

# PHYS-439 Introduction to astroparticle physics

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Cursus	Sem.	Type
Ingphys	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	4 weekly
Lecture	2 weekly
Exercises	2 weekly
Number of positions	
positions	

## **Summary**

We present the role of particle physics in cosmology and in the description of astrophysical phenomena. We also present the methods and technologies for the observation of cosmic particles.

#### Content

- 1. The observed universe: cosmological expansion, age of the universe, cosmic microwave background radiation.
- 2. Dark matter in the Universe. Rotation curves of the galaxies, experiments on detection of dark matter.
- 3. Astrophysical sources of high-energy gamma quanta and cosmic rays.
- 4. Pulsars and supernovae. Neutrinos from the supernova SN1987A.
- 5. High-energy particle acceleration near magnetized neutron stars.
- 6. Astrophysical black holes: stellar mass black holes and supermassive black holes in the nuclei of active galaxies.
- 7. High-energy particle acceleration and production of cosmic rays by the black holes.
- 8. Charged cosmic rays: energy flux and composition; origin and acceleration. Direct detection of cosmic rays: the AMS and DAMPE experiments. Extensive air showers: composition, longitudinal and lateral profiles. The indirect detection of cosmic rays: the Pierre Auger Observatory.
- 9. Cosmic photons: production mechanisms and sources; the multiwavelength astronomy. Direct detection of cosmic gamma rays: the Fermi experiment. Indirect detection of cosmic gamma rays: imaging atmospheric Cherenkov telescopes and extensive air shower detectors.
- 10. Solar neutrinos: production, spectra and detection; the solar neutrino problem. Astrophysical neutrinos: production mechanisms and candidate sources. The neutrino astronomy and the neutrino telescopes: IceCube and KM3NeT.

### **Learning Prerequisites**

#### **Recommended courses**

Nuclear and particle physics I and II (PHYS-311, PHYS-312)

### **Learning Outcomes**

By the end of the course, the student must be able to:



- Analyze the physical phenomena associated with cosmic rays
- Discuss the detection principles of astroparticle physics experiments
- Interpret the main results of selected experiments
- Assess / Evaluate the state of the art of astroparticle physics

# **Teaching methods**

Ex cathedra and classroom exercises

## **Assessment methods**

oral exam (100%)

## Resources

## **Moodle Link**

• https://go.epfl.ch/PHYS-439