# Simulation of the trajectory of the satellite Galileo-FOC FM4


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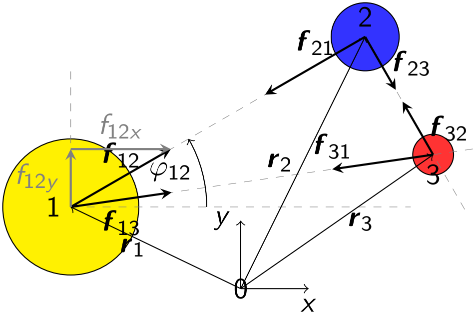
- Problem: simulate the trajectory of the satellite (subscripted by 3) with given initial conditions
- mass afflicted bodies generate gravity forces to each other




$$\boldsymbol{f}_{ij} = \gamma \underbrace{\frac{m_i m_j}{|\boldsymbol{r}_j - \boldsymbol{r}_i|^2}}_{\text{magnitude}} \underbrace{\frac{\boldsymbol{r}_j - \boldsymbol{r}_i}{|\boldsymbol{r}_j - \boldsymbol{r}_i|}}_{\text{direction}} = \gamma \frac{m_i m_j}{|\boldsymbol{r}_j - \boldsymbol{r}_i|^3} (\boldsymbol{r}_j - \boldsymbol{r}_i)\,, \tag{1}$$

To obtain a system of ordinary differential equations use *Newtons* 2nd Law:

$$m\ddot{r} = \sum_n f_n. \tag{2}$$

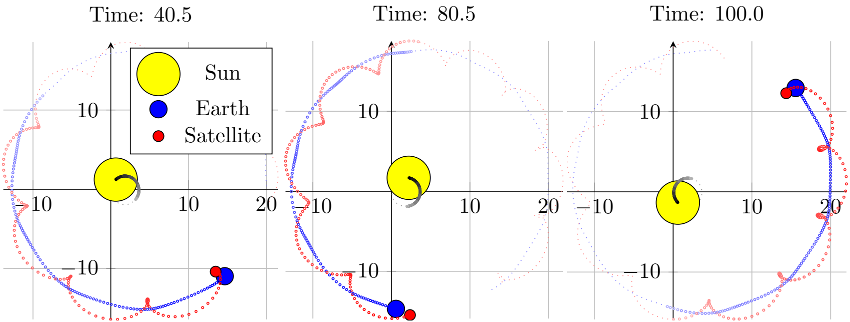
By defining the state vector $\boldsymbol{x}$ as:

$$\boldsymbol{x} = \begin{bmatrix} r_{1x} & r_{1y} & r_{2x} & r_{2y} & r_{3x} & r_{3y} & \dot{r}_{1x} & \dot{r}_{1y} & \dot{r}_{2x} & \dot{r}_{2y} & \dot{r}_{3x} & \dot{r}_{3y} \end{bmatrix}^T$$

equation 2 can be written as

$$\dot{\boldsymbol{x}} = \begin{bmatrix} \boldsymbol{x}(7:12) \\ \frac{1}{m_1}\left(f_{12x} + f_{13x}\right) \\ \frac{1}{m_1}\left(f_{12y} + f_{13y}\right) \\ \frac{1}{m_2}\left(f_{21x} + f_{23x}\right) \\ \frac{1}{m_2}\left(f_{21y} + f_{23y}\right) \\ \frac{1}{m_3}\left(f_{31x} + f_{32x}\right) \\ \frac{1}{m_3}\left(f_{31y} + f_{32y}\right) \end{bmatrix} \tag{3}$$

Solving of equation 3 with the advanced *Euler*-method leads to:



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- the trajectory of the satellite is stable
- but a phase shift of the satellite can be observed, which is increasing by every rotation around the sun by the earth
- by accepting this, a later control of the satellite will not be necessary