Elements of Celestial Mechanics
(Elementi di Meccanica Celeste)

2024/2025, second semester

Teachers: Giulio Baù, Giacomo Lari

Celestial Mechanics is a branch of Mathematics devoted to the study of the motion of celestial bodies on the basis of Newton's law of universal gravitation formulated in his work *Principia* (1687).

Newton's theory of universal gravitation was developed right after the fundamental contributions of Galileo and Kepler. In particular, Galileo made experimental studies on falling bodies, and Kepler formulated his three laws of planetary motion as a result of direct observations. Newton's idea was that the force keeping the Moon in orbit around the Earth is the same that governs the fall of the bodies on Earth.

One fundamental problem in Celestial Mechanics is to predict the motion of N massive bodies, which are viewed as point particles, interacting with each other through Newton's gravitational force. The simplest case, represented by the two-body problem ($N = 2$), can be completely solved. On the other hand, for $N > 2$ the problem has no closed-form solution in general. Other interesting problems arise when the bodies are assumed to have a finite size, like for example the study of the effects produced by tides.

In the first part of the course we will study in detail the two-body problem, the circular restricted three-body problem, and the problem of tides. In the second part we will deal with the elimination of the singularity at collision of the two-body problem, the planetary equations of Lagrange and Gauss, and we will show how to describe the Earth as a rigid rotating body.

Practical information

The course lasts 48 hours and it takes place in the second semester. The exam consists of an oral discussion on the topics presented during the lectures. The prerequisites for this course are the notions acquired in the first/second year courses in Mathematics, Physics or Aerospace Engineering.

If you are interested to have more information about this course, you can contact us by e-mail: giulio.bau@unipi.it, giacomo.lari@unipi.it.