M. PEPLOW

Rising star

As construction on the world's largest optical telescope nears completion in Spain, the country's astronomers are gearing up for an expanded role on the global stage. Mark Peplow follows the preparations for first light.

The vast silver dome of the Gran Telescopio Canarias (GTC) glitters as the sun beats down on the volcanic peak of Roque de los Muchachos. Here on La Palma, one of the Spanish Canary Islands, construction continues apace. When it finally opens for business at the end of this year, the GTC will take the title of the world's largest optical telescope — an impressive symbol of how far Spanish astronomy has come in a remarkably short time.

The telescope is also a testament to the lifelong vision of one man, a man who has made it his life's work to establish world-class observatories in the Canaries and put Spain at the forefront of astronomy research.

For ground-based telescopes, size and location are everything. When looking for dim and distant stars, the largest mirrors simply catch more photons, allowing astronomers to see farther and more clearly. With a mirror that is 10.4 metres wide, the GTC is unlikely to disappoint. And Los Muchachos is already home to 14 telescopes because, at 2,400 metres, its high altitude and cloudless weather reduce atmospheric distortion.

Tramping between the telescopes is like touring a futuristic martian outpost. Gleaming white buildings rise out from the red volcanic rocks, and a short stroll in the thin air quickly leaves me breathless. A perfectly still layer of cloud hangs 1,000 metres below, covering the Atlantic Ocean in a white blanket broken only by neighbouring volcanic peaks.

In 1856, the first astronomer to visit these islands, Charles Piazzi Smyth, the Astronomer Royal for Scotland, declared Tenerife to be ideal for astronomy. But another 100 years passed before the rector of the University of La Laguna in Tenerife asked a new physics graduate called Francisco Sánchez to make detailed tests of a potential telescope site close to Mount Teide on the island.

"I quickly realized two things," recalls Sánchez. "That I was very attracted to astronomy; and that the site was incredibly good." From that point onwards, he devoted his life to making best use of this natural resource.

Leading light

Sánchez is now director of the Canaries Institute of Astrophysics (IAC) in Tenerife, a post he has held since it was founded in 1975. When he began his investigations in the 1960s, there were four professional astronomers in Spain. Now there are more than 400, including 150 permanent research staff. Many of them credit Sánchez with single-handedly creating the vibrant research community from virtually nothing. "I just felt it would be a great shame if the islands were used only to tan people," Sánchez says.

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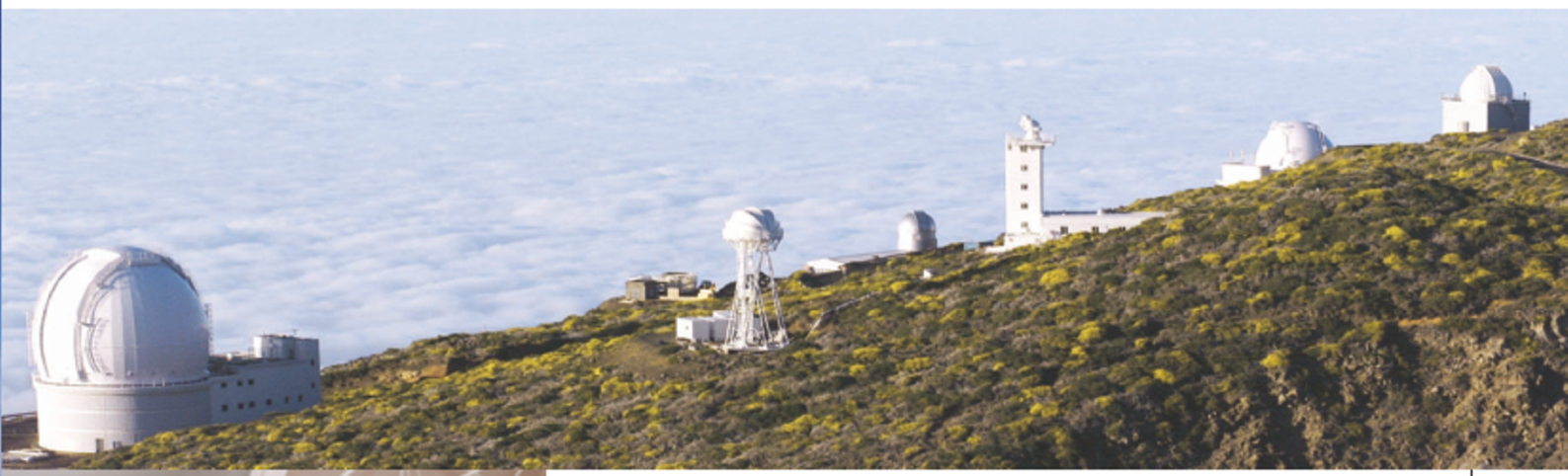
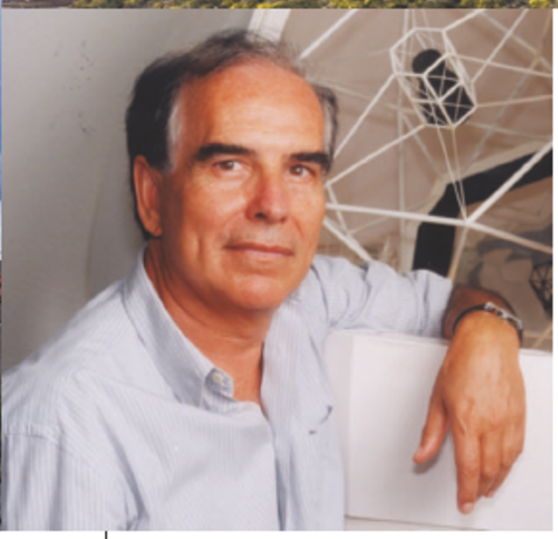
Jean-Claude Gérard and his wife take a tour of the Canaries' new telescope with Casiana Muñoz.

Although he now does little research, Sánchez commands great respect from his colleagues for the hard bargains he drives with politicians and international researchers. In person, Sánchez is genial, and speaks with the velvet-clad phrases of a consummate politician. "He's an autocrat, and he does get things wrong, but his right decisions wash away his sins," says John Beckman, a British astronomer who moved to the Canaries in 1984, and was the IAC's first research director.

Once Teide and Los Muchachos were established as prime locations for telescopes, Sánchez spent six years in negotiations to





IAC

Top of the world: the Gran Telescopio Canarias (opposite) is the latest addition to the instruments on Los Muchachos (above), largely thanks to the efforts of Spanish astronomer Francisco Sánchez (left).

IAC

ensure that whenever other nations wished to build observatories there, 20% of their observing time would be reserved for Spanish astronomers. Nineteen countries have telescopes in the Canaries, operated by more than 60 institutions worldwide. Part of the deal is that each country must also pay for several Spanish postdocs to work abroad each year. This was crucial in helping Spanish astronomy to come up to scratch so quickly, says Beckman.

Clear view

Sánchez says his ability to convince others stems from his own belief in the potential of the observatories. "I'm just a pathological optimist," he smiles.

His negotiating skills were also needed to convince the tourist industry, the Canaries' biggest money-spinner, to dim streetlights and neon signs. Legislation introduced in 1988 protects the observatories from light pollution, low-flying aircraft and air pollution. Public outreach activities have been essential to the observatories' progress, says Sánchez, who recently had a street named in his honour.

Strong local support for the IAC resulted in the regional government of the Canaries, together with the Spanish government, providing 90% of the €100 million (US$128 million) funds for the GTC. Universities in Florida and Mexico have contributed the rest.

Many astronomers, even in Spain, doubted whether the GTC would be built, says José Miguel Rodríguez Espinosa, who leads the GTC project and is president of the Spanish Astronomical Society. The largest optical telescope built by Spain before the GTC was just 80 centimetres wide.

To convince funders that Los Muchachos was the perfect site for a giant telescope, IAC astrophysicist Casiana Muñoz used atmospheric physics to model the air turbulence above La Palma. She says that the site is as good as Hawaii, home to the world's largest optical instruments currently in operation — the two 10-metre Keck telescopes. The GTC is almost a direct copy of the Kecks, and will also use adaptive-optic techniques to modify its mirrors to compensate for turbulence in the air above. This should deliver images that rival space telescopes such as Hubble, Muñoz says proudly.

> "Spain has been very good at using the telescopes other countries put on its land. Now it has the techniques needed to build its own facilities."
> — Rafael Bachiller

The GTC will house several special instruments to extract maximum information from the photons it collects. The first few are all Spanish-built. One of the most versatile optical instruments is OSIRIS, which takes spectroscopic measurements that can reveal the chemical composition of a light source. Such detailed measurements usually focus on individual, bright objects, but OSIRIS is designed to survey many dim objects over large parts of the sky. This means that it can be used to catalogue the ages and compositions of stars in the farthest reaches of our Galaxy.

Closer to home, OSIRIS will also focus on Kuiper-belt objects, frosty remnants from the formation of the Solar System that lie beyond the orbit of Neptune. Information about these primitive snowballs is limited to the largest and brightest objects, so OSIRIS should provide a more complete census.

Another instrument, EMIR, offers similar advantages at the near-infrared end of the optical spectrum. One of its first goals will be to peer deep inside the thick dust clouds that shroud stellar nurseries and capture the birth of a star on film. Because visible light is blocked by the clouds, astronomers hope that infrared surveys will allow them to see inside.

Broad scope

These instruments will not be operational until the end of 2006. Although engineering work on the GTC's 300-tonne superstructure is now complete, the project is two years behind schedule and the inside is still a building site. Wandering through the empty dome, I had a chance encounter with Jean-Claude Gérard, an astronomer from the University of Liège in Belgium, accompanied by his wife. They had taken a break from their holiday on La Palma to get a sneak preview of the building. "It would be fantastic to be able to use it," Gérard says, admiring one of several hexagonal-mirror segments, each costing half-a-million dollars, that will soon be mounted on the telescope.

Gérard may well get his wish — the GTC has proved to be a powerful bargaining chip for Spanish astronomers who want to join the European Southern Observatory (ESO), a consortium of 11 European nations that share facilities such as the Very Large Telescope in Chile. On 28 April at a meeting in Madrid, Spanish and ESO negotiators confirmed that Spain would become a full ESO partner in 2006. The deal gives Spain a 25% reduction in its €65-million entry fee in return for a steady supply of data from the GTC to other ESO scientists.

"I think it's a good deal for Spain," says Rodríguez, a key player in the talks. Spanish astronomers will keep 90% of the observing time on the telescope, but some of this will be

earmarked for collaborative projects with ESO researchers.

Similar deals operate at the Keck telescopes, for example, where 85% of the time is reserved for researchers from Hawaiian and Californian universities or their research partners. Rodríguez is unapologetic. "If you own the telescope, your community uses the telescope," he says firmly.

But such comments reveal another side to the islands' success story, say several foreign researchers working there. "There is a degree of nationalism here that can be good and bad," says Mark Kidger, a British astronomer who moved to the Canaries with Beckman in the 1980s, and still has a contract position there. "It can be a great driving force, but there's also a reluctance in some areas to accept help from outside."

Closed shop

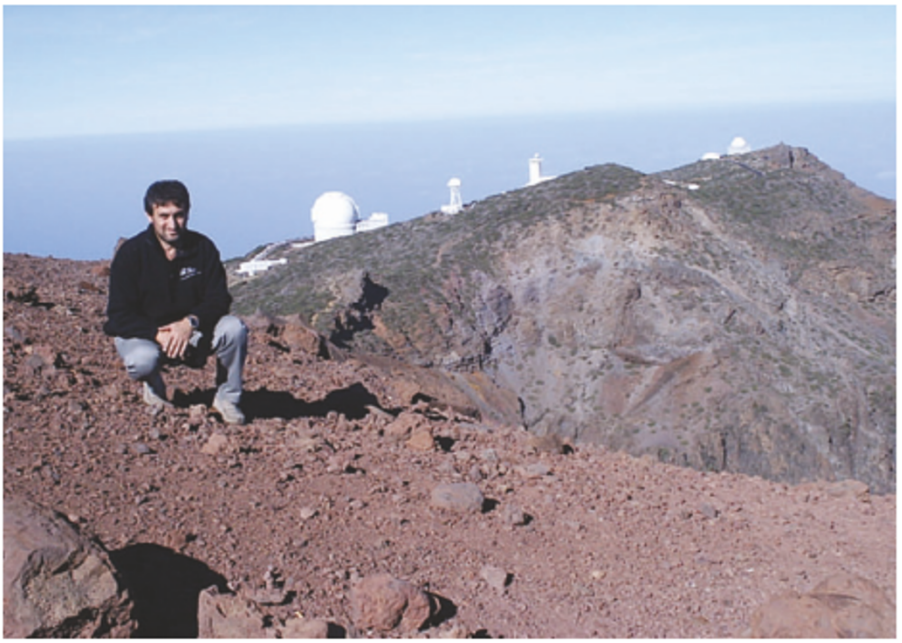
Because permanent research positions in Spain are regarded as civil-service jobs, Spanish applicants tend to be favoured. Those with foreign qualifications must undergo an expensive accreditation process, lasting several years, before they can apply to take the formal examinations required for an appointment. This bureaucracy will ultimately hinder Spanish astronomy's development, argues Kidger.

For example, the Armenian astronomer Garik Israelian, a rising star at the IAC, has been encouraged to take up Spanish citizenship to help with his career. "I have many Armenian colleagues who are professors in Britain and the United States who have had none of these problems," says Israelian. Still, he is keen to battle through the red tape. "I've had much better collaborations here because people are much more open to working together," he says.

Stories like Israelian's are not unusual. Nepotism is all too common, says Chris Benn, a British astronomer who works at the Isaac Newton Group of Telescopes on La Palma. Astronomy in Spain is "much more about having friends in the right places", he notes.

Spanish astronomers accept that there are problems, but insist the climate is changing. "Individualism has been the rule for many years in Spain, but now we're making large-scale collaborations with international partners," says Rafael Rebolo, one of the IAC's senior researchers. The IAC now requires students with new PhDs to spend at least two years working abroad before they return to the Canaries. "It gives a clear sign that these students must spend part of their career elsewhere," says Rebolo.

"Most Spanish astronomers agree that it would be good to open things up," says Johan Knapen, a Dutch astronomer at the University of Hertfordshire, UK, who worked with Beckman in the Canaries. "But they don't want to if it means they won't get the jobs themselves."



IAC

Armenian Garik Israelian says he may need to take up Spanish citizenship to progress his career.

> "Individualism has been the rule for many years in Spain, but now we're making large-scale collaborations with international partners,"
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Finding jobs for returning postdocs is one of the biggest problems facing Spanish astronomy, says Artemio Herrero Davó, head of research at the IAC. He is pushing for more government funding for junior positions. "Otherwise, young people will be discouraged and Spanish astronomy will lose its momentum," he says.

But most Spanish astronomers are positive about the future. In a global survey of astronomical research, Benn and his colleague Sebastian Sánchez (no relation to Francisco) found that Spain now produces just under 5% of all astronomy papers, which is comparable to the output from Japan and the Netherlands (S. F. Sánchez and C. R. Benn *Astron. Nachr.* **325**, 445–450; 2004). European countries with a longer tradition in astronomy, such as Germany, France and Britain, produce about 10% each.

Treasure island

"The Spanish have made a decision to put a lot of money into astronomy, and it's growing faster than in any other country," says Benn. But much of that money has gone to the IAC, which some say has caused a bitter rivalry between the Canaries and astronomers on the mainland.

Rafael Bachiller, director of the Spanish National Astronomical Observatory (OAN) in Madrid, disputes this. "What happens in the Canaries is good for astronomy everywhere," he insists. "About 20 or 30 years ago, when optical and infrared astronomy were moving to the Canaries, the OAN decided to focus on radio astronomy," he says, adding that the two institutions now have complementary rather than competing interests.

Bachiller is especially proud of the OAN's new 40-metre radio telescope at Yebes in central Spain, which he calls "an equivalent in radio waves to the GTC". The telescope was inaugurated in April, and will study the very first galaxies that evolved in the Universe.

Both the GTC and the 40-metre radio telescope are remarkable, says Bachiller, for being almost entirely Spanish-built. "Until now, we have been very good at using the telescopes that other countries put on our lands," says Bachiller, "but Spain has now developed the techniques needed to build its own facilities."

With the GTC close to completion and his legacy assured, Francisco Sánchez is expected to retire by the end of the decade. So will Spanish astronomy survive without his guiding hand? Many of his colleagues fall into a whisper as they explain that it's not possible to imagine astronomy without him. "I can't think of any single astronomer who could take over from Sánchez," says Israelian.

Others point out that he was an ideal leader during the 1970s, when funding was secured by charming a politician over a glass of wine. But now that research funding is far more structured, Sánchez's political skills are less essential for the IAC to flourish, they say.

Although Sánchez is cagey about naming his potential successors, Rebolo and Beckman are clearly front-runners. But for now, Sánchez is looking forward to returning to research after decades away from a telescope. "I'm going to become directly involved with research again on the GTC," he says, adding that he is particularly interested in studying planets outside our Solar System and understanding galactic structure. "I believe I've got the right to enjoy it," he laughs. ■

Mark Peplow is a reporter for *news@nature.com*.