Stampare su carta intestata del CdS

General information	
Academic subject	*Gamma-ray astrophysics in the multimessenger context*
Degree course	*Physics*
Academic Year	*2020-2021*
European Credit Transfer and Accumulation System (ECTS)	*3*
Language	*English*
Academic calendar (starting and ending date)	*September / November 2021*
Compulsory attendance	*No*

Professor/ Lecturer	
Name and Surname	*Elisabetta Bissaldi*
E-mail	*elisabetta.bissaldi@poliba.it*
Telephone	*3492939262*
Department and address	*Dipartimento Interateneo di Fisica, Via E. Orabona 4, 70125, Bari*
Virtual headquarters	
Tutoring (time and day)	*Friday, from 4PM to 6PM.* *Virtual tutoring on Microsoft Teams.*

Syllabus	
Learning Objectives	*Advanced knowledge of gamma-ray astrophysics in the multimessenger context. Main properties of extragalactic sources: focus on Active Galactic Nuclei (AGN) and Gamma-Ray Bursts (GRBs). Currently operating space- and ground-based observatories. Emphasis on the latest scientific breakthroughs in Multimessenger Astrophysics since 2017: (1) discovery of gravitational waves (GWs) and their association with electromagnetic counterparts, e.g. GRB 170817A (2) observation of neutrino emission from the direction of known blazars, e.g. TXS 0506+056.*
Course prerequisites	*Basic astrophysics, Stellar physics, Cosmic Ray Physics*

Contents	1) *Detection of gamma radiation (satellite and telescopes): scintillation detectors, pair-production telescopes, Cherenkov telescopes.*
	  - *Currently operating space missions: highlight on Fermi, with its two instruments, the Large Area Telescope (LAT) and the Gamma-Ray Burst Monitor (GBM).*
	  - *Currently operating Cherenkov telescope: MAGIC, H.E.S.S. Prospects for the future Cherenkov Telescope Array (CTA).*
	2) *Extragalactic sources visible at gamma-ray energies: focus on AGN and GRBs. Temporal and spectral characteristics. Multi-frequency studies. Open questions in the multimessenger context.*
	3) *Gravitational wave theory and detection. Interferometers.*
	4) *Neutrino detection principles. The IceCube experiment.*
	5) *Multimessenger Astrophysics:*
	  - *LIGO/Virgo GW detections from 2015 to 2020.*
	  - *The case of GRB 170817A / GW 170817 as seen by LIGO/Virgo and Fermi.*
	  - *The case of neutrino emission from the TXS 0506+056 as seen by IceCube, Fermi and MAGIC.*

Books and bibliography	*1. Spurio – "Probes of Multimessenger Astrophysics"* *2. Longair – "High-energy astrophysics"* *3. De Angelis & Pimenta - "Introduction to Particle and Astroparticle Physics"* *4. Recent Publications*

Additional materials	*The main reference text is n.1. The other books can be consulted to review introductory and / or more specific concepts. A series of recent publications in the sector will also be presented during the course to deepen some aspects.*

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	*Classroom lessons / tutorials, supported by video projector and with the help of networked PCs, team building pre-, during and post- laboratory, exercises and peer-review.*		
Expected learning outcomes			

Knowledge and understanding on:	• *Basic aspects of high-energy astrophysical phenomena*
	  o *Focus on GRB physics and the connection with Gravitational Waves*
	  o *Focus on AGN physics and the connection with Neutrino detections*		

Applying knowledge and understanding on:	• *Ability to critically review and summarize a scientific article;* • *Ability to perform simple analysis of experimental data taken by the Fermi instruments;* • *Computer skills related to data processing and analysis as well as presentation of data sample.*		

Soft skills	*Making informed judgments and choices:*
	  - *Ability to estimate and classify the analysed astrophysical sources depending on the relevant spectral and temporal properties*
	Communicating knowledge and understanding:
	  - *Communication skills in English:*
	  - *Presentation skills;*
	  - *Skills in the exposition of experimental results using appropriate scientific language;*
	Lifelong learning skills:
	  - *Ability to learn and to transfer simple experimental procedures.*
	  - *Ability to work in a group, and to be inserted quickly and effectively in the workplace*		

Assessment and feedback	
Methods of assessment	*Laboratory Report (50%), Oral exam (50%)*

Evaluation criteria	• *Knowledge and understanding*
	  o *Solid knowledge of basic principles of multimessenger astrophysics*
	• *Applying knowledge and understanding*
	  o *Capacity to identify and discuss various types of astrophysical sources like AGN and GRBs;*
	  o *Capacity to estimate the errors of a measurement and to graphically represent the experimental data in an appropriate way;*
	• *Autonomy of judgment*
	  o *Capacity to evaluate, describe and discriminate the temporal and spectral properties of astrophysical sources, e.g. between short and long GRBs;*

	• *Communicating knowledge and understanding*
	  o *Ability to write a comprehensive summary report*
	• *Communication skills*
	  o *Ability to present results in a clear and exhaustive way*
	• *Capacities to continue learning*
	  o *Curiosity and interest in further studying and deepening the knowledge*

Criteria for assessment and attribution of the final mark	*Clear and exhaustive final report; Solid knowledge demonstrated during the final oral exam.*
Additional information	