The Role of Astronomy in Society and Culture
Proceedings IAU Symposium No. 260, 2009
D. Valls-Gabaud & A. Boksenberg, eds.

doi:10.1017/S1743921311002808

An astronomical observatory for Peru

Juan Quintanilla del Mar[1], Bruno Sicardy[2], Víctor Ayma Giraldo[3] and Víctor Raúl Aguilar Callo[3]

[1]DIL, Observatoire de Paris,
5 Place Jules Janssen, 92195 Meudon, France
email: juan.quintanilla@obspm.fr

[2]LESIA, Observatoire de Paris, Université P. et M. Curie, Institut Universitaire de France,
5 Place Jules Janssen, 92195 Meudon, France
email: bruno.sicardy@obspm.fr

[3]Universidad Nacional San Antonio Abad del Cusco,
Av. de la Cultura, No. 733, Cusco 51084, Perú
email: vaymagiraldo@hotmail.com rectorado@unsaac.edu.pe

Abstract. Peru and France are to conclude an agreement to provide Peru with an astronomical observatory equipped with a 60-cm diameter telescope. The principal aims of this project are to establish and develop research and teaching in astronomy. Since 2004, a team of researchers from Paris Observatory has been working with the University of Cusco (UNSAAC) on the educational, technical and financial aspects of implementing this venture. During an international astronomy conference in Cusco in July 2009, the foundation stone of the future Peruvian Observatory was laid at the top of Pachatusan Mountain. UNSAAC, represented by its Rector, together with the town of Oropesa and the Cusco regional authority, undertook to make the sum of 300,000€ available to the project. An agreement between Paris Observatory and UNSAAC now enables Peruvian students to study astronomy through online teaching.

Keywords. Teaching, astrophysics, cosmology, university, students, architecture, telescope, Cusco, Paris

1. Introduction. A brief history of astronomy in Peru

Over many centuries the various civilisations which forged Peru's history developed a wide-ranging knowledge of astronomy. For example: on the North coast of Peru, Chankillo (Ghezzi and Ruggles 2007) is perhaps the oldest astronomical observatory of the Americas, dating back to 2,400 years ago; the world-famous Nazca lines at Nazca-Paracas are giant geoglyphs depicting perhaps the constellations dating from 600 years ago; the sacred Inca citadel of Machupicchu with its Sun temple and '*Intiwatana*' sundial, and many other sites are all proof of this. Peru must now renew the links with its astronomical past and bring it forward into the future. This country and the Cusco region in particular meet all the requirements for the establishment of an astronomical observation site: altitude and arid regions, geographical location near the Equator, etc. Peru is one of the few countries in the Andean region without its own observatory, so it must set up a modern astronomical observatory worthy of the name. The present project is aimed at giving the country an astronomical observatory whose main objective will be basic research and education, providing the means to study this science and to promote its development.

The study of astronomy in Peru today requires the tools that will enable a pertinent scientific return and allow professionals from Peru and other countries to participate actively in the practice and dissemination of this discipline. The project has three aspects:

(1) Teaching for three different audiences: universities, schools and the general public; (2) A telescope; (3) The architectural development of the site of the national astronomical observatory of Peru.

2. Background to the project

The project was conceived in 2004 by a French architect of Peruvian origin, Juan Quintanilla del Mar, and a group of astrophysicists from Paris Observatory, including Bruno Sicardy and Thomas Widemann. Initial contact was made with Peru in 2005 during a co-ordinated observation operation carried out in Chile, Argentina and Brazil. Before leaving to participate in this event, the team met with the Peruvian Ambassador to France (Javier Pérez de Cuéllar, former UN Secretary General), who assured them of his support. During the visit to Peru in July 2005, F. Colas, J. Quintanilla, B. Sicardy and T. Widemann met Maria Luisa Aguilar and staff from the Universidad Nacional Mayor San Marcos (UNMSM) in Lima, the science attaché at the French Embassy in Peru, and the Rector and staff of Cusco University. Public lectures were organised and talks were given at several primary schools. Many contacts were made by telephone and e-mail and two UNSAAC professors (Gabrielle Frisch in July 2007 and Víctor Ayma Giraldo in January 2009) visited France to discuss the project. Juan Quintanilla returned from a visit to Peru in July 2008 with a letter of intention signed by the Rector of the University of Cusco and the Mayor of Oropesa and an undertaking from the Cusco Region's Financial Chairman to pay for half the cost of the telescope and the whole cost of the infrastructure required for the establishment of the observatory. The President of Paris Observatory, Daniel Egret, and Harry Belevan-McBride, Peruvian Ambassador to France, met in January 2009 and a number of points were confirmed, including the common interest of both parties to set up a 60 cm telescope (or 'T60') in Peru, to be funded partly by France (Paris Observatory and other potential sources) and partly by Peru (UNSAAC, the town and regional councils of Cusco).

3. The project: education

3.1. *University level*

The teaching of university students and professors as proposed by the Paris Observatory's tele-education unit (UFE, Unité de Formation-Enseignement) will be in Spanish. The scheme proposes courses and practical work concerning the planned 60 cm telescope. It includes visits by Peruvian doctorate students to the various laboratories of the Paris Observatory, e.g. GEPI (Galaxies-Etoiles-Physique-Instrumentation –Galaxies, Stars, Physics and Instrumentation lab); IMCCE (Institut de Mécanique Céleste de et de Calcul des Ephémérides – Institute of Celestial Mechanics and Ephemeris); LESIA (Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique –Laboratory for Space Studies and Astrophysical Instrumentation).

Science Programme. The establishment of a series of scientific and research programmes between France and the Peruvian scientific community, including: Photometry of variable stars; Detection of exoplanets by transit; Astrometry of planets' small natural satellites for the improvement of the ephemeris tables; Observations of star occultations by Pluto, Charon, Triton and other objects distant from the solar system. See also the programme of scientific activities typical of the T60.

https://doi.org/10.1017/S1743921311002808 Published online by Cambridge University Press

3.2. *School level*

Primary and secondary schools. Training school teachers to teach astronomy (UFE-Paris Observatory via internet). Teaching astronomy to pupils through workshops, experiments, visits and observations, specific programmes. This part of the project is aimed at making young people aware of astronomy, and awakening their curiosity by showing them the important rôle astronomy and the other sciences play in their education.

3.3. *General public*

Making astronomy accessible through a programme of visits, for which a 60-cm telescope is sufficient.

4. The project: telescope

A 60 cm telescope has been selected because of its ability to adapt to various usage programmes, from the educational, the scientific and the research points of view. A 60 cm telescope is small enough to allow visits by the general public, and big enough to undertake interesting scientific programmes. It will also promote an interest in astronomy at national level, which in time will lead Peru to undertake more ambitious projects.

4.1. *Scientific activities with the 60 cm telescope*

The T60 will enable several scientific programmes. It is to be noted that all these programmes are both scientific and educational, since they require mastery of the observations and associated instruments, and the learning of methods for the reduction and analysis of data. For example:

(*a*) Stellar physics. Photometry of different types of variable stars: cepheids, cataclysmic, eruptive RCrB type, etc.; analysis of light curves and phenomenology of these stars for scientific and teaching purposes; analysis of temporal data, frequencies, amplitudes; Photometric monitoring of stars to detect exoplanets by transit (this method, carried out with telescopes of lower diameter has been comprehensively proved). A by-product is the revealing of eclipsing binary stars.

(*b*) Galactic and extragalactic physics: Imaging the regions close to the Galactic centre (which passes near the zenith at Cusco) to detect novae; identical programme in relation to the Large and Small Magellanic Clouds. Imaging and photometry of galaxies near the local cluster and supercluster in order to analyse the stellar populations via colour-colour diagrams, and to detect supernovae. Later on, numerous programmes involving stellar, galactic and extragalactic spectroscopy may be implemented once the telescope is fitted with a medium-resolution spectrograph.

(*c*) Planetology: Observations of mutual (Jupiter, Saturn) phenomena and astrometry of small natural satellites, with a view to improving the accuracy of the ephemeris tables. Astrometry and photometry of trans-Neptunian objects (TNO) to discover their rotation periods and to improve knowledge of the orbital elements currently not well known. Predictions of stellar occultations in the southern hemisphere (the telescopes currently used are either in sites that are not favourable from the point of view of climate, or too many demands are made of them). Observations of stellar occultations by Pluto, Charon, Triton and TNOs which occur at a typical frequency of 3 to 5 interesting events a year and which, in certain cases, could be combined with campaigns conducted in Chile (VLT, La Silla, etc.). Monitoring meteorite swarms with a wide-lens camera in the context of

Figure 1. An artist view of the planned buildings at the Pachatusan Observatory site.

a doctorate project for Peruvian students. Temporary monitoring of clouds in planetary atmospheres (Venus, giant planets, Titan). Continuous, network monitoring of the Moon.

4.2. *Architecture*

The selected site is located on the slopes of Apu Pachatusan Mountain, 13°33′00″ S, 71°45′41″ W, at an altitude of 4,400 m. It is near the town of Oropesa, about 40 km to the East of the university city of Cusco (ancient capital of the Inca Empire, a UNESCO World Heritage Site). The site was selected because of its privileged geographical situation. It is sufficiently distant from Cusco to escap e light pollution, while being easily accessible by students and the general population, as over 95% of the road from Oropesa is suitable for motor vehicles.

Architecture of the various components of the Observatory. Intentions: the architectural design of the Observatory complex has a strong symbolic profile. The various users of the site will be able to identify with these cultural symbols of Andean cosmology. All the elements making up the complex reflect this symbolism and the visitor will be able to see in them the identity references of the installation. The outline plan of the complex represents the constellation of the Southern Cross, which, for the inhabitants of the Andes, is the equivalent unchanging bearing of the North Star for people in the northern hemisphere.

The five constituent elements of the complex are :

• The *Intiwatana*, or sundial. The sundial will be placed on a spiral-shaped, double ramp tumulus. In addition to being a sundial, this element also symbolically represents the spiral of space, and the span of a lifetime. Its spiral shape, centred on a gnomon, evokes a galaxy or a vortex.

• The *Chakana* or Inca Cross represents the transfiguration of the constellation of the Southern Cross in which the whole of Inca cosmology is concentrated. The building is located at the centre, where the two branches of the constellation intersect. The Chakana is the hub of the whole complex. The Chakana has two parts: (1) A private section for scientists and students, comprising bedrooms, kitchen, dining room, service areas and a work area with offices, meeting room and technical premises; (2) A public section with showrooms, lecture hall and service premises.

• The meeting place. This area represents the Earth, or *Pacha Mama*, representing fertility and generosity. It is a spacious open-air plaza which will be used for large public meetings and events.

• Telescope dome. The dome will represent the Sun, the source of life and energy and will house the 60 cm telescope.

• Fountains. Two fountains located at either end of the minor arm of the Southern Cross symbolise the presence of water, the divinity of the sacred mountain of Apu Pachatusan.

https://doi.org/10.1017/S1743921311002808 Published online by Cambridge University Press

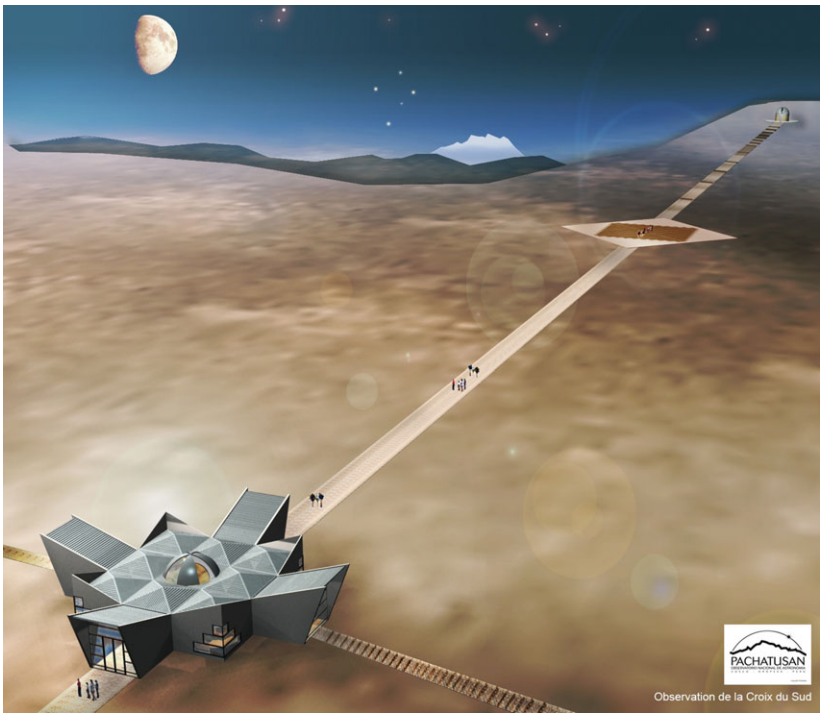

Figure 2. Artist's impression of the planned buildings at the Pachatusan Observatory site.

5. Implications

The aim of the project is to establish and maintain a university-level facility enabling the study of astrophysics not only at Cusco (UNSAAC) but also at all other Peruvian universities wishing to participate. The project sees itself as a force for federation in the country. The teaching will be delivered by the tele-education department (UFE) of the Paris Observatory, initially via the internet. Each Peruvian student will have a designated mentor from the Paris Observatory who will monitor his or her course work.

The site of the new Pachatusan National Observatory being easily accessible, students, schoolchildren and the general public will be able to visit it. Further to the very successful international astronomy meeting '*Entre estrellas y cosmologia*' in Cusco in July 2009, the various institutions, UNSAAC and Paris Observatory initiated a number of projects, including that of teaching astronomy to Peruvian students and school teachers as well as launching the infrastructure for the Peruvian observatory. During their visit, the French researchers contacted two universities in Lima and collaboration between these universities (PUCP and UNI) and Cusco (UNSAAC) was established. In addition, in July 2009, UNSAAC, the town council of Oropesa and the Cusco regional authority formally agreed to pay all the costs of the infrastructure to a maximum amount of 300,000€. A professor of architecture at UNSAAC and an architect from the Paris Observatory will manage the architectural aspect of the project. They will be joined by a doctorate student from the University of Arequipa who will use the observatory project in the preparation of her thesis.

The plans for the observatory are currently being prepared in order to draw up the specifications of the project.

https://doi.org/10.1017/S1743921311002808 Published online by Cambridge University Press

Acknowledgements

We thank Jane Brebner for translating part of this text into English. V. Ayma Giraldo thanks the SOC of IAU Symposium 260 for a generous IAU travel grant which enabled him to attend the conference.

Reference

Ghezzi, I. & Ruggles, C. 2007, *Science*, 315, 1239