

NUCLEAR ASTROPHYSICS (6 ECTS)

The subject will be taught in 18 sessions of 1.5 hours. It includes tutorial sessions to discuss proposed exercises, questions about the contents of the lectures, etc.

Lectures:

- A.1. Brief history of the Universe. Life cycle of a star. Hertzsprung-Russell diagram
- A.2. Hydrostatic equilibrium. Star formation. The Sun: density, pressure and temperature
- A.3. Primordial nucleosynthesis
- A.4. Stellar nucleosynthesis
- A.5. Explosive nucleosynthesis
- B.1. Equation of state of an ideal gas: electrons and photons
- B.2. Phenomenological models of nuclear matter: Skyrme interactions
- B.3. Equation of state of symmetric, asymmetric and β -stable matter
- C.1. Astroparticle physics and nuclei: direct detection of dark matter (I)
- C.2. Astroparticle physics and nuclei: direct detection of dark matter (II)
- C.3. White dwarfs: mass and size
- C.4. Neutron stars: general characteristics
- C.5. Neutron stars: crust and cooling
- D.1. Numerical applications (I): nuclear equation of state
- D.2. Numerical applications (II): white dwarfs and neutron stars

Basic Bibliography:

- 1) "The Physics of Stars", A. C. Phillips, John Wiley & Sons, 2004.
- 2) "Particle Astrophysics", D. H. Perkins, Oxford University Press, 2003.
- 3) "Fundamentals in Nuclear Physics: from Nuclear Structure to Cosmology", J. L. Basdevant, J. Rich, M. Spiro, Springer, 2004.
- 4) "Introductory Nuclear Physics", P. E. Hodgson, E. Gadioli, E. Gadioli Erba, Oxford University Press, 2003.
- 5) "An Introduction to Particle Dark Matter", S. Profumo, World Scientific, 2017.

Timetable and teachers

WEEK 1	Monday 26/4 Classroom	Tuesday 27/4 Classroom	Wednesday 28/4 Classroom	Thursday 29/4 Classroom	Friday 30/4 Classroom
9:30 – 11:00	A.1 A. Rios	A.2 A. Rios	A.3 A. Rios	B.3 X. Roca-Maza	A.4 / A.5 A. Rios
11:30 – 13:00	B.1 X. Roca-Maza	C.3 X. Roca-Maza	C.4 X. Roca-Maza	C.2 J. Menéndez	Tutorial J. Menéndez
13:15 – 14:45	C.1 J. Menéndez		C.2 J. Menéndez		

WEEK 2	Monday 3/5 Online	Tuesday 4/5 Online	Wednesday 5/5 Online	Thursday 6/5 Online	Friday 7/5 Online
9:30 – 11:00	D.2 X. Roca-Maza	Tutorial A. Rios	Tutorial X. Roca-Maza		Presentations JM / AR / XRM
11:30 – 13:00	C.5 J. Menéndez	B.2 / D.1 J. Menéndez			Presentations JM / AR / XRM

The lectures of the first week will be given at the Faculty of Physics of the University of Barcelona. The lectures of the second week will take place online.

Evaluation:

The Nuclear Astrophysics course offers a continuous assessment option consisting of two parts. First, students must solve an exercise assigned during class; this is done in pairs and accompanied by a presentation of the solution followed by questions about the presentation. This component accounts for 40% of the continuous assessment grade. Second, students must submit solutions for 3 exercises (small projects), presented before the end of classes. The exercises are explained and discussed in class, as well as the software (available on the Campus Virtual) to be used to solve them. Students have a few weeks after classes end to submit their solutions. After submitting the exercises, students must answer oral questions about their work. Each exercise contributes 20% to the student's final grade, with this section making up 60% of the continuous assessment score.

Alternatively, students may choose to take the final exam, which will consist on both written and oral questions covering the contents of the course.