UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

DIPARTIMENTO INTERUNIVERSITARIO DI FISICA

General information	
Academic subject	Cosmic Ray Physics
Degree course	Physics
Academic Year	1
European Credit Transfer and Accumulation System (ECTS)	**3**
Language	ENGLISH
Academic calendar (starting and ending date)	28/9/22-5/12/22
Attendance	Yes

Professor/ Lecturer	
Name and Surname	Nicola Giglietto
E-mail	nicola.giglietto@ba.infn.it
Telephone	0805443221
Department and address	*Physics, via Orabona 4 Bari*
Virtual headquarters (Microsoft Teams code)	*//*
Tutoring (time and day)	Thursday, 11:00-13:00

Syllabus	
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.
Contents	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*
Books and bibliography	- *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*
Additional materials	*Scientific articles and reports published on international peer reviewed journals; slides shown during the course*

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

Teaching strategy	

	Lectures; simulated laboratory experiences under the supervision of a teacher.

Expected learning outcomes	
Knowledge and understanding on:	○ Cosmic ray composition and their energy spectrum ○ Sources, acceleration mechanisms and diffusion of cosmic rays ○ Gamma-rays observation of cosmic-ray sources ○ Experimental techniques for direct measurement of cosmic rays ○ Experimental techniques for indirect measurement of cosmic rays ○ Dark matter direct and indirect searches (hint)
Applying knowledge and understanding on:	○ Ability to analyse the data collected in typical cosmic ray experiments ○ Ability to design a basic detector scheme for cosmic rays
Soft skills	• **Making informed judgments and choices** ○ *Ability to understand the precision of a measurement, depending on the available instrumentation* ○ Ability to reproduce detailed explanation of the acceleration mechanism • **Communicating knowledge and understanding** ○ communication skills in English; ○ coding skills related to data processing and analysis; ○ skills in the presentation of experimental results using appropriate scientific language • **Capacities to continue learning** ○ ability to learn and transfer experimental procedures; ○ knowledge of basic data analysis techniques

Assessment and feedback	
Methods of assessment	Oral exam (100%)
Evaluation criteria	• knowledge and understanding ability of problematics • knowledge of the understanding of the detection techniques • autonomous judgment of results • communication skills • learning level
Criteria for assessment and attribution of the final mark	The student • knows the mechanisms of interactions of cosmic rays in space and in Earth atmosphere; • knows how to evaluate particle identification in direct measurements of cosmic rays; • knows the basic physical quantities to identify very ultra high energy cosmic rays using indirect techniques; • knows how to derive the models which describe the cosmic ray acceleration mechanism and the possible sources; • knows the basic elements of gamma ray physics and high energy gamma ray sources; knows how to present the results of an experiment in written and oral forms;
Additional information	/////