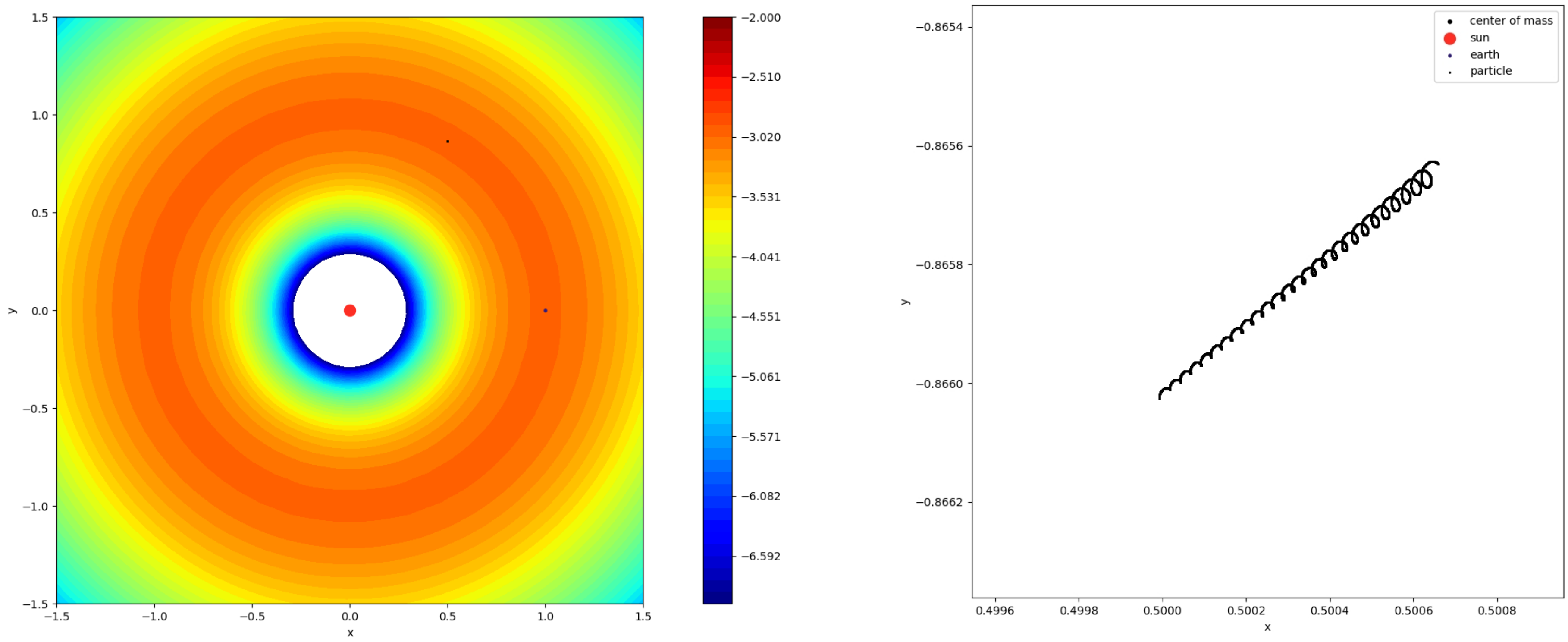
$$L5: \quad \left(\frac{R}{2}\left(\frac{M_1 - M_2}{M_1 + M_2}\right), -\frac{\sqrt{3}}{2}R\right).$$



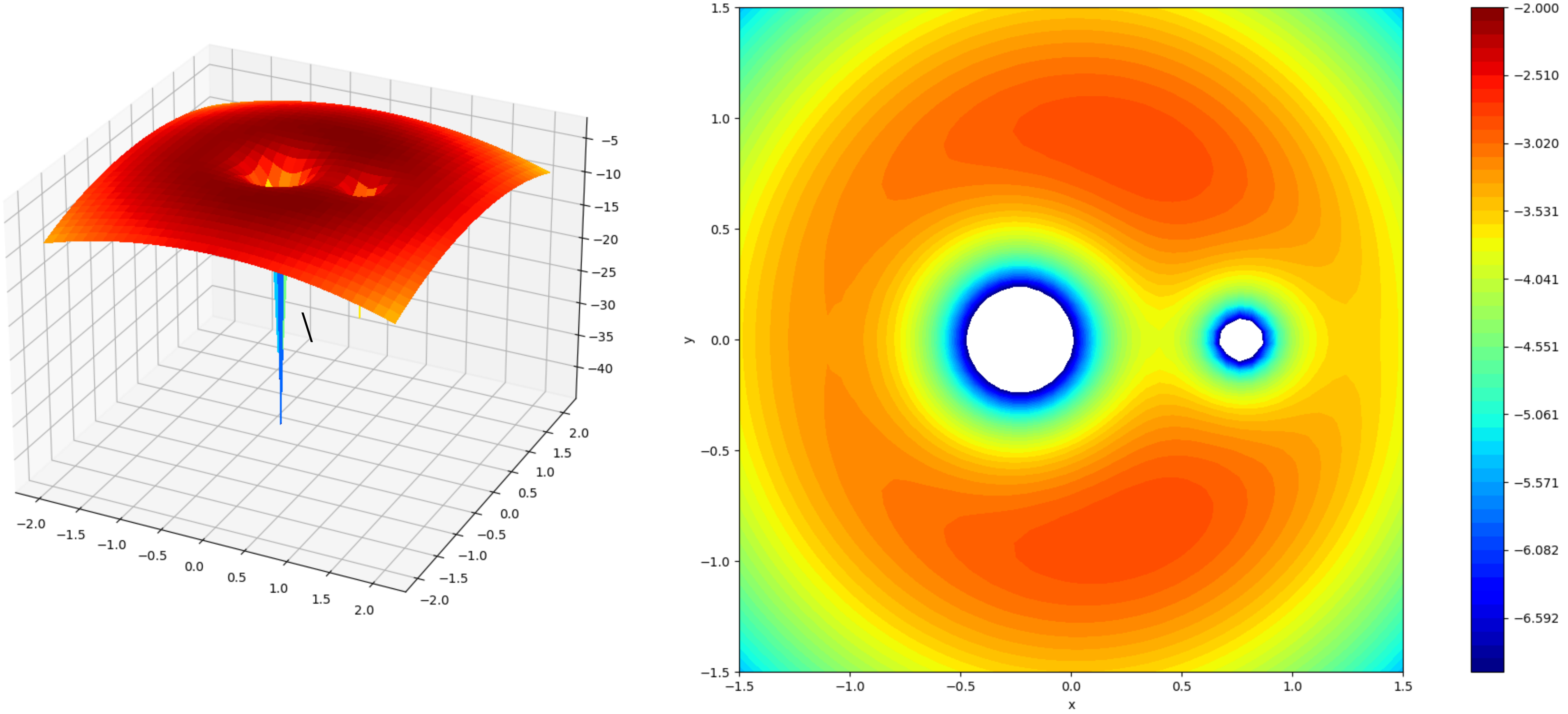
center of mass
sun
earth
particle
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
x

1e11
sun
earth
particle
1.498
1.496
1.494
1.492
1.490
1.488
y
−1.0
−0.5
0.0
0.5
1.0
1.5
x
1e10



center of mass
sun
earth
particle
x
y



−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
−5
−10
−15
−20
−25
−30
−35
−40
x
y
−2.000
−2.510
−3.020
−3.531
−4.041
−4.551
−5.061
−5.571
−6.082
−6.592