Planets of the Solar System and Exoplanets: Life in the Universe

Code: 44085
ECTS Credits: 6

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<td>4313861 High Energy Physics, Astrophysics and Cosmology</td>
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Contact

Name: Ignasi Ribas Canudas
Email: Desconeugut

Teachers

Juan Carlos Morales Peralta
Josep Maria Trigo Rodríguez
Serni Ribó Vedrilla
Aldo Marcelo Serenelli
Gemma Busquet
Estel Cardellach Gali

Prerequisites

Basic knowledge of Physics and Astronomy is strongly advised.

Objectives and Contextualisation

The objective of the course is to provide the student with the basic knowledge on topics related to planets (both Solar System and exoplanets) and life in the universe from a broad perspective. This includes understanding the processes of planet formation, the structure of planet interiors and atmospheres, the concept habitability in general, techniques for exoplanet detection and characterization, methods for remote sensing, and the main characteristics of life on Earth and beyond. The course will make use of theoretical lectures as well as practical work and exercises to be carried out by the students. Up-to-date literature will be used to complement the topics discussed in class and the student should be able to comprehend the details of the techniques and methodologies used in such publications. The final goal is that the students acquire sufficient basic knowledge to carry out work in this field of research and, most importantly, that they learn to think by themselves.

Skills

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.
Learning outcomes

1. Acquire general knowledge vision of a multidisciplinary discipline like astrobiology.
2. Analyse the concept of inhabitability from the broadest of perspectives, including physical concepts like energy balance, biological ones, such as terrestrial extremophiles, and chemical ones, such as biomarkers.
3. Master the theoretical and practical concepts related to remote sensing, applied to the Earth and to the characterisation of exoplanets.
4. Understand the general aspects of the formation and structure of the planets, both in the Solar System and in other exoplanetary systems.

Content

- Introduction to stellar evolution and origin of chemical elements
- Formation and evolution of planetary systems
- Astrochemistry
- Habitability: definition and feedback mechanisms
- Solar System: Mars and its atmospheric evolution
- Solar System: water words vs. icy satellites
- Atmospheres and interiors of Solar System planets
- Exoplanet detection
- Observation of exoplanet atmospheres
- Biomarkers and detection of life
- Planet Earth
- Remote sensing techniques and new challenges
- Sustainable remote sensing
- Life as we know it
- Earth’s biosphere: Gaia and photosynthesis
- Life at the edge: extremophiles
- Extraterrestrial intelligence: the SETI program

Methodology

- Theory lectures.
- Resolution of practical exercises and problems.
- Oral presentation of a journal paper.
- Active participation in class and attendance to relevant seminars in the campus.
- Classwork and homework.

Activities

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<tr>
<th>Title</th>
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<th>Learning outcomes</th>
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<td>Discussion of problem sets</td>
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<td>0.08</td>
<td>1, 2, 3, 4</td>
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<th>Hours</th>
<th>ECTS</th>
<th>Learning outcomes</th>
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<tr>
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<tr>
<td>Discussion and team work</td>
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<td>Preparation of exam</td>
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<td>Resolution of problem sets</td>
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Evaluation

The evaluation will consist of four different elements:

1. Written exam that may contain multiple choice questions, developing a topic and/or practical exercises.
2. Oral presentation of a journal paper from the literature.
3. Problem sets handed in during the course.
4. Attendance and active participation in class.

Evaluation activities

<table>
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<tr>
<th>Title</th>
<th>Weighting</th>
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<tr>
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Bibliography

NUCLEOSYNTHESIS AND CHEMICAL ELEMENTS

- "Supernovae and Nucleosynthesis: an investigation of the history of matter from the Big Bang to the present", D. Arnett, 1996, Princeton University Press

PLANETS AND EXOPLANETS

- "Protostars and Planets VI", H. Beuther et al. (eds), 2014, The University of Arizona Press
- "The early evolution of the atmospheres of terrestrial planets", J.M. Trigo-Rodríguez et al., 2013, Springer

ASTROBIOLOGY AND LIFE
• “Astrobiology. An Introduction”, A. Longstaff, 2015, CRC Press

REMOTE SENSING