

## **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  $\beta$ -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 31-03 Classroom	Tuesday 01-04 Classroom	Wednesday 02-04 Classroom	Thursday 03-04 Classroom	Friday 04-04 Classroom
9:30 – 11:00	C.1 J. Menéndez	C.2 J. Menéndez	C.3 A. Ríos	C.4 A. Ríos	B.2 J. Menéndez
11:30 – 13:00	A.1 X. Roca-Maza	B.1 A. Ríos	A.2 X. Roca-Maza	A.3 X. Roca-Maza	B.3 A. Ríos
13:15 – 14:45					

WEEK 2	Monday 07-04 Online	Tuesday 08-04 Online	Wednesday 09-04 Online	Thursday 10-04 Online	Friday 11-04 Online
9:30 – 11:00	C.5 J. Menéndez	D.1 / Tutorial A. Rios	Tutorial J. Menéndez	D.2 / Tutorial A. Ríos	Tutorial J. Menéndez
11:30 – 13:00	A.4 X. Roca-Maza	A5 /Tutorial X. Roca-Maza		Tutorial X. Roca-Maza	
15:00 – 16:30					
17:00 – 18:30					

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

**Examination:** the examination will be based on the solution of a few proposed exercises, to be submitted by the student before May 23, 2025.