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The outreach plan around the first science with the Gran Telescopio CANARIAS (GTC)

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Abstract. 2009 is important for Astronomy in Spain, not just because of the celebration of the International Year of Astronomy, but because of the beginning of the Gran Telescopio CANARIAS's operation. The Project 'Consolider-Ingenio 2010: First Science with the GTC', is a project funded by the Spanish Ministry of Science & Innovation (MICINN). For this project, it is fundamental that the GTC, a complex and expensive installation, produces science from the very beginning. One of the project objectives is Public Outreach and, in this paper we explain the outreach and education plans around the first science with the GTC.

Keywords. GTC (Gran Telescopio CANARIAS), public outreach, Consolider-GTC

1. Introduction

2009 is important for Astronomy in Spain, not just because of the celebration of the International Year of Astronomy, but because the beginning of the operation of the Gran Telescopio CANARIAS, the GTC. The GTC is a reflecting telescope designed to incorporate the most up-to-date technology and, when it enters service, it will be one of the most advanced telescopes in the world. The GTC will 'see' the farthest, faintest objects in our Universe. This is like travelling through time –the light that reaches us from the remotest objects in the Universe started its journey some 13,000 million years ago. This light will help to provide answers to many questions about how the known Universe was formed and how it evolved.

Figure 1. GTC's dome and building. Credit: GTC.

2. Overview

The GTC Project is a Spanish initiative led by the Instituto de Astrofísica de Canarias (IAC). It is located in one of the top astronomical sites in the Northern Hemisphere, the Observatorio del Roque de los Muchachos (ORM, La Palma, Canary Islands). Works began in late 1999. The First Light event took place on July 2007. Its first science is expected for 2009. The cost of construction and administration formalities is around 130 M€. The project is actively supported by the Spanish Government and the Local Government from the Canary Islands through the European Funds for Regional Development (FEDER) provided by the European Union. The project also includes the participation of institutions from Mexico and the USA. Mexico's National Institute for Astrophysics, Optics and Electronics (INAOE), and the Institute of Astronomy of the National Autonomous University of Mexico (IA-UNAM), contribute with 5% of the project's construction, running and start-up costs. The agreement also sees the GTC exchanging observing time with the Large Millimetre Telescope (LMT), a 50 m telescope built by the INAOE and the University of Massachusetts. From the USA, the University of Florida Research Foundation signed an agreement under which it will contribute 5% of the project's cost in return for 5% of the observing time. The Mexican institutions and the University of Florida are also developing some of the telescope's instruments.

Figure 2. The GTC telescope. Credit: Miguel Briganti (IAC)

3. The Gran Telescopio CANARIAS (GTC)

3.1. *Mirror*

The GTC's primary mirror has been designed as a segmented mirror. It is made up of 36 hexagonal segments, which, when put together, will be equivalent in size to a single, circular mirror with a diameter of 10.4 m. The GTC has a larger light-collecting surface (75.7 m^2) than any other optical or infrared telescope. The GTC has also monolithic secondary and tertiary mirrors, the latter deflecting the light to the foci where scientific instruments can be mounted.

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3.2. *Active optics*

Image quality is crucial and, in addition to this large light-collecting surface, the GTC will use those two systems to optimise it. Active optics will be used to align, bend and move the mirrors (the segments of the primary mirror and the secondary mirror) to keep them in exactly the same shape and position regardless of external conditions such as temperature, gravitational flexures and manufacturing imperfections that would otherwise affect image quality (see the video *The Primary mirror moving* at `http://www.gtcdigital.net/imagenes.php?op1=7&num=2&ind=424&lang=en` and *The secondary mirror active optics* at `http://www.gtcdigital.net/imagenes.php?op1=7&num=8&ind=36&lang=en`).

3.3. *Adaptive optics*

Adaptive optics is a new technology being developed for the world's leading telescopes. When in place it will allow the Universe to be observed almost as clearly as if there were no atmosphere. Adaptive optics involves the use of flexible mirrors to compensate for the aberrations caused to light as it passes through the Earth's atmosphere (the so-called seeing, see the video *The adaptive optic system* at `http://www.gtcdigital.net/imagenes.php?op1=7&sec1=2&sec2=13&sec3=5&lang=en&id_vid=24&lang=en`).

3.4. *The dome*

The dome is 34 m in diameter and almost 24 m high at its tallest point. The whole 500 tonnes structure rests on tracks at its base so that it can rotate. It is like an enormous jacket that protects the telescope from windy and humid conditions, facilitates ventilation and cuts the internal and external air turbulence that can compromise the image (see the videos: *The construction of the dome* at `http://www.gtcdigital.net/imagenes.php?op1=7&num=40&ind=6&lang=en` and *The natural ventilation system* at `http://www.gtcdigital.net/imagenes.php?op1=7&num=12&ind=36&lang=en`).

3.5. *Queue Scheduling*

The GTC will use observing time efficiently by employing a *queue scheduling* system of observation, a process that automatically decides which instruments and what types of observations are best suited to the atmospheric conditions at any given time.

3.6. *Control system*

GTC will also have an advanced control system and will be highly reliable thanks to a programme of preventive maintenance designed to deal with problems before they arise. This will ensure that downtime caused by system failure is kept to a minimum.

4. The Gran Telescopio CANARIAS Scientific Instrumentation

Thanks to the GTC, Spain is at the head of one of the world's biggest science and technology initiatives in the field of astronomy. But, a telescope needs instrumentation, otherwise it would be like a camera with no film. The GTC will have state of the art instruments optimized for visible and infrared light. These instruments are OSIRIS, CanariCam, ELMER, EMIR and FRIDA, and they will capture light and produce direct images (viewable by the human eye) and spectra (spectrographs split the light into its different wavelengths).

OSIRIS (Optical System for Imaging and low Resolution Integrated Spectroscopy) is designed to obtain direct images of the sky and to carry out spectroscopy of a number of different objects simultaneously. It will work in the visible range, that is, with the light

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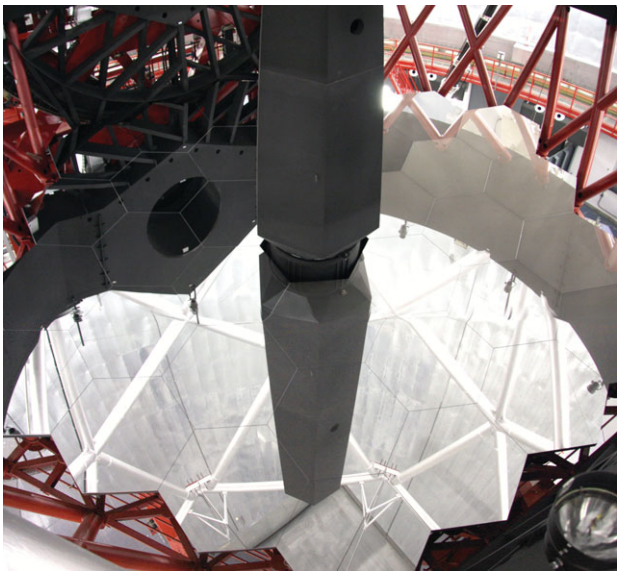

Figure 3. GTC's primary mirror. Credit: G. Pérez & I. Jiménez (IAC)

from the sky that can be seen by the naked eye. OSIRIS was designed and built by the IAC, with the collaboration of IA-UNAM and it is now being tested at the telescope.

CanariCam (a thermal infrared spectrograph with imaging capability) will be able to 'sense' the heat from a star. It will have imaging capacity and will be able to perform spectroscopy, polarimetry and coronography in the mid-infrared part of the spectrum. CanariCam has been built by the Astronomy Department of the University of Florida.

ELMER is capable of conventional imaging using both broad and narrow band filters so that it can be used to check the calibration of the telescope and perform long-slit spectroscopy, fast photometry, fast-slit spectroscopy and slitless multi-object spectroscopy. It was designed and built by the GTC's Project Office.

EMIR (Infrared Multiobject Spectrograph) is a wide-field, near-infrared, multi-object spectrograph. It will be the first of the second-generation instruments and will be a key tool for studying the history of the formation of stars in the Universe. It will be capable of obtaining images from many different sources simultaneously, using the multi-slit mask method. EMIR is led by the IAC, with a Consortium that includes other Spanish and French institutions.

FRIDA (InFRared Imager and Dissector for the Adaptive Optics System of the GTC) is an Infrared Camera with Integral Field Unit and it will be the first instrument to work with light corrected by the GTC's Adaptive Optics. This instrument is being developed by an international team led by the IA-UNAM.

5. Public outreach around the Gran Telescopio CANARIAS and the CONSOLIDER-INGENIO 2010: First Science with the GTC project

Since the beginning, the GTC, through the Directors board of the Instituto de Astrofísica de Canarias (IAC), has bet for doing public outreach before the telescope enters service to prepare the society and let them know that Spain leads the biggest project in current optical/infrared astronomy.

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That's why a position was created specifically for this purpose, as well as a web site just concerning public outreach that contains news, photos and videos to explain all the process of construction and how the telescope works. This is probably the first time that the construction of a telescope is followed so closely and in detail. `www.gtcdigital.net` is a web site in Spanish and English. From July 2008, I am working for the Project '*Consolider- Ingenio 2010: First Science with the GTC*', a project funded by the Spanish Ministry of Science & Innovation (Ministerio de Ciencia e Innovación, MICINN). For this project, it is fundamental that the GTC, a complex and expensive installation, produces science from the very beginning. There are 12 scientific groups involved: the main thrust bonding so many different scientific groups together is the interest of the project for getting the best science out of the GTC.

The project Consolider-GTC has over 150 participants, 19 research teams in 12 different centers (including centers in Mexico and Florida); it is funded by the Spanish Ministry of Science & Innovation (MICINN) with over 5 M€ for 5 years, 2011 being the last year.

Main Objectives of the project:

- GTC. To help to accelerate the GTC optimisation so it starts producing science as soon as possible.
- SCIENCE. To carry out a number of scientific projects that results in qualitative advancements in astronomy.
- E-ELT. To benefit from the know-how acquired during the GTC construction to get involved in the new generation of ELTs
- INSTRUMENTATION. To foster the participation of the Spanish community in the design and construction of state of the art instruments for the GTC and other large telescopes.
- EDUCATION. Implementation of an Advanced School for Scientific Instrumentation: IScAI. The International School for Advanced Instrumentation (IScAI) is a major international initiative in higher education that aims to become a centre of excellence to learn expertise in all areas related to the construction of cutting-edge scientific instrumentation, with a particular emphasis on astronomical instrumentation. The thrust of IScAI is to educate the necessary workforce of specialized personnel in scientific instrumentation and facilitate the partnerships of universities, research institutes and high-tech companies, beeing a bridge between the intellectual resources and technology transfer capabilities in the construction of state-of-the-art instrumentation for the new generation of scientific facilities. IScAI-2009 is open to astronomers, physicists and engineers world-wide. After the successful pilot program in 2008, the IScAI officially started in 2009. IScAI-2009 offers an intensive programme of courses and laboratory work in key areas related to the design and construction of scientific instrumentation. The laboratory work will be done at various research institutions and high-tech companies with world-class instrumentation programs in Europe and America. More information at `www.iscai.iac.es/iscai`.
- PUBLIC OUTREACH- To develop an attractive, well-designed public outreach programme to share with the public the scientific and technical achievements of the GTC. Why?
    - To transfer the new results obtained with GTC by the CONSOLIDER-GTC members.
    - To promote the interest towards astrophysics in the next generation of students.
    - To transfer the interest for astrophysics to all of the society.
    - To make the basic ideas from astrophysics and cosmology be part of the *common knowledge*.

We want to make the society participant of the adventure that is implicit in the scrutiny

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of the sky and, to do so, to transfer this research dreams to all of society, all signing members of this collaboration must be fully involved through a variety of activities:

- University orientation talks to communicate how attractive it is the study of astrophysics and promote love for science.
- Teaching materials for primary and secondary school teachers: simple scripts that would allow practical use of the data provided by the GTC data center.
- A contest among students whose prize would be a visit to the GTC. The contest has different levels depending on the age of the students: (i) For the youngest the contest would be through drawings and written texts about the observation of the universe (the prize would be an amateur telescope); (ii) For secondary students we propose the preparation of a scientific observation. The winning group would be invited to visit the GTC and carry out the proposed observations, under the supervision and coordination of researchers from our team.
- Public outreach talks about this project's science distributed through the web page to non professional astronomers, scientific journalists, and the general public to be used in scientific public outreach activities.
- Lecture courses or seminars specialised on astronomical public outreach for future journalists. To reach agreements with universities engaged in science journalism and offer them lecture courses or seminars specialised on astronomical public outreach. Such lectures would provide basic knowledge in astronomy to future journalists. It would also help them to correctly interpret the news related to astrophysics.
- Institutional participation of the project team in organized events such as: science week, scientific fairs, ... organised within the European Union, and also in other countries. The aim is to communicate to the largest possible audience the transcendence of the research that we shall carry out with the GTC.
- Informative dossiers on each scientific team. A background information kit about the scientific field, the first scientific data obtained, images ...
- Web site `www.iac.es/consolider-ingenio-gtc`. It must be a "meeting point" and an exchange and communication virtual place for members, as well as for general public and public outreach professionals. The aim is to have an English version as soon as possible.
- Public outreach on the web site includes: News (press releases, last news, milestones, scientific news, etc); Gallery: photographs and astronomical images obtained by the members of the Consolider-GTC team, processed and adapted for its public distribution; Teaching materials (talks, teaching units); Informative dossiers on each scientific item/team.
- IYA2009. Astronomy Days along 2009 promoting GTC and Consolider in Florida: Verónica Donoso, at the University of Florida, is the contact person and the one who is managing the organization of those activities: Teleconference with the Gainesville Museum (september); Talks at the Children Museum of Miami (sept-oct); Collaboration with the activity 'Pure Platinum Astronomy' at the Miami Planetarium; Collaboration with the IYA2009 Inauguration in Mexico through a teleconference from the GTC (31st January) and with an information point at the Zócalo. This teleconference is into a project called '*TeleAstronomía*' that is organised by Alfred Rosenberg, Consolider member and Scientific Advisor at the Public Information Office of the IAC.

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