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Editors: Mario Armando Higuera Garzón & Santiago Vargas Domínguez

ASTRONOMY IN COLOMBIA

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RESUMEN

Hace más de dos siglos, José Celestino Mutis y Francisco José de Caldas dieron comienzo a la expedición astronómica colombiana. En la actualidad, el país cuenta con una comunidad superior a 50 científicos, vinculados a seis instituciones en todo el país, y más de 250 estudiantes e investigadores (PhDs and Postdocs), quienes llevan a cabo investigaciones en astronomía de alto impacto alrededor del mundo.

ABSTRACT

More than two centuries ago, José Celestino Mutis and Francisco José de Caldas initiated the Colombian Astronomical Expedition. Today, Colombia has a community of over 50 scientists, linked to six institutions nationwide, and more than 250 students and researchers (PhDs and Postdocs), having high-impact astronomical research around the world.

Key Words: education — history and philosophy of astronomy

1. 1803, THE FIRST OBSERVATORY IN AMÉRICA

The creation of the Astronomical Observatory, in the Spanish colony "la Nueva Granada" was the initiative of naturalist José Celestino Mutis, constituting the first astronomical observatory that was built in the Americas. Mutis named, as head of the Astronomical Observatory, the self-taught scientist Francisco José de Caldas, who began to make astronomical and meteorological observations at the end of 1805. Caldas was murdered by order of the general Pablo Morillo in 1816. The research at the Observatory was null until 1823 with the arrival to the country of the Mission Boussingault, initiative of the general Simón Bolívar.

In 1848, the Observatorio Astronómico Nacional (OAN) became part of the Military College, an institution created a year earlier by Tomás Cipriano de Mosquera for the training of civilian and military engineers. On May 26 (1867), the Observatory became a prison-fortress housing the recently ousted president Tomás Cipriano de Mosquera. In that same year the National University of Colombia was organized and in February of 1868, Dr. Manuel Ancízar, in his character of Rector, designated to Jose Maria González Benito like director of the institution.

In 1891 Julio Garavito Armero was appointed director, who made numerous theoretical studies and meteorological and astronomical observations. In particular, his works on the calculation of probabilities, mathematical optics and the movement of the Moon, were very prominent.

Fig. 1. Observatorio Astronómico Nacional, Universidad Nacional de Colombia. Bogotá, Colombia.

Today, the OAN is equipped with optical telescopes housed within two observing domes. The instrumentation is used for training undergradu-

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Fig. 2. Image of the crater "Garavito" on the Moon's far side. (Lunar Orbiter Mission). Coordinates: 47°30′ S 156°42′ E. Gazetteer of Planetary Nomenclature, International Astronomical Union (IAU) Working Group for Planetary System Nomenclature (WGPSN, LFC-1A).

ate and master students in astronomical techniques, aiming to develop a wide range of research projects such as probing stellar variability and solar observations. Moreover we promote science by doing weekly public outreach activities.

On the other hand, theoretical research in cosmology and gravitation, and archival data research in AGNs, stellar physics and solar physics, form master and PhD students in these areas.

2. COLOMBIA 21ST CENTURY

The Colombian Astronomy and Astrophysics Community has been growing and consolidating in the country; examples of this are the creation of the Undergraduate Program in Astronomy at the Universidad de Antioquia, the Master of Science and the opening of the Ph.D., in Astronomy at the OAN, Universidad Nacional de Colombia (UN), as well as the astronomy research program at the Universidad Industrial de Santander and astronomy courses at: Universidad de los Andes, Departamento de Física (UN), Universidad Distrital "Francisco José de Caldas", Universidad de Nariño, Universidad ECCI, Universidad Sergio Arboleda, Universidad Antonio Nariño and Universidad Tecnológica de Pereira.

In the last five years professional astronomy at Universidad de Antioquia (UdeA, Medellín) has been developing mainly in three fronts: First, Research

Fig. 3. Poster of the national meeting: Congreso Colombiano de Astronomía (COCOA), Bucaramanga, 2012.

is being developed by the Group of Computational Physics and Astrophysics. This group has been ranked by COLCIENCIAS with the highest quality grade due to his research in the fields of Galaxies and Cosmology, Planetary Sciences and Exobiology and Star formation, with results that are commonly published in main journals. Second, formation of master and PhD students has been one of the strongest efforts in the last years. Students enroll in to the graduate program of the Institute of Physics, and there, they do their master or PhD research under advisory of professors of the research group. Finally, one of the most important milestones in the last few years has been the start up of the Undergraduate Program in Astronomy at UdeA. This has been a milestone in a national wide sense. The Undergrad Program in Astronomy started activities in 2009; currently there are around 250 students in the program and around 10 astronomers have already finished their students and graduated as astronomers.

On the other hand, the astronomy group linked at Universidad de los Andes (Uniandes, Bogotá) con-

ducts border research within the observational and computational fields. Specific topics are: Stellar variability: spectroscopic and photometric studies in the optical and infrared bands of Galactic and extragalactic Be stars. Spectroscopic variability of Antares. Classification of variable stars in optical and infrared by using supervised learning techniques. Statistical analysis of the period-luminosity relation of Cepheid variables. Galaxy formation and cosmology: distant galaxies, the Milky Way and the Universe at large scale, using Monte Carlo methods for radiative transfer, cosmological N-body simulations and applications of Bayesian statistics.

Uniandes also takes part in the coordination of the Andean Regional Office of Astronomy for Development (ROAD), a project supported by the International Astronomical Union and supervised by the Office of Astronomy for Development in South Africa. The main aim of this office is to use astronomy to foster human development in the region. Currently there are six countries in the Andean ROAD (Bolivia, Colombia, Chile, Ecuador, Peru and Venezuela).

Further evidence of growth in intellectual production and international projection include more than 400 hundred contributions published in international astronomy journals, and national meetings like the Colombian Congress of Astronomy and Astrophysics (CoCoA). In parallel, the Colombian Astronomy and Astrophysics Community maintains regular communication with Colombian diaspora researchers through an active mailing list: astrocol2014@googlegroups.com.

In 2015, our country joined the IAU as national member, and 28 astronomers are linked as individual members. In 2016 Colombia was host of five important meetings: The XV Latin American Regional IAU Meeting (Cartagena), CAP 216, Communicating Astronomy with the Public (Medellín), The IAU 327 Symposium (Cartagena), Workshop on astronomy beyond the common senses for accessibility and inclusion (Cartagena), and Astronomía Dinámica en Latinoamérica (ADeLA) 2016 (Bogotá).

Colombia has international collaborations with the following projects, universities and observatories: Pierre Auger Observatory (Argentina), LatinAmerican Giant Observatory (LAGO), Observatorio Astronómico Nacional SPM (México), Universidad de Leiden (Netherlands) Centro de Investigaciones de Astronomía CIDA (Venezuela).

Planetariums as: Planetario de Bogotá, Planetario de Medellín, Planetario Combarranquilla, Planetario UIS, and Planetario Universidad Tecnológica de Pereira; Interactive Science Museums as: Parque Explora (Medellín) and Maloka (Bogotá) and many Amateur astronomy groups, also contribute in the diffusion of Astronomy and planetary sciences in Colombia.

Fig. 4. CAP 2016, Medellín, Colombia.

2.1. *Astroparticle Physics*

In Colombia, since 2010, at the Universidad Industrial de Santander (UIS, Bucaramanga), the Relativity and Gravitation Research Group (GIRG for its Spanish acronym for Grupo de Investigación en Relatividad y Gravitación) has been developing a research line in Astroparticle Physics. This research program has devised a simulation chain to calculate precisely the flux of cosmic ray secondary particles at any altitude, at any place in Earth, taking into account different atmospheric conditions and short and long term geomagnetic effects.

With this simulation chain, we study the background flux and its variations: A) at Latin American Giant Observatory (LAGO) sites to study the fingerprint of the Forbush decreases and their relations with the near-Earth environmental conditions;

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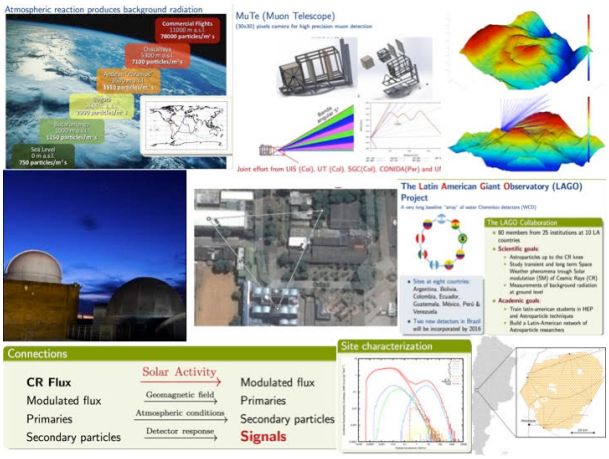

Fig. 5. The Relativity and Gravitation Research Group (GIRG), Universidad Industrial de Santander.

B) along commercial aircraft specific trajectories, to study possible radiation cell damage; C) on the crossing muon flux which crosses volcano edifices, producing muongraphy of the volcano inner structures. These three branches reflects an interesting applications of basic science on highly importan topics with social impact.

2.2. *Solar Radio Interferometer*

Among the students projects we are developing the First Colombian Solar Radio Interferometer (FiCoRI) is an instrument thought to observe the Sun in a dynamic range of frequencies with a bandwidth of 1000 MHz. It is expected to study the space weather, the particle acceleration processes during flares, among others.

The versatility of FiCoRI make it an instrument easily modifiable to observe astrophysics radio sources different to the Sun, such as galactic nuclei and even pulsars. Currently the instrument is being tested and calibrated and it is expected to acquire data available for the public by the end of March 2017.

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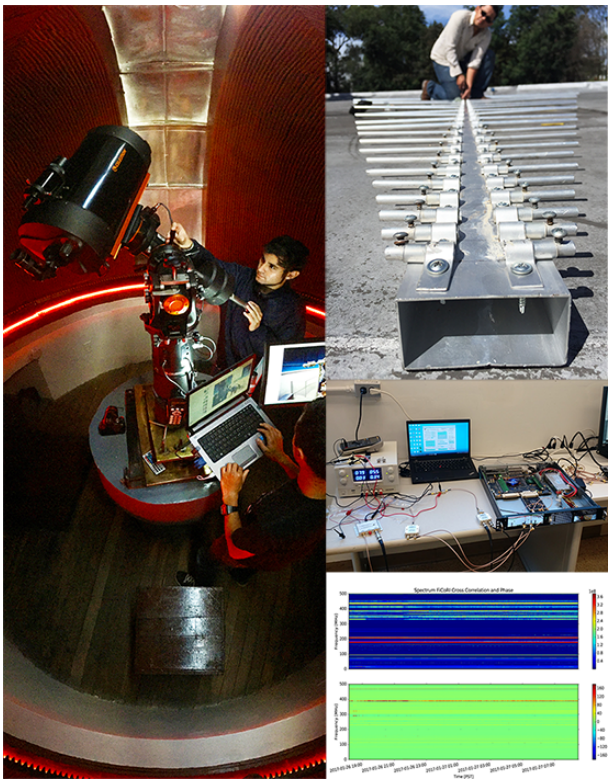

Fig. 6. First Colombian Solar Radio Interferometer (FiCoRI).

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