Universitat Autònoma de Barcelona

2019/2020

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

Code: 44085
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

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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.

Competences

- 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

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Discussion of problem sets	2	0.08	1, 2, 4, 3
Oral presentation of a journal paper	2	0.08	1, 2, 4, 3
Theory lectures	41	1.64	1, 2, 4, 3
Type: Supervised			
Oral presentation of a journal paper	5	0.2	1, 2, 4, 3
Problem sets	8	0.32	1, 2, 4, 3

Type: Autonomous			
Attendance to seminars relevant to the subject	5	0.2	1, 2, 4, 3
Discussion and team work	30	1.2	1, 2, 4, 3
Preparation of an oral presentation on a paper	10	0.4	1, 2, 4, 3
Preparation of exam	20	0.8	1, 2, 4, 3
Resolution of problem sets	25	1	1, 2, 4, 3

Assessment

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.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance and active participation	10%	0	0	1, 2, 4, 3
Oral presentation of a journal paper	20%	0	0	1, 2, 4, 3
Problem sets	35%	0	0	1, 2, 4, 3
Written exam	35%	2	0.08	1, 2, 4, 3

Bibliography

NUCLEOSYNTHESIS AND CHEMICAL ELEMENTS

- "Nuclear astrophysics: the unfinished quest for the origin of the elements", Jordi José, Christian Iliadis, 2011, Reports on Progress in Physics, Vol. 74, Issue 9
- "Origin of the Chemical Elements", T. Rausher, A. Patkos, (arXiv:1011.5627) in Handbook of Nuclear Chemistry, pp 611-655, Springer
- "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

- "Exoplanets", S. Seager (ed.)., 2010, The University of Arizona Press
- "Fundamental Planetary Science", J.J. Lissauer. I. de Pater, 2013, Cambridge University Press
- "The Exoplanet Handbook", 2014, M. Perryman, Cambridge University Press
- "Protostars and Planets VI", H. Beuther et al. (eds), 2014, The University of Arizona Press
- "The early evolution of theatmospheres of terrestrial planets", J.M. Trigo-Rodríguez et al., 2013, Springer
- "The catalytic potential of cosmic dust: Implications for prebiotic chemistry in the solar nebula and other protoplanetary systems", H.G.M. Hill, J.A. Nuth, 2003, Astrobiology, Vol.3, Num. 2

ASTROBIOLOGY AND LIFE

- "An introduction to Astrobiology", I. Gilmour, M.A. Sephton, 1999, The Open University, Cambridge University Press
- "Astrobiology. An Introduction", A. Longstaff, 2015, CRC Press
- "Life in the universe", D. Schulze-Makuch, L.N. Irwin, 2008, Springer-Verlag

REMOTE SENSING

- "GNSS Remote Sensing: Theory, Methods and Applications", S. Jin, E. Cardellach, F. Xie, 2014, Springer Verlag, Remote Sensing and Digital Image Processing
- "Handbook of Global Navigation Satellite Systems", P.J.G. Teunissen, O. Montenbruck, 2017, Springer