CHILE

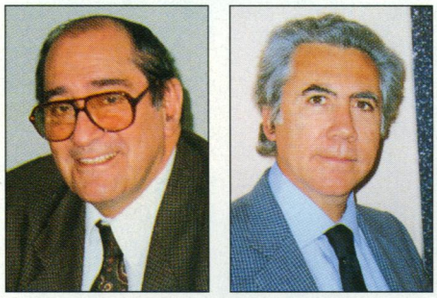
Astronomers Struggle to Keep Up With Their Opportunities

SANTIAGO, CHILE—While scientists the world over complain ever more plaintively that global economic conditions and their governments' funding policies stand in the way of much-needed facilities, the astronomers on Cerro Calán have a rather different worry: They fear they won't be able to keep pace with the opportunities being laid before them.

Streetlights and smog long ago dimmed the view of the stars from this scrub-covered hill in the suburbs of Santiago, but the astronomers who have offices in the University of Chile's hilltop observatory have ample alternatives. They and other Chilean astronomers have preferential access to some of the world's best telescopes, built with foreign funds on the high desert of northern Chile—a collection of astronomical hardware that could grow to $1 billion worth of instruments within a decade. But while the guaranteed observation time allotted to Chileans skyrockets, the number of full-time astronomers in Chile, now around two dozen, has changed little in the past 30 years.

Worse yet, the total national spending on astronomy is stalled at about $1 million a year. And this year, the University of Chile has just one new student entering its graduate program in astronomy (which ends at the master's degree), while across town, there are two enrollees in the Catholic University's fledgling Ph.D. program, run by astronomer Hernán Quintana. "We have such an opportunity to use superb instruments," laments José Maza of the University of Chile. In between taking advantage of those instruments to do some first-rate astronomy, he and his colleagues are appealing to the Chilean government to take extraordinary measures to build up their numbers—a task that could be made even more difficult by a division in their ranks. But there's no argument about the need to boost salaries and create new positions. As radio astronomer Leonardo Bronfman, head of the university's astronomy department, puts it, "We have to grow or die."

The roots of the dilemma go back to the 1960s, when foreign astronomers began flocking to the clear desert air and high altitudes of northern Chile. On the barren mountaintops sprouted the domes of two U.S. observatories, at Cerro Tololo and Cerro Las Campanas, and the European Southern Observatory (ESO) at La Silla. In return for sites on Chilean soil and other considerations, the two U.S. observatories agreed to set aside roughly 10% of their telescope time for Chilean projects.



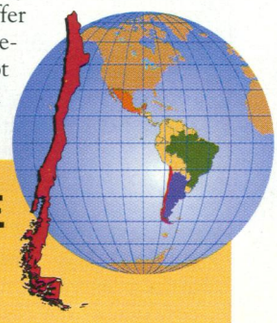
PHOTOS BY T. APPENZELLER

Differing views. Astronomy leaders Claudio Anguita *(left)* of the University of Chile and Hernán Quintana of Catholic University.

But Chilean plans to exploit those opportunities were put on hold soon afterward, when the military regime of General Augusto Pinochet took power. Pinochet, who staged a 1973 coup that toppled the elected Marxist government of Salvador Allende, was no friend to the universities, and during his regime they shrank drastically. Many scientists and students fled abroad.

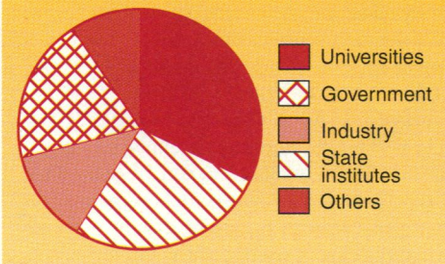
Pinochet's retirement in 1990 made way for a democratic government, however, and the "glass time" available to Chileans is about to multiply yet again. Chilean astronomers will have time allotted on the Carnegie Institution's Magellan telescope, a 6.5-meter instrument planned for Cerro Las Campanas. Two years ago the Chilean government decided to buy a 5% share in Gemini, a U.S.-led project to build twin 8-meter telescopes in Hawaii and Chile. And Chile and ESO have been negotiating access to ESO's Very Large Telescope (VLT), a set of four 8-meter telescopes being built on Cerro Paranal in northern Chile (*Science*, 19 August 1994, p. 1026). Claudio Anguita of the University of Chile, a longtime leader in Chilean astronomy, expects an agreement that will give his colleagues preferential access to ESO telescopes much like what they now enjoy at the U.S. observatories.

All told, says Anguita, within a decade Chilean astronomers will command the equivalent of a majority share in an 8-meter telescope. Such abundance has its advantages—it is already allowing Chilean researchers to undertake long-term, time-intensive searches for supernovae, quasars, and other astronomical objects that astronomers elsewhere, facing stiffer competition for telescope time, might not be able to do (see box on p. 820). But some



CHILE AT A GLANCE

R&D by Performer, 1992



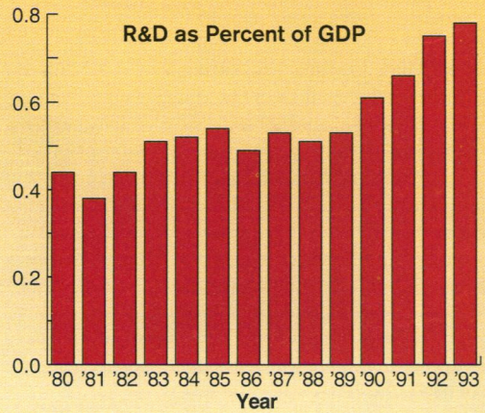
SOURCE: CONICYT

The Big Picture

Population, 1994:	14.0 million
GDP, 1993 (est.):	$40.1 billion
Total R&D Spending, 1993 (est.):	$312.68 million
Scientists and Engineers, 1992:	6000

SOURCES: GDP, R&D, Scientists and Engineers: CONICYT; Population: 1994 CIA World Fact Book

R&D as Percent of GDP



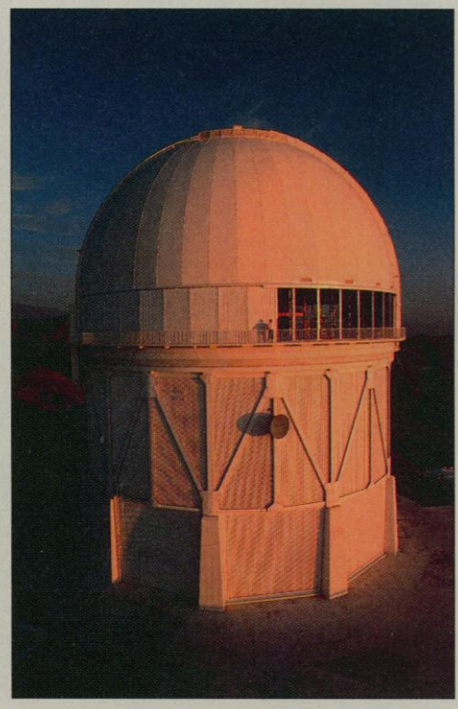
SOURCE: CONICYT

The Chilean government supports peer-reviewed research through its National Commission for Scientific and Technological Research (CONICYT). CONICYT spends most of its budget—$47 million in 1993—on two funding programs. One, the National Fund for Scientific and Technological Development (FONDECYT), supports roughly 1000 basic research projects for up to 3 years. The other, the Fund for Fostering Scientific and Technological Development (FONDEF), spends a roughly equal amount on 99 research projects with potential economic impact, in areas such as mining and agriculture. A variety of state institutes also sponsor applied work, in agriculture, forestry, nuclear energy, and other areas.

Profiting From an Embarrassment of Riches

Many Chilean astronomers are embarrassed by the gulf between the generous time available to them on foreign-built telescopes and the tiny cadre of observers able to take advantage of it (see main text). But there's something to be said for such wealth. Because of it, says Robert Williams, former director of the Cerro Tololo Inter-American Observatory (CTIO) and now head of the Space Telescope Science Institute in Baltimore, "Chileans have been able to carry out survey programs that would have been difficult to do otherwise."

"I'm using the comparative advantages of working in Chile," agrees María-Teresa Ruiz. The University of Chile astronomer's own survey project is a search for cool white dwarfs—ordinary sunlike stars whose nuclear fires have burned out after billions of years and are gradually cooling toward oblivion. Such stars, with surface temperatures perhaps a third of the sun's, are faint and difficult to find and study, requiring long exposures on large telescopes. But Ruiz is collecting a sample of cool white dwarfs that may hold a key to the age of the galaxy.



ROGER RESSMEYER/STARLIGHT

A privileged vantage. The dome of the 4-meter telescope at CTIO, where Chilean astronomers have preferential access.

Ruiz is building on work done in the late 1980s by University of Arizona astronomer James Liebert. Liebert had searched the northern sky for cool white dwarfs and reported that he simply couldn't find any that were cooler than a certain temperature. The stars at the cutoff, it seemed, had to be the cinders of the first generation of stars in the disk of the galaxy, and the temperature to which they had cooled implied that the disk could be no more than 9 billion or 10 billion years old—much younger than other parts of the galaxy. But Ruiz's survey has already turned up at least one, and perhaps several, dwarfs that seem to be cooler, and perhaps several billion years older.

Age on an even grander scale is the subject of José Maza's supernova survey. The supernovae he is seeking are known as type Ia's—vast thermonuclear explosions triggered when extra mass is dumped on a white dwarf by a companion star. Assumed to reach the same maximum brightness every time, these supernovae have been a favorite "standard candle" for some astronomers trying to measure how fast the universe is expanding—the famous Hubble constant, which is a clue to the age of the universe. But they have posed a conundrum by pointing to a lower Hubble constant and an older, slower growing universe than do other standard candles, such as variable stars (*Science*, 28 October 1994, p. 539).

Maza and his colleagues Mario Hamuy, Mark Phillips, and others at CTIO "have taken it on themselves to significantly improve the quality of the data," says Michael Pierce of Indiana University. They have identified and studied some 30 type Ia supernovae since 1990, and the resulting data trove has already shown that the assumption of consistent maximum brightness is a risky one. Maza and his colleagues have been correcting the measured brightness of their supernovae based on earlier hints that explosions whose brightness declines faster are intrinsically dimmer. The result is a more accurate standard candle and a Hubble constant more in line with the results of other methods.

"I think now that the supernovae are not far off" in what they tell us about the size and age of the universe, says Pierce, who advocates a high Hubble constant based on his work on variable stars. And that's a result, he says, that would have been difficult to achieve if not for the generous telescope time available for Maza's work. If so, a terrestrial embarrassment will have gone some way toward solving a cosmic one.

–T.A.

outsiders think it also puts the onus on Chile to build up its own strength in astronomy.

Says Michael Rich of Columbia University, "They really need to have more university-level researchers to keep up with the upcoming bounty of telescope time." Robert Williams, who was director of Cerro Tololo until August 1993 and now heads the Space Telescope Science Institute in Baltimore, adds: "They're so highly leveraged because of the outstanding facilities that I would be hard-pressed not to advocate some sort of national astronomy program."

Anguita, Maza, and their colleagues agree. They would like their government to fund a boost in the number of Chilean astronomers by a factor of 5 within the next 15 years or so. And that's where the debate begins. "The solution I would love to see," says Maza, "is that the government, through CONICYT [Chile's science funding agency], establish a national institute of astrophysics." As he and Anguita picture it, the institute could bring together researchers, instrument builders, and engineers, and it could be a base for participation in Gemini. At the same time, it could improve on the meager university salaries and open up new opportunities for young astronomers.

Maza and Anguita take heart from a proposal by CONICYT President Enrique D'Etigny for a $25 million national program of research centers, perhaps 10 in all, that would target areas of science in which Chile has particular strengths. While D'Etigny notes that "we are not proposing specific centers—we are proposing the [general] idea," he told *Science* that an astronomy institute would probably be among them.

Quintana, though, thinks centralizing astronomy in a national institute would be a mistake. "The problem with state institutions is that they tend to become bureaucratic, rigid; there's a lack of competition once you are there." What's more, he thinks an institute would be a threat to university programs, including his own at Catholic University. Instead, he advocates a government-supported council for astronomy that would channel funds to regional universities wanting to set up astronomy programs and provide salary supplements.

So far, neither side can take any heart from the government's response. D'Etigny's proposal for national research centers was not funded by the Chilean Congress for 1995, although he says he is still hoping for 1996. And Maza notes that government spending of any kind is out of vogue in the free-market Chile of today. "To tell you the honest truth, I don't know how we're going to convince our politicians." Anguita speaks for many when he voices his frustration at the impasse. "It's a shame," he says. "The people outside [Chile] are waiting."

–Tim Appenzeller