SPACE Area Courses (AA 2022-2023)

- **Introduction to General Relativity** (PILLAR)
  Lecturer: Prof. Capozziello
  Email: salvatore.capozziello@unina.it
  Period: November-December  |  Hours: 24
  Teaching mode: in presence
  The course intends to provide an introduction to General Relativity for which knowledge of the basic principles of Special Relativity, Electromagnetism and Classical Mechanics is required. It is aimed at graduates in engineering, physics and mathematics.

- **Introduction to Cosmology** (PILLAR)
  Lecturer: Dr. Benetti and Dr. D’Agostino
  Email: micol.benetti@unina.it, rocco.dagostino@unina.it
  Period: November-December  |  Hours: 24
  Teaching mode: in presence
  The course addresses the theoretical foundations of modern cosmology, and the observational basis of the standard cosmological model. The main physical concepts and fundamental events in the cosmic history are introduced, including the theory of inflation, the generation of cosmic microwave background anisotropies from primordial inhomogeneities, and the process of structure formation.

- **Statistical Mechanics: from basic concepts to applications in Complex Systems, Astrophysics and beyond** (PILLAR)
  Lecturer: Prof. Nicodemi
  Email: nicodem@na.infn.it
  Period: January - February  |  Hours: 24
  Teaching mode: mixed (in presence and online)
  The course introduces the theory of Statistical Mechanics, from its fundamental concepts to more advanced applications in Complex Systems, Astrophysics and beyond.
• **Introduction to Quantum Mechanics (PILLAR)**
  Lecturer: Prof. Miele  
  Email: gannaro.miele@unina.it  
  Period: March - April  | Hours: 24  
  Teaching mode: mixed (in presence and online)  
  The course aims to provide the main concepts of this very counterintuitive theory as well as the mathematical tools necessary to tackle quantitatively the subject. In particular, the Schrödinger equation will be introduced and studied for some particular quantum systems. The axiomatic structure of QM will be outlined and discussed.

• **Introduction to Astrophysics (PILLAR)**
  Lecturer: Prof. Risaliti  
  Email: guido.risaliti@unifi.it  
  Period: January - February  | Hours: 24  
  Teaching mode: in presence  
  The course describes the physical processes determining the inner structure of stars, including hydrostatic equilibrium, the equation of state of stellar matter, nuclear fusion, radiative and convective transport, the main mechanisms of interaction between radiation and matter. We will then discuss the main aspects of stellar evolution with a final brief treatment of the main properties of white dwarfs and neutron stars. Also, we will describe the most common techniques for measuring cosmic distances.

• **Introduction to Deep Learning (PILLAR)**
  Lecturer: Prof. Poggi and Dr. Gragnaniello  
  Email: poggi@unina.it, diego.gragnaniello@unina.it  
  Period: TBA  | Hours: 24  
  Teaching mode: TBA  
  Aim of this introductory course is to provide fundamental concepts and theoretical tools on machine learning, artificial neural networks, deep learning. In addition, coding sessions in Python and Keras will provide practical tools to implement and use popular deep learning models. Image processing problems will be used to demonstrate concepts and tools.
- **Introduction to Astroparticle Physics (PILLAR)**
  Lecturer: Prof. Vissani
  Email: francesco.vissani@lns.infn.it
  Period: March - April  |  Hours: 24
  Teaching mode: TBA
  The course introduces the main aspects of astro-particle physics, treating the most relevant methods and results of particle physics. Astro-particle physics covers research in astrophysics that essentially involve the study of the smallest parts of matter, and, vice versa, particle investigations with an impact on our understanding of celestial objects and of the cosmos.

- **Standard Model of Fundamental Interactions**
  Lecturer: Prof. Sannino
  Email: sannino@cp3.sdu.dk
  Period: TBA  |  Hours: 12
  Teaching mode: TBA
  The course introduces the student to the fascinating world of fundamental interactions. The students will learn how to fuse quantum field theory, group theory and other deep mathematical tools to bridge the gap between theory and experiments in particle physics. We will arrive at the frontier of our understanding of the ultimate laws of nature.

- **High-Energy Astrophysics**
  Lecturer: Dr. De Falco
  Email: vittorio.defalco-ssm@unina.it
  Period: TBA  |  Hours: 12
  Teaching mode: in presence
  In this course, we aim at analysing the geometric features and structures of four classical black hole solutions in General Relativity (Schwarzschild, Kerr, Reissner–Nordström, and Kerr–Newman). Besides to focus on the mathematical aspects, we provide also the physical meaning and their applications in the current high-energy astrophysical panorama.

- **Inflation in the Early Universe: theoretical developments and observational predictions**
  Lecturer: Prof. Matarrese
  Email: sabino.matarrese@pd.infn.it
  Period: February  |  Hours: 12
  Teaching mode: online