Astronomy in West Germany Goes Supernational

The science of astronomy virtually demands international cooperation. Astronomers in the Federal Republic plan a balance of 'supernational' and local projects

By DIETRICK E. THOMSEN

Most nations, particularly those of Europe, can no longer afford the luxury of strictly national programs of research in the physical sciences. West Germany provides a stark reminder of this in a new review of its astronomy program. Although it proposes a large new optical telescope and radiotelescope as national projects, the report of that review, *Denkschrift Astronomie,* indicates the degree of West German dependence on international collaboration in the practice of astronomy.

According to the report, published recently (in German) by the German research organization *Deutsche Forschungsgemeinshaft,* "The present situation [in astronomy] is distinguished by a structural development that has led, as also in physics, to ever-larger national and 'supernational' [research] centers."

Internationalization in science seems to depend on what a country can afford and where its scientific priorities are. The U.S. government has resisted internationalizing the Superconducting Super Collider (SSC), even though foreign governments urged it. When New York and Quebec Province tried to internationalize the SSC by the back door, proposing a site that crosses the border between them, the U.S. Department of Energy threw out the proposal at first look.

On the other hand, the Department of Energy is now proposing the internationalization of the magnetic fusion research program, which aims to make thermonuclear fusion a source of electric power. Magnetic fusion has suffered severe budget constraints in recent years, and many of its proponents have come to believe it is a poorly regarded stepchild of the government's overall scientific program. Internationalizing it may be the only way to keep some kind of program going.

Back in the days when internationalism in science was largely a matter of communication and occasional movements of personnel, Germany had important national programs in all the natural sciences. Much scientific publishing was in the German language, and schools in other countries gave special courses in "scientific German."

The Nazi era ruined much of that. Persecution drove prominent scientists out of the country, and the war destroyed a great deal of equipment. Recovery took a long time. Indeed, according to *Denkschrift Astronomie*, the last previous review of West German astronomy took place in 1962, at a time when German astronomers felt they had just about finished repairing what could be repaired of the damage done by the Third Reich.

Since 1962, as *Denkschrift Astronomie* points out, astronomy has become a wider science. In 1962 radioastronomy had already developed alongside optical astronomy, but X-ray astronomy hardly existed, and such exotica as gamma-ray astronomy and neutrino astronomy were hopes or promises rather than science. All these fields have developed extensively since then, and several of them are largely dependent on space travel, a technology which then had also hardly begun.

Parallel to observational and technological extensions, a change has come in what might be called the spirit of astronomy. Physics has increasingly pervaded astronomy, and the science is now much more a branch of physics than it used to be. Astronomers now often like to be called astrophysicists. It is no longer enough to know how the heavens go, as Galileo is supposed to have defined the goal of astronomy; astronomers want to know what *makes* the heavens go the way they do.

The connection to physics tends to be strongest in the newer realms of astronomy, particularly X-ray and gamma-ray astronomy. Because these observations have to be done above the interference of the atmosphere, they are also the domain where astronomy depends most heavily on spaceflight technology.

Spacefaring started out as a nationalistic competition between the United States and the Soviet Union. Ironically, in this realm the West German program is entirely dependent on international cooperation. *Denkschrift Astronomie* envisions German programs in cooperation with the European Space Agency, in which West Germany is a partner, and also with the American NASA and the Soviet space agency.

For X-ray and extreme-ultraviolet astronomy, the two ROSATs (short for *Roentgensatellit*) will be largely German projects flown by NASA. ROSAT, which is scheduled to fly in 1990, will be the first all-sky survey in the energy range between 0.01 and 2 kilo-electron-volts. ROSAT-2/SPECTROSAT (launch 1992 or 1993) will carry a spectrograph to study the X-ray emission lines (cyclotron-resonance lines) found in the spectra of magnetic neutron stars.

The West German astronomers also envision participation in several more major space projects of the next couple of decades. For infrared, the West Germans expect to provide 15 to 25 percent of the cost of NASA's planned Stratospheric Observatory for Infrared Astronomy (SOFIA), an aircraft that will carry a 3-meter telescope for observations while flying. This will be a preparation for a European Space Agency project intended for about the turn of the century, called FIRST (Far Infrared Space Telescope).

In radioastronomy, the preferred method of observation today is interferometry, combining signals received at widely separated telescopes to gain resolution of details that a single telescope could not distinguish. Very-long-baseline interferometry (VLBI), which has used antennas continents and oceans apart, is now poised to go into space and combine observations by ground-based and space-based telescopes. The Soviet Union plans to launch a satellite called RADIOASTRON for VLBI in 1992, and the report proposes German participation in the network that goes with it.

There is still plenty of ground-based VLBI to do, however, particularly in the shortest-wave range of radio, the millimeter-wave range. For this purpose *Denkschrift Astronomie* recommends increasing a millimeter-wave interferometer on the Plateau de Bure in France from three telescopes to six and, to provide VLBI capability, adding to the network a 30-meter-diameter telescope on Pico Veleta in Spain and a 10-meter telescope on Mount Graham in Arizona.

In the 100-meter antenna on the Effelsberg, a mountain in the Rhineland, West Germany possesses Europe's largest single radiotelescope. The Effelsberg installation has long been a part of international and intercontinental VLBI, and is now used about 30 percent of the time for VLBI. As larger and larger VLBI combinations come into being, particularly those that include space stations, this percentage can be expected to increase.

"However," the report says, "the 100-meter telescope cannot be permitted to give up all other astronomical observations in the long run." Therefore, it goes on to propose Effelsberg II, a 50-meter telescope to relieve the 100-meter telescope of some of the VLBI work.

Visible-light astronomy is still the center of the science. Whenever astronomers find a source of invisible radiation, they try also to find it in visible light – mainly for astrophysical reasons, but also because humans find satisfaction in being able to see the thing. Germany has had visible-light telescopes and observatories for hundreds of years. However, as a country in the northern part of Europe, it has certain disadvantages as a site for large new optical telescopes, even when, like the proposed *Deutsches Groszteleskop* (DGT) or German Large Telescope, they are envisioned as national projects.

From high latitudes a telescope sees only a restricted part of the sky. Closer to the equator, more of the sky is in view. An observatory in Germany could not be south of the large one located on the Zugspitze, an alp on the Austrian border at about 47°N latitude. For this reason, none of the large optical telescopes in which West German participation is envisioned will be located in Germany.

The DGT, which for now is an entirely national project, is intended to be an innovative combination of the monolithic and segmented mirror designs that the builders and planners of large telescopes have so far used separately. It will have a single 8-meter mirror in the center, surrounded by manipulable segments that will bring the total reflecting surface to 12 meters diameter. The site is not yet selected, but will probably be in the Southern Hemisphere.

West Germany is a participant in the European Southern Observatory (ESO), which operates an observatory on Cerro La Silla in Chile. ESO's next large project is the Very Large Telescope (VLT), which will be an array of four 8-meter mirrors and several smaller ones. Its site could be La Silla or the Canary Islands. *Denkschrift Astronomie* recommends participation.

The VLT will be capable of doing interferometry in visible light. Until a few years ago, interferometry was technically impractical in visible light, but lately techniques for doing it have proved themselves in small arrangements, and the builders of large telescopes are now going for interferometry (SN:1/3/87,p.10). As an extension of the VLT, the West German report proposes a 1-kilometer-long array of six to 12 telescopes that would be capable of resolving detail in visible light to one ten-thousandth of a second of arc, which is as well as radio VLBI now does.

Neutrino astronomy, according to its practitioners, was born in the supernova 1987A. Scientists had observed neutrinos coming from the sun for a decade and a half, but the supernova offered the first proof that neutrinos from other astronomical objects can reach the earth. That finding has encouraged the planners of neutrino observatories. A European one, with West German participation, is now under construction in the Gran Sasso tunnel in Italy.

Gravity-wave astronomy has not yet really been born. There is no definitive evidence that gravity waves exist nor that those from astronomical sources can be detected on earth. However, they are gravity's predicted analog to radio waves, and they could give astronomers information not otherwise available. As the report notes: "Should the direct observation of this physically fundamental process succeed, we would get information about circumstances and processes in extremely dense matter that are otherwise impossible to observe directly."

Scientists in a number of countries are betting on the eventual success of the observation. The West German proposal for a gravity-wave observatory, by the Max Planck Institute for Quantum Optics in Garching, would build an L-shaped arrangement of vacuum tubes, in which test weights would be hung. The passage of a gravitational wave would make the weights swing in a coordinated fashion. Laser beams would track the motion. The expected movement is so minute that the weights would have to be in a vacuum to avoid air resistance and currents, and the laser beams would need a long run to be able to discriminate the motion. The proposal is for an L with vacuum-tube arms each 3 kilometers long.

International science is made of national contributions, but a certain muting of national competitive instinct is necessary to make it work. Since World War II, the European nations have had to absorb this lesson. Nowadays even U.S. scientists are beginning to learn it, with projects like the Canada-France-Hawaii Telescope and the international collection of observatories planned for Mount Graham. It may be the wave of the future. □