COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2023-2024*

ACADEMIC SUBJECT *Cosmic Ray Physics*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September - December 2023
Credits (CFU/ECTS):	3
SSD	FIS/01
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
Name and Surname	Nicola Giglietto
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Telephone	0805443221
Department and address	Dipartimento Fisica Bari
Virtual room	///
Office Hours (and modalities: e.g., by appointment, on line, etc.)	By appointment, on-line.

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
75	16	15	44
CFU/ECTS			
3	2	1	

Learning Objectives	Knowledge of cosmic ray definition, composition, energy spectrum, origin and experimental techniques to their detection.
Course prerequisites	Basic knowledge of detector and particle physics.

Teaching strategies	*Lessons with slides and notes shared with students*
Expected learning outcomes in terms of	
Knowledge and understanding on:	o Cosmic ray composition and their energy spectrum o Sources, acceleration mechanisms and diffusion of cosmic rays o Gamma-rays observation of cosmic-ray sources o Experimental techniques for direct measurement of cosmic rays o Experimental techniques for indirect measurement of cosmic rays o Dark matter direct and indirect searches (hint)
Applying knowledge and understanding on:	o Ability to analyse the data collected in typical cosmic ray experiments o Ability to design a basic detector scheme for cosmic rays
Soft skills	• **Making informed judgments and choices** o *Ability to understand the precision of a measurement, depending on the available instrumentation* o Ability to reproduce detailed explanation of the acceleration mechanism • **Communicating knowledge and understanding**

	o communication skills in English; o coding skills related to data processing and analysis; o skills in the presentation of experimental results using appropriate scientific language - **Capacities to continue learning** o ability to learn and transfer experimental procedures; o knowledge of basic data analysis techniques
Syllabus	
Content knowledge	1. *Cosmic rays: a short history of the cosmic ray discovery, Earth magnetic field and solar activity on cosmic ray fluxes* 2. *Composition and spectrum of cosmic rays on the top of the atmosphere. Primary and secondary components of cosmic rays; shower developments if the atmosphere. Spectrum and composition of secondary cosmic rays on Earth and underground.* 3. *Origin and propagation of cosmic rays. Possible source of cosmic rays: SNR, pulsars. Fermi acceleration model, leaky box propagation model.* 4. *Search for primordial antimatter in cosmic rays: electron, positron, antiproton and antinuclei fluxes.* 5. *Gamma ray physics as a probe to identify cosmic ray acceleration regions. Gamma ray physics: diffuse emission, point like sources, galactic and extragalactic components.* 6. *Experimental techniques for cosmic ray physics: direct measurements* 7. *Experimental techniques for cosmic ray physics: indirect measurements (estensive air showers and Cherenkov telescopes)* 8. *Experimental techniques for Ultra-High Energy(UHE) cosmic rays ($E>10^{18}$ eV);* 9. *Hints on Dark matter direct and indirect measurements.*
Texts and readings	*- M.S. Longair, "High Energy Astrophysics", Cambridge University Press* *- T.K. Gaisser, "Cosmic Rays and Particle Physics"* *- A.De Angelis, M.Pimenta, Introduction to Particle Astrophysics, Springer*
Notes, additional materials	*Scientific articles and reports published on international peer reviewed journals; slides shown during the course*
Repository	*Dropbox link*

Assessment	
Assessment methods	Oral exam
Assessment criteria	● knowledge and understanding ability of problematics ● knowledge of the understanding of the detection techniques ● autonomous judgment of results ● communication skills o learning level
Final exam and grading criteria	The student should: ● know the mechanisms of interactions of cosmic rays in space and in Earth atmosphere; ● know how to evaluate particle identification in direct measurements of cosmic rays; ● know the basic physical quantities to identify very ultra high energy cosmic rays using indirect techniques; ● know how to derive the models which describe the cosmic ray acceleration mechanism and the possible sources; ● know the basic elements of gamma ray physics and high energy gamma ray sources; ● know how to present the results of an experiment in written and oral forms.

Further information	/////
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