PHYS-439

Introduction to astroparticle physics

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Cursus	Sem.	Type
Ing.-phys	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Contact language	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	

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