UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Planetary Surface Dynamics

2627-1-F7402Q048

Title

Planetary surface dynamics

Teacher(s)

Fabio Vittorio De Blasio

Language

English

Short description

1. INTRODUCTION
   1.1 A brief historical introduction to the study of the planets: early studies; archaeoastronomy; the contribution of the ancient Greeks; the Renaissance and the era of telescope observation before space missions
   1.2 General overview of stellar systems and our own planetary system; its position within the Galaxy; the interstellar medium
   1.3 The solar system: a brief overview according to modern science
   1.4 Physics, Chemistry, Astrophysics, Geology, Biology: the conceptual framework for the study of the

planets
1.5 Chemical elements, their formation and abundance in the solar system

2. THE SUN, THE MOTION OF THE PLANETS, AND THE DYNAMICS OF THE SOLAR SYSTEM
2.1 The Sun: Structure and Characteristics
2.2 Gravitation and the Laws of Planetary Motion
2.3 Empirical Laws of Planetary Motion
• () *The Interplanetary Medium, the Solar Wind, and the Planetary Magnetospheres*
• () Further information on orbital motion

3. SURFACE PROCESSES OF TERRESTRIAL PLANETS
3.1 Meteorites and their contribution to understanding of the interior of terrestrial planets
3.2 Mechanisms of generation of planetary magnetic fields
3.3 Thermal and volcanic processes on planetary surfaces; radioactivity and generation of internal heat within planets; notes on planetary interiors
3.4 Impact cratering mechanisms: an important element in the evolution of planets
3.5 Planetary atmospheres; thermodynamics and fluid dynamics
3.6 Solar radiation and its effect on atmospheres and planetary surfaces
3.7 Planetary geomorphology: role of water, ice, volcanic activity, gravitational phenomena in the evolution of planetary surfaces
• (*) Planetary probes for the study of planets: flyby and planetary rendezvous missions, Hohmann orbits; Gravitational slingshot

4. THE TERRESTRIAL PLANETS (1): MERCURY, VENUS, AND EARTH
4.1 Mercury, Venus, Earth: general and orbital characteristics
4.2 Mercury's surface: cratering
4.3 General characteristics of Venus: shield volcanoes, domes, coronae, etc.
4.4 Earth: an overview of its structure, internal dynamics, and geomorphology, and comparison with the other terrestrial planets
• () *Venus: the surface and the role of the atmosphere in surface evolution*
• () Past and current missions to the terrestrial planets; types of information obtained from orbiters and landers; optical, infrared, and radar instruments; absorption and reflection spectroscopy; neutron absorption spectroscopy

5. THE TERRESTRIAL PLANETS (2): MARS
5.1 Mars: general characteristics
5.2 The surface of Mars: most important features, major impact basins, the global dichotomy, highlands and plains
5.3 Volcanoes, Martian geology and tectonics
5.4 Water and ice on Mars, and the putative ancient ocean
• () *The atmosphere, Martian winds, and Aeolian landforms*
• () Comparative analysis of the terrestrial planets: atmospheres, magnetic fields, and geological activity; evolution of the terrestrial planets

6. NOTES ON THE GIANT PLANETS (this module may be alternative to module 9)
6.1 Jupiter and Saturn: basic properties, atmosphere, composition, and magnetic field
• () *The rings of Saturn and of the other giant planets: composition and dynamic stability, origin*
• () Uranus and Neptune

7. MOONS OF THE SOLAR SYSTEM
7.1 Moons, orbital characteristics, tidal forces on orbital evolution
7.2 Our Moon: general characteristics
7.3 Lunar rocks (basalts, anorthosites), origin and evolution of the moon
7.4 The Galilean satellites of Jupiter: Io, Europa, Ganymede, and Callisto; and other moons of Jupiter
• () *The satellites of Mars*

• () The icy satellites and other moons of Saturn, Uranus, and Neptune; Titan

8. MINOR BODIES OF THE SOLAR SYSTEM
   8.1 Meteorites: a closer look at the different types: chondrites, achondrites, lunar and Martian meteorites, iron meteorites, pallasites
   8.2 Near-Earth objects, the probability of major asteroid impacts with Earth
   8.3 Main-belt asteroids: Ceres, Vesta; Trojans, Centaurs
   8.4 Comets and the Oort Cloud
   • () *Dynamical stability issues: a brief overview of celestial mechanics, asteroid distribution, Kirkwood gaps, Lagrangian points*
   • () The Pluto-Charon system, Eris, and trans-Neptunian objects; the Kuiper Belt
   • () *Spectral classification of asteroids*
   • () Influence of impacts on the evolution of life

9. EXOPLANETS (this module may be alternative to module 6)
   9.1 Stars: a closer look at their nature; energy produced by a star and stellar nucleosynthesis; Jeans critical mass, protostars, and insights into stellar evolution useful for planetary science
   9.2 Extrasolar planets or exoplanets
   • () *Detection and study of exoplanets: radial velocity, astrometric techniques, photometric variations during transit, imaging, and microlensing; the Kepler mission*
   • () Characterization of the exoplanets discovered to date and comparison with the solar system

10. PLANETARY SYSTEM FORMATION, ASTROBIOLOGY
    10.1 Early theories on the formation of the solar system
    10.2 New formulations of planetary system formation as deduced from our solar system and exoplanet systems: evolution of protoplanetary disks
    10.3 Evolution of planetesimals and formation of terrestrial planets, accretion, differentiation; formation of giant planets; models for the formation of exoplanets
    10.4 Extra-terrestrial Life: Drake equation, biological thermodynamics, biochemistry, geobiology, birth of life on Earth
    10.5 Problems and Future Directions in Planetary Geology

PRACTICAL LABORATORIES
Part of the training program includes hands-on activities.
• Practical use of some of the main software programs used to study the surfaces of terrestrial planets: optical and infrared imaging, altimetry, crater counting and age determination of Martian surfaces, radar imaging, mineralogy from remote sensing
• Analysis of selected areas of Mars and their geological characteristics
• Reading of two scientific papers in the field of planetary geology and geomorphology, understanding the purpose of the research and of the methods used, and identifying the main conclusions
• Study of selected satellite images of the Moon and Venus, flyby missions of various planets and asteroids, and rovers (Mars)
• (*) Possible examination of meteorite samples

CFU / Hours

Teaching period

first semester

Sustainable Development Goals

PEACE, JUSTICE AND STRONG INSTITUTIONS