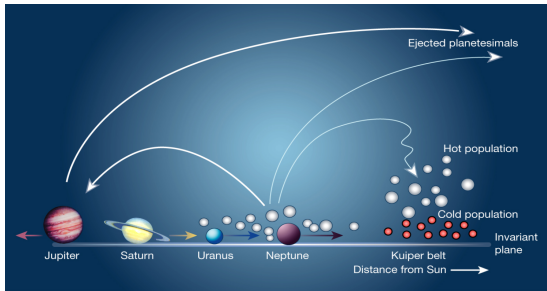




Applications of Celestial Mechanics in Planetology and Astrodynamics



SUMMARY.

In recent years, celestial mechanics – the powerful mathematical theory that describes the motions of celestial bodies and systems – has reached its full applications potential, due to the evolution in our theoretical understanding of chaotic phenomena as well as of computational methods and technology. Its applications encompass a wide range of space-related topics, such as: origin and dynamical evolution of our solar system and exoplanetary systems, dynamics of small-bodies and systems, manifold dynamics and advanced space mission design, and long-term dynamical evolution of satellites and space debris mitigation strategies. In this METEOR, we discuss the basic theoretical and numerical tools of celestial mechanics, placing emphasis on a wide range of applications.

— OBJECTIVES —

The students are expected to learn:

- How to use fundamental concepts of dynamical systems theory (perturbation approach; chaos, sources and long-term effects) and build models of celestial mechanics (few-body problem and variants)
- How to perform numerical computations in general problems of space dynamics, using suitable schemes
- How to analyse and interpret the results, using advances tools and their theoretical knowledge
- How to study planetary, small-body and artificial satellites dynamics
- How to use dynamics as tracers of the origin and future evolution of natural and artificial celestial systems

— INSTITUTE —

- Section of Astrophysics, Astronomy and Mechanics
- Physics Department
- Aristotle University of Thessaloniki
- A.U.Th. Campus, 54124 , Thessaloniki, Greece

— THEORY —

by K. TSIGANIS, G. VOYATZIS

The theoretical knowledge offered is centered around two primary pillars:

Fundamental Celestial Mechanics

- Beyond Keplerian Motion
- Basic physical models (3- and N-body problems, gravitational And non-gravitational perturbations)
- Dynamical systems and Chaos basics
- Examples from Solar System dynamics (asteroids, planets, satellites)

Computational Methods

- Numerical integration techniques (general and symplectic methods)
- Analysis tools (frequency and deviation methods)
- Regular and chaotic motions: sources and typical signatures
- What do these mean for the long-term evolution of celestial systems?

— APPLICATIONS —

by K. TSIGANIS, I. GKOLIAS

In the practical applications segment, students will concentrate on the following domains:

Planetary systems

- Planetary, satellite and small-body dynamics on short and long timescales
- Asteroid families and NEAs
- Dynamics tracing the origins of the solar system
- Evolution of model types of extra-solar systems

Astrodynamics

- Basic formalism and concepts
- Beyond classical astrodynamics (dynamical systems approach)
- Advanced mission design (manifolds dynamics)
- Dynamics and passive debris mitigation strategies

— MAIN PROGRESSION STEPS —

- Weeks 1-3: celestial mechanics theory
- Weeks 4-9: applications & project

— EVALUATION —

- Theory grade [30%]
 - Oral presentation followed by questions
- Practice grade [30%]
 - Project: initiative, progress, analysis
- Defense grade [40%]
 - Oral and slides quality
 - Context
 - Project / Personal work
 - Answers to questions

— BIBLIOGRAPHY & RESOURCES —

- Murray & Dermott
- Fitzpatrick
- Scheeres

— CONTACT —

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