UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Dynamics of Stellar Systems

2627-1-F5803Q023

Aims

The acquisition of basic knowledge of the structure of galaxies and the comprehension of the fundaments of the dynamics of complex stellar systems.
More specifically:

Knowledge and understanding (DdD1)
Understanding of the connection between mass distributions and their associated gravitational potential, and of the allowed orbits within these potentials.
Knowledge of the distribution function as a descriptor of self-gravitating phase space distribution
Knowledge and comprehension of the secular processes affecting self-gravitating systems.

Applying knowledge and understanding (DdD2)
Ability to derive either analytically or numerically the gravitational potential generated by a given mass distribution
Ability to derive and use the distribution function (the probability density of having a star at a given position with a given velocity) for highly-symmetric systems
Operative knowledge of numerical simulation techniques.

Making judgements (DdD3)
Students will design a numerical experiment aimed at validating the analytical predictions for a class-discussed topic.

Communication skills (DdD4)
In several sessions, students will present the results of their proposed tests to the rest of the class. Through this experience and the feedback gathered from the instructor and their peers, they will develop the ability to communicate exhaustively, clearly, and concisely. This skill will be assessed during the exam.

Learning skills (DdD5)
Students will have the opportunity to complete their understanding of non-trivial numerical testing, both individually and in groups.

Contents

Galactic dynamics. Introduction to N-body numerical simulations. Introduction to the physics of galaxy clusters.

Detailed program

Introduction to galactic dynamics. The two body problem. Introduction to direct N-body codes. Potential theory. Simulation of the collapse of a homogeneous sphere. Introduction to galaxies: morphology and dynamics. Introduction to tree-codes, Orbits in spherical and axisymmetric potentials. Introduction to the Toomre parameter and simulation of a stellar disc fragmentation. Introduction to the distribution function. Collisionless Boltzmann equation. Jeans and virial equations. Jeans theorem. Derivation of the distribution functions for spherically symmetric systems. Simulation of a Plummer sphere in equilibrium. Relaxation processes. Two-body relaxation time. Dynamical friction. Introduction to the physics of galaxy clusters.

Prerequisites

Undergraduate degree in physics

Teaching form

Blended learning

In addition to the more traditional lectures and to the blended numerical experiments, the course will feature lectures based on the story-telling technique and the possibility for the students to design their own numerical experiment on the topics discussed.

In details:
7 traditional lectures of 2 hours each in presence ("didattica erogativa" - DE, 2 cfu)
3 traditional lectures of 2 hours each and 1 lecture of 1 hour held remotely ("didattica erogativa" - DE, 1 cfu)
5 lectures of 2 hours each and 1 lecture of 1 hour of interactive teaching in presence ("didattica interattiva" - DI, 1 CFU)
11 lectures of 2 hours each of interactive teaching, held remotely ("didattica interattiva" - DI, 3 cfu)

Textbook and teaching resource

Galactic Dynamics - Binney & Tremaine – Princeton series in Astrophysics. Videos and articles on the e-learning page of the course

Semester

Second semester

Assessment method

The final exam is a viva and is based on the topics discussed during the class. Each exam will include the discussion of a specific topic of galactic dynamics previously agreed between the student and the professor, including the design of a numerical test of the topic. It is recommended to prepare a 20-minute presentation on the completed work (plus questions).

The basic knowledge of the arguments of the class, the ability of the students use them to derive quantitative predictions and to test such predictions with numerical tests, and their presentation skills will be evaluated (with equal weights) during the exam.

There are no evaluated intermediate tests. Intermediate team-works will be available to consent the self-evaluation of the students learning curve.

Office hours

Monday from 16 to 18

Sustainable Development Goals

QUALITY EDUCATION