International School of Young Astronomers ISYA2018

Sunday 08 July 2018 - Saturday 28 July 2018

Universidad Industrial de Santander

Topics and lecturers

Exoplanets and planet formation. *Dante Minniti* (Universidad Andrés Bello, Chile).

Relativistic Astrophysics. *Jorge Armando Rueda* (ICRANet Italy). The era of multifrequency astronomy from the microwaves to the radio to the optical to the X and to the gamma-rays has enriched our knowledge of the properties of astrophysical systems and has allowed us to explore the entire Universe up to epochs just after the Big Bang. As expected, these high quality and amount of data, at the same time, have allowed us to know extreme relativistic systems such as pulsars, supernovae and gamma-ray bursts, whose complete understanding, including their interconnections, represents one of the most exciting challenges of modern astrophysics. We are now facing the new era of multimessenger astronomy in which information from different carriers in addition to photons, such as gravitational waves, neutrinos, cosmic rays, and possibly dark matter, can shed light on the nature of the astrophysical systems. It is very difficult to give a full overview of all the information we have learned in Relativistic Astrophysics in the latest 50 years from the discovery of neutron star (NS) pulsars and of the first observational confirmation of the existence of black holes (BHs). Therefore, I will give a personal overview on the relevant aspects on the physics and astrophysics of NSs, in connection with the most powerful and extreme astrophysical systems in the Universe: supernovae (SNe) and gamma-ray bursts (GRBs).

Observational Astronomy and Data Reduction. *Karín Menéndez Delmestre* (Observatorio Valongo, Brazil). In this course we aim to familiarize students with basic concepts related to astronomical instrumentation, observational strategies and the processing of astronomical data. After a brief review of fundamental concepts including celestial coordinate systems, the impact of the Earth's atmosphere on ground-based observations and the different sources of noise, we will combine lectures and hands-on activities to delve into the following topics: planning astronomical observations, remote observing (pending formal arrangements with ISYA), reduction of imaging data (with brief discussion on how to handle spectroscopic data), signal characterization and basic photometric analysis of astronomical data. These topics will be addressed primarily in the context of optical (and near-infrared) observations, but if time permits we will also include a discussion devoted to these topics in various spectral ranges.

Stellar Structure, Evolution and Atmospheres. *Karla Peña Ramirez,* (Universidad de Antofagasta, Chile) The goal of these lectures is to explore the key observational properties beneath the structure, evolution, and atmospheres of stars. How these properties relate back to fundamental physical processes including the interaction of matter and radiation, thermodynamics and the equation of state of gasses, nucleosynthesis and the formation of elements, line profiles, and atmosphere modeling. Each topic will be imparted along with recent relevant observational/theoretical journal references that give the students a state-of-the-art context to the physical concepts explored.

General Astronomical Software: Linux Basics, Visualization, Python R Basics. *Jaime Forero Romero* (Universidad de Los Andes Colombia) Python has become a de facto standard in scientific computing. It is open source, easy to learn and has a rich ecosystem of libraries. It has also become the language of choice for many astronomical communities and projects. Furthermore, python skills are a valuable asset for astronomers looking for industry jobs (inside and outside astronomy.) In this series of lectures we will cover the basics of python together with the most popular libraries for scientific computing, visualization, data analysis and basic astronomy calculations.

Interstellar Medium and Chemical Abundances. *Leticia Carigi* (Instituto de Astronomía, Universidad Nacional Autónoma de México México). In this short course I will provide an overview of the basic properties of the interstellar medium (ISM) in the Milky Way. I will emphasize on the chemical evolution, through cosmic time, of different Galactic components and types of galaxies. I will present the main restrictions to obtain the evolution of a Galactic Habitable Zone.

Galaxies *Gustavo Bruzual* (Instituto de Radioastronomía y Astrofísica -Universidad Nacional Autónoma de México México). An overview of the basic properties of galaxies due to the distribution, kinematics, dynamics, relevance, and evolution of their different stellar populations. A view of the basic properties and processes in the distant universe as revealed by galaxies of all types discovered so far.

Astrostatistics, Data Analysis and XRay Astronomy *Juan Rafael Martínez-Galarza* (Harvard-Smithsonian Center for Astrophysics - Harvard University USA). Astronomers are currently gathering data at higher rates than ever before, and this rapid increase in astronomical data volume will likely continue over the next decade or two . As an example, upcoming facilities such as the Large Synoptic Survey Telescope (LSST) and the Square Kilometer array will gather data at rates of several terabytes per second. The era of big data in astronomy (but also proper data analysis and model selection in the small data regime) requires sophisticated statistical inference methods, and the astronomer of today requires a solid knowledge of statistics and its application to astronomical measurements, large datasets, and discovery of the unexpected. In this lecture I will provide an overview of the statistics that all astronomers should know, with applications to X-ray data from NASA's Chandra Space Observatory.

High Performance Computing, Big Data and Machine learning *Juan Carlos Muñoz-Cuartas*, (Universidad de Antioquia Colombia). This is an ambitious course that aims to present the basic ideas of high performance computing, dealing with data, big data and machine learning. Although concepts and definitions will be provided, most of these concepts will be presented through application to problems of interest in astronomy. "Homeworks" and exercises will be the main strategy to allow students to get in touch with techniques and tools presented in the lectures. Many of those exercises are related to the topics presented in other courses attended during the school (python in astronomy, galaxies, cosmology, etc.).

Science Communication *Héctor Rago* (Universidad Industrial de Santander Colombia and Universidad de Los Andes Venezuela). *Ysabel Briceño* (Universidad Autónoma de Bucaramanga Colombia) In these lectures we will explore some basic strategies of science communication as a key phase in the contemporary production of knowledge. We will talk about the challenges of making science visible, through narrations that captivate the interest of various audiences. These strategies will be oriented to build stories adapted to meet the different styles and communication platforms: from traditional media (press and radio) to the rich possibilities of transmedia narratives on web and social network.

Magnetohydrodynamics for Astrophysicists *Elisabete M. de Gouveia Dal Pino* (Department of Astromony at Universidade de Sao Paulo Brazil). Ionized gas permeated by magnetic fields also called "plasma" is everywhere in the Universe – both in Astrophysical sources and environments. This course will introduce to the students the theory that allows for a fluid description of Astrophysical plasmas, namely, magnetohydrodynamics (MHD). In 4 or 5 lectures, we will learn what plasma is; see several examples of astrophysical plasmas; the key concept of charge neutrality; the magnetohydrodynamical (MHD) conservation equations that describe the plasma time-space evolution; the magnetic force; magnetic flux freezing; and fundamental phenomena that have important applications in Astrophysics like waves and instabilities; shock waves; magnetic field generation (dynamo); magnetic field dissipation by reconnection; and particle acceleration. Some examples of MHD numerical modeling of astrophysical sources and environments will be also presented.

Cosmology and Cosmo-computing *Octavio Valenzuela* (Instituto de Astronomía, Universidad Nacional Autónoma de México México) Modern Cosmology is reaching a golden age due to the exquisite observations of galaxy clustering in current and ongoing surveys. In this course we will take a tour since basic cosmology to the contemporary challenges of dark matter and dark energy and make emphasis on the role of numerical simulations in the interpretation of observations.

A review of binary research impact on cosmology and an introduction of emission-line stars research *Kam-Ching Leung* (University of Nebraska, USA).

Active Galactic Nuclei, *Itziar Aretxaga* (Instituto Nacional de Astronomía, Optica y Electrónica, Mexico) An overview of activity in the nuclei of galaxies not ascribed to stellar processes. Classification of objects, unification framework, supermassive black holes and their role in galaxy formation and evolution.

Virtual Observatories. Survival guide for young astronomers in the big-data era *Rodolfo Barbá* (Universidad de La Serena, Chile) The world and the sciences are changing so fast that it becomes a daily challenge for everyone to keep abreast of these changes. New data are being ingested by the databases at all times, expanding exponentially the number of astrophysical sources, and the number of observable parameters determined for them. Furthermore, new modes of discovery are enabled by this overwhelming growth of data and computational resources dedicated in the Astrophysics. The worldwide computational infrastructure including databases, virtual observatories and distributed data, high-performance and distributed computing (e.g. grid, cloud), new methods for intelligent search and analysis, discovery tools, powerful visualization environments and methods for interchange and sharing of the information and research are completely different to those used in the past century. A new paradigm of how to do research is emerging. These lectures and labs are oriented to help the student survive the tsunami of data and learn the essentials about the structure of astronomical data, its repositories, how they are collected and organized, and how to access them efficiently. Some very funny discovery exercises will be performed.