Highway to the stars

A Stellar Safari

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The "big eye" fixed on the African sky, the SALT Telescope, has begun peering into the vast reaches of the cosmos. Are there great discoveries in store for it? Research findings have a way of taking everyone by surprise...

At the end of the 1990s, the Polish astronomical community began to ponder the notion of joining a project to construct a large optical telescope for spectroscopic research. Most of the big telescopes extant at that time were already either in operation (the Keck telescopes) or under construction (the VLT, Gemini, Hobby-Eberly, Subaru, and Magellan telescopes). Only two projects then getting geared up, the GTC telescope in the Canary Islands (subsidized by the Spanish government) and the South African

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A huge spiral galaxy, NGC 6744, located at a distance of approximately 30 million light years, often considered one of the most Milky Way-like galaxies known. SALT took this image using the SALTICAM monitoring camera

Maciej Biernacki

What great discoveries are in store for the "big eye" fixed on the African sky - the SALT telescope?

Large Telescope, or SALT (subsidized by the South African government), were open to the international astronomical community. What proved crucial for our decision was the cost of the investment: the SALT Telescope was four times cheaper than the GTC, even though its price-tag of USD 25 million was still quite a large sum.

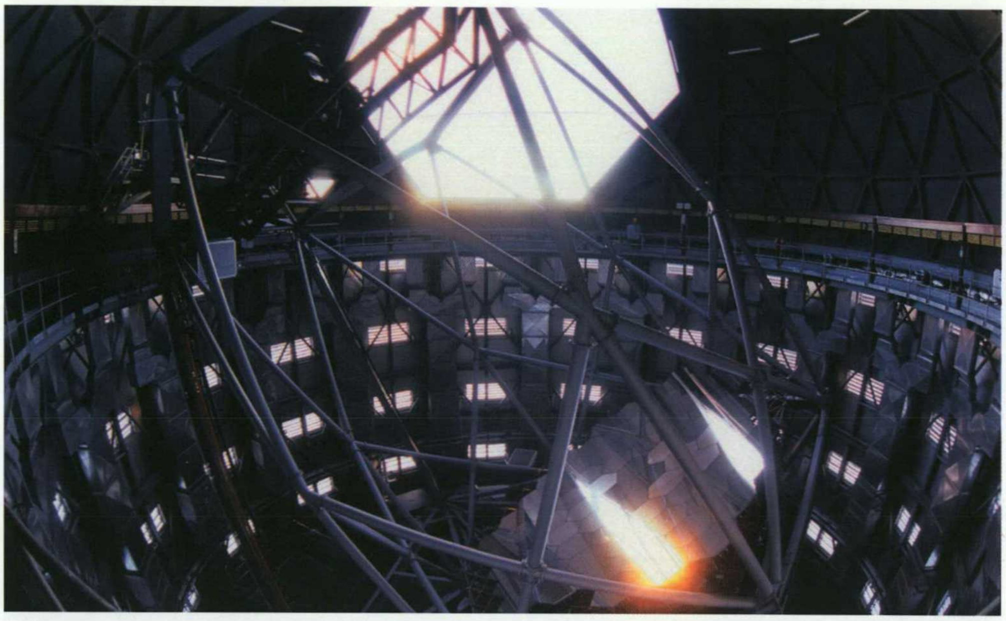
Polish science in the antipodes

In March 1999, the Committee on Astronomy of the Polish Academy of Sciences backed the initiative of the Polish astronomical community. The committee stated that our country might be interested in holding a 10% share in the telescope's observation time, which would require an investment of USD 2.5 million. The Chairman of the State Committee for Scientific Research, Prof. Andrzej Wiszniewski, signed an agreement between Poland and South Africa in Pretoria on 25 November 1999, which stipulated that Poland committed itself to involvement in the SALT project, taking on 11% of the construction costs. Poland's joining the project came at a crucial moment, because it allowed the amassed funding to reach the watershed level of 80%, thereby releasing the funding that had been conditionally put forward by the South African government.

The cornerstone was officially laid in Sutherland on 1 September 2000, and the South African Large Telescope (SALT) was commissioned for use five years later, on 10 November 2005. The opening ceremony brought 700 invited guests and astronomers together in Sutherland. The telescope was officially inaugurated by South African President Thabo Mbeki and Minister of Science and Technology Mosibudi Mangena; Poland was represented by Romuald Szuniewicz, Polish Ambassador to South Africa, Prof. Andrzej B. Legocki, President of the Polish Academy of Sciences, and Prof. Marek J. Sarna, who coordinated the Polish involvement in the SALT project on behalf of the Ministry of Scientific Research and Information Technology. Astronomers from most of the significant Polish university centers were also in attendance.

SALT was built by a consortium of 11 scientific institutions from South Africa, Germany, New Zealand, Poland, the United States, and the United Kingdom. The Polish financial contribution to the telescope's construction was made by the Ministry of Scientific Research and Information Technology, as well as by Adam Mickiewicz University, Jagiellonian University, Nicolaus Copernicus University, and the Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences.

SALT is at this point the largest telescope in the world, with a mirror diameter of 11 meters. It stands on the Karoo plateau, 370 km to the north of Capetown, at an altitude of 1759 meters above sea level. The loca-



Nearly 11 meters in diameter, the mirror is the most important element in the telescope's construction

tion was chosen in view of the conditions that prevail in the telescope's vicinity: most significantly, the number of nights with good weather and the sufficiently dark night sky (which can only be found in locations far from cities).

Other factors of paramount importance for the quality of the data gathered by the telescope include the thickness and condition of the atmosphere, e.g. the smallest possible chaotic movements of the air and the lowest possible water vapor content. Such ideal conditions are only present atop certain mountains, which are usually located in the Earth's tropical zone.

There are not many places on our planet that meet all these criteria. They include the Chilean Andes, the mountains of Arizona, and the summits of extinct volcanoes on the Canary Islands and Hawaii. Another such location is the Karoo plateau in the south of Africa.

How does it work, and what can it do?

The construction of the SALT Telescope is unique. Its main mirror, which is shaped like a segment of a sphere, consists of 91 closely adjoining, hexagonally-shaped mirror segments. The mobile portion of the telescope weights 82 tons, and the dome covering it is 30 meters high. The positioning of the mirror segments is controlled by a complicated system of computer-driven sensors. Each night, before observations are begun, rays of laser light are sent out from a tower situated next to the main building, enabling the ideal shape of the mirror to be achieved. After observations are begun, a special mobile device suspended above the primary mirror - in the so-called secondary mirror - tracks the object being observed and keeps it in the telescope's sights. The construction is unusual in that the main mirror remains immobile during a given observation. It is the sky, seemingly turning as a result of the Earth's rotation, that moves instead. This design has enabled the costs of the entire project to be reduced three - or fourfold.

Just like other devices of its class, the SALT Telescope has to be outfitted with basic instruments to analyze the signals it gathers. In this case these will be medium- and high-resolution spectrographs (which disperse the light that reaches them, like a prism) and an imaging camera. SALT will be able to observe very weak objects: it will "see" a candle lit on the surface of the Moon.

The first two of the planned instruments are already correctly operating at present: the monitoring camera (SALTICAM) and the medium-resolution spectrograph (the Robert Stobie Spectrograph). The next instrument, the high-resolution spectrograph, will be installed before the end of 2007.

First results

The telescope's first research results are already in. Over several nights in September and October, the SALTICAM camera tracked the brightness fluctuations of a certain unusual object: a pair of stars that are closely bound to each other by gravitation, and form a so-called binary system. The stars are so close together that the system fits within an area the diameter of our own Sun. The system consists of a white dwarf and a cold red star, three times smaller than the Sun. The white dwarf has an extraordinary strong magnetic field (30 million times stronger than that of the Earth). The red star is losing matter, which falls upon the white dwarf and forms two hot spots at the latter's magnetic poles. Binary stellar systems of this sort are called "polars." The SALT Telescope has made it possible to prove by observation, for the first time, the existence of such spots on the surface of such a white dwarf.

Polish astronomers now have a series of ambitious projects lined up. Researchers from most of the astronomical centers in Poland have already filed requests to be awarded SALT observation time. They are proposing to observe close stellar systems in globular clusters (in order to measure their distance), low-mass X-ray binaries where one of the components is a neutron star or black hole, and star systems with very short orbital periods (less than 30 minutes). The proposals also include observations of rapidly rotating planetoids in the close terrestrial vicinity and Trans-Neptunian Objects, and of dwarf galaxies in the Local Group of galaxies (a group that includes our galaxy, the Andromeda Galaxy, and others).

What does the future hold?

For more than a decade now, work has been underway in Europe and the United States towards producing a new generation of what have been dubbed "extremely large" telescopes. Designers and astronomers are aiming to pass a new milestone in developing modern observation methods: creating telescopes with a mirror diameter of 25-100 meters.

European projects envisage the construction of a 100-meter telescope by the European Southern Observatory (ESO) and a 50-meter telescope by Finland, Spain, Ireland, and the UK. A US project calls for the construction of a 30-meter segmented telescope, with a construction analogous to that of the SALT. Extremely large telescopes stand a chance of being built maybe even within the next 10-15 years. Already now, the Carnegie Foundation has begun construction of a large telescope consisting of seven monolithic mirrors, each 8.4 meters in diameter. Their overall reflecting surface will be equal to that of a single round mirror 22 meters in diameter; this telescope is slated to begin observations in 2016.

Time will tell whether Poland stands a chance of joining these gigantic projects. For now, however, we should concentrate on putting the SALT Telescope to maximal use - as it is here that the future of Polish astronomy lies. ■

Further reading:

http://salt.camk.edu.pl
http://www.salt.ac.za

Handling the individual telescope mirror elements requires extreme care and precision

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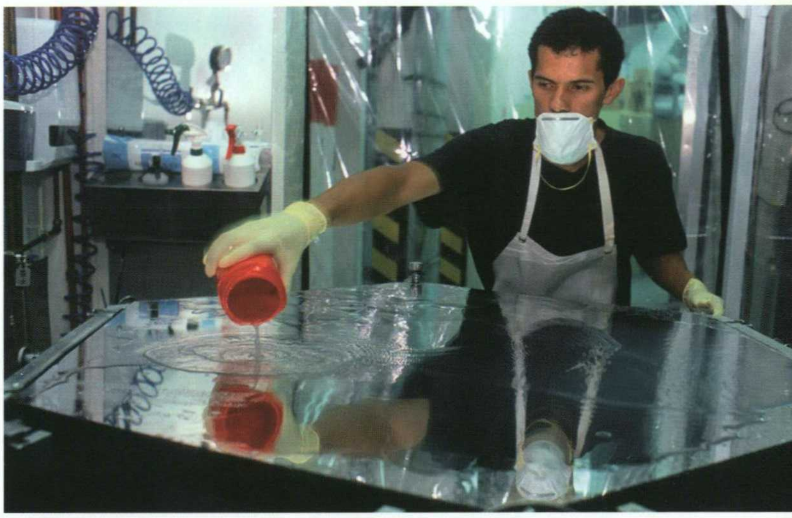

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