Orbit Determination
(Determinazione Orbitale)
(2023/2024, first semester)

Teacher: Giacomo Tommei

1 Introduction

The determination of the orbits of the solar system bodies (both natural and artificial) is an important branch of Celestial Mechanics and Astrodynamics and has attracted the interest of several scientists over the last centuries (e.g. E. Halley, A. J. Lexell, J. L. Lagrange, A. M. Legendre, F. F. Tisserand, P. S. De Laplace, C. F. Gauss, O. Mossotti, H. Poincaré, C.).

The classical orbit determination (OD) problem can be formulated as follows: given a set of observable quantities of a celestial body (e.g. astrometric observations of an asteroid), made at different epochs, compute the position and velocity of the body at the average time of the observations, in order to predict the position of the body in the future. The observations of celestial bodies are affected by errors, thus it is necessary to take into account the effect of these errors in an OD procedure. From the mathematical point of view we can consider the OD problem as composed by three basic elements, the dynamics, the observations and the error model, expressed in terms of functions and/or random variables.

It is possible to classify OD problems by the central body: Earth satellite orbits (Moon, artificial satellites, space debris); heliocentric orbits (planets, asteroids, comets, artificial interplanetary probes); satellite orbits of other planets (natural satellites, planetary orbiters, binary asteroids, and asteroid/comet orbiter missions); orbits around another star (binary stars, extrasolar planets); cases without a dominant central body (orbits near the Lagrangian equilibrium points, temporary satellite captures).

But the classification we are interested in deals with the collaborative and the population OD problems. In this course we will explore the population OD, with particular emphasis of the OD of Near Earth-Objects (NEOs) and impact monitoring.

2 Practical Information

The course will last 42 hours, and it will take place in the first semester. The exam will be an oral examination: the student will prepare a short seminar agreed with the teacher.

The prerequisites for this course are the skills acquired in a B.Sc. in Mathematics, Physics or Aerospace Engineering

Whoever is interested in knowing more about this course can contact me via e-mail: **giacomo.tommei@unipi.it** .