


A diagram illustrating a vector field. A source point S is shown on the left, and a target point T is shown on the right. A dashed vector \vec{r}_0 points from S to T . At point T , a solid vector \vec{j}_0 points upwards.

$$\vec{R}_{ij} = \vec{R}_i - \vec{R}_j$$

Força : $\vec{F}_{ij} = G M_i m_j \cdot \frac{\vec{R}_{ij}}{R_{ij}^3}$

 $\vec{F}_{ij} = m_j \vec{a}_{ij}$

$$\vec{a}_{ij} = G M_i \frac{\vec{R}_{ij}}{R_{ij}^3}$$

Aceleração Total:

$$\vec{a}_j = \sum_{i \neq j} \vec{a}_{ij}$$

$$\vec{z}(t) = \begin{pmatrix} x \\ y \\ \sigma_x \\ \sigma_y \end{pmatrix}$$

Runge-Kutta: $\frac{\partial \vec{z}}{\partial t} = \begin{pmatrix} \vec{v} \\ \vec{a} \end{pmatrix} = f(\vec{z}, t) = \begin{pmatrix} v_x \\ v_y \\ a_x \\ a_y \end{pmatrix}$

Terra - Sol

$$\cancel{m_T} \frac{\partial^2 \vec{r}}{\partial t^2} = -G \cancel{m_T} \cdot M_S \frac{\vec{r}}{r^3}$$

⑤ $\vec{r} \rightarrow \bullet T$
 $\vec{r} = (x, y)$

Linear: Redução de ordem

$$\vec{z}(t) = \begin{pmatrix} \vec{r}(t) \\ \vec{v}(t) \end{pmatrix}$$

$$\left\{ \begin{array}{l} \frac{\partial}{\partial t} \vec{r}(t) = \vec{v}(t) \quad \frac{\partial}{\partial t} \vec{v}(t) = \vec{a}(\vec{r}(t)) \end{array} \right.$$

$$\vec{a}(\vec{r}) = -G M_S \frac{\vec{r}}{r^3}$$

$$\left\{ \begin{array}{l} \frac{\partial}{\partial t} \vec{z}(t) = \vec{f}(\vec{z}(t), t) \end{array} \right. \quad \begin{array}{l} RK \\ Euler \end{array}$$

odeint \rightarrow
+ cond. initial $\vec{f}(\vec{z}, t) = \begin{pmatrix} \vec{v} \\ \vec{a} \end{pmatrix}$

$\vec{z} = (x, y, v_x, v_y)$
 $\vec{a} = \vec{a}(\vec{r})$

$t=0 \quad \Delta t \quad 2\Delta t \quad \dots$

$\vec{z}_0 = \begin{cases} \vec{r}_0 \\ \vec{v}_0 \end{cases}$

$\vec{z}_1 = \begin{pmatrix} \vec{r}_1 \\ \vec{v}_1 \end{pmatrix}$

Euler: $\vec{z}_1 = \vec{z}_0 + \Delta t \vec{f}(\vec{z}_0, t_0)$

$$\begin{aligned} \vec{r}_1 &= \vec{r}_0 + \Delta t \vec{v}_0 \\ \vec{v}_1 &= \vec{v}_0 + \Delta t \vec{a}(\vec{r}_0) \end{aligned}$$