a beam can be focused by a good lens to a spot only a few wavelengths in diameter. Its amplitude and frequency are very stable, so it can be modulated to carry broad-band communications, much as microwave beams can. But much work needs to be done before all of the uses of these fascinating devices will be discovered, and before it is known which of its many uses are important.

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Astronomy: Academy Study Urges 10-Year, $224 Million Program Of New Telescope Construction

As financial and political considerations impinge on federal support for science, and as the tools of research become increasingly expensive, the scientific community has developed a literary form to assist its relations with government—namely, the experts' report spelling out the requirements, opportunities, and benefits of federal support for particular fields of research. The distinguishing feature of these reports is careful analysis of the present situation and cautious appraisal of the future, woven through with assertions that the projections of financial needs are conservative, and that the failure of the government to meet them will have unwelcome consequences.

Last year's Ramsey report on high-energy physics, prepared under the joint auspices of the Atomic Energy Commission and the White House Office of Science and Technology, was one of the first fully developed examples of this genre; and though the final word is not yet in on the future of that costly discipline, the quality, thoroughness, and prudence of that report seem to have left little to be said for a long time on what can and should be done in the accelerator field.

Now, just this week, another report has come forth to present the scientists' case for federal support in a costly field, ground-based astronomy.* The report, prepared by a panel of eight astronomers and chaired by A. E. Whitford of the Lick Observatory, in California, is the first of a series planned by the National Academy of Sciences' Committee on Science and Public Policy (*Science*, 23 October). In general it follows the pattern of analysis and advocacy that marked the high-energy physics report, but it adds a new line of argument for support—that the astronomy recommendations, totaling $224 million over a decade, are a pittance compared to the funds going into the space program. The report states that the yearly cost for implementing its recommendations would amount to only one-half of 1 percent of the present annual space budget, and it argues that (i) "our new space capability increases the need for ground-based facilities," and (ii) the National Aeronautics and Space Administration, in its own interest, should start putting substantial funds into earth-bound radio and optical telescopes. NASA's reaction is yet to be heard, but since many disciplines are eyeing the space treasury, and since NASA claims it is close to being financially overdrawn on its commitment to land a man on the moon in this decade, it is difficult to see why the space agency would clutch at a chance to become a major financier for a field that it has heretofore managed virtually to ignore. NASA is, in fact, putting a great deal of money into space-borne astronomical facilities, and the ground-based astronomers praise this space effort and urge its continuation, but they point out that one orbiting observatory costs $60 million and lasts 1 year, whereas "a similar telescope on the ground" costs about $330,000 and can be expected to serve for at least 50 years.

Outside of eyeing the NASA budget as a source of funds, the Astronomy panel sticks to studious analysis of the present and offers what George B. Kistiakowsky, chairman of the parent committee, refers to as "very reasonable" and "definitely conservative" plans for a 10-year program of construction and training.

"Legacy of the Past

"In optical astronomy," it points out, "we are living largely on the legacy of the past, using instruments handed down to us from the era of private financing." The panel acknowledged that many of these can be expected to continue as productive facilities, but it argued that "rapid progress on the unsolved problems" is limited by the "*extremely small number of telescopes of adequate size in dark-sky locations* . . ." (original italics), and it went on to present a dismal picture of the availability of major facilities for the nation's astronomers.

Only the 120-inch Mount Lick and the 200-inch Mount Palomar telescopes, it pointed out, "are adequate for pushing current frontier problems to the observational limit." Experience with these and other facilities, it continued, has shown that they can handle an optimum number of perhaps ten long-term problems at any one time, giving each of them about 35 nights a year. Since, at this rate, 2 to 4 years are often required to complete work on a problem, "this means that 10 to 15 staff astronomers per major telescope is all that can be effective. With only two major frontier telescopes operating," the panel went on, "this means that no more than two or three astronomers in the entire world now have the opportunity to work on the most exciting problems in any given field. Competition and the obviously needed opportunity to check results are lacking. The problem, serious enough from the standpoint of progress, is even more serious in another respect; it squeezes out of research life at the frontier top-notch men who, by accident, are not among the fortunate staff members of the big observatories."

General Inadequacy

But in the optical field it is not only large telescopes that are lacking, the panel found. "The inadequacy . . . is equally critical all along the line" and is producing harmful effects on research as well as on the increasing number of students who have been attracted to astronomy studies.

Continuing its appraisal of optical astronomy, the panel recommended that "first priority" should go to the construction of three large telescopes in the 150- to 200-inch aperture range. Why not two or six large telescopes? The answer appears to be a mixture of scientific judgment, public relations, and financial caution. The panel explained its choice of three as follows: "The decision to recommend three such telescopes was dictated in part by the . . . need for acceleration of research on faint objects, and the fact that the number of large telescopes has not in recent years kept pace with the growth of the astronomical work force in this country. Three more such telescopes would double the number of U.S.-controlled large telescopes in the aperture range 100 to 200 inches. Since . . . the number of astronomers in the United

* *Ground-Based Astronomy, A 10-Year Program*, 105 pp.; $4, Publications Office, National Academy of Sciences, Washington, D.C.

States is expected to double, at least, in the next decade, the number should not be any less. Consideration of the number of experienced operating groups that could undertake sizeable projects of this kind, plus the size of the burden that would be placed on the instrumentally-inclined astronomers, sets an upper limit."

Similar considerations guided the panel in its recommendations for smaller optical instruments. In the 60- to 84-inch range, it recommended the construction of four general-purpose telescopes to supplement the five now in operation at good climate sites in this country. In the 36- and 48-inch range, it proposed the construction of eight telescopes, basing this recommendation, in part, on "an estimate of the number of astronomy departments that are likely to come forward with meritorious proposals." In this case the panel again made clear that it considered itself to be thinking small. It pointed out that at the end of the decade, eight may turn out to be too few, but that if the number should turn out to be 12, "the added cost would still be only a small percentage of the total expenditure recommended by the Panel, and well within the margin of error." The panel also recommended that after design work had been completed on the three large telescopes, $1 million be spread over four years to consider design of the "largest feasible optical reflector, in the 400–600 inch range."

In all, the recommendations for optical telescopes were set at a total of $68.2 million, and it was estimated that annual operating costs would be about 4 percent of this sum.

Radio Astronomy

The panel's examination of needs in radio astronomy produced the conclusion that the problems in this field are different from those in optical astronomy. It isn't the lack of observing time with "frontier" instruments that is limiting progress in radio astronomy, it found; rather, the problem is that existing and planned instruments fall short in angular resolution. "There is no natural barrier that prevents building radio telescopes on the ground with angular resolution far beyond that yet achieved," the panel stated. The problem is that they haven't been built.

In its specific proposals for the next 10 years in radio astronomy, the panel called for a $97-million construction program, to include construction of a large, very-high-resolution array with about 100 separate antennae, each perhaps 85 feet in diameter. The cost of this array was placed at $40 million. It also recommended two additions to the interferometer at the Owens Valley Observatory of the California Institute of Technology, $10 million; two fully steerable 300-foot paraboloids, $16 million; approximately 15 smaller, special-purpose instruments, $2 million each; and $1 million for design study of the largest feasible steerable paraboloid. As for operating costs, the panel concluded that radio astronomy, because of the large areas and the complex and changing electronic facilities needed for its activities, requires about 10 percent of construction costs.

The report also recommended that $1 million a year be devoted to the development of instruments for astronomical research, and, harking back to NASA's seeming affluence, it concluded that NASA's fellowship program, which is projected ultimately to support 4000 graduate students, "may be counted . . . as one of the sources of support that will sustain the current rapid expansion of interest in astronomy in the universities."

Repeatedly, the panel stressed that it had taken a conservative approach to the need for new facilities. For example, it argued that proposals to provide facilities to double the number of observers "cannot be considered rash." And it added that "there will surely be more than enough astronomers waiting to use the new instruments." Another argument that it chose to rely upon was national supremacy. When the cold war was in a fiercer state, this argument indeed went a long way, but it is becoming doubtful whether this still has its old power to move Congress. Nevertheless, the panel expressed concern at several points about efforts in astronomy abroad. In regard to radio telescopes, it stated that "it cannot be said that the American position is dominant." It made reference to the need for a "U.S.-controlled" telescope of major size in the Southern Hemisphere, whatever other countries may do.

And, finally, the panel shied away from the prickly question of where the proposed facilities should be located. "Such designations by the Panel," it stated, "could have created conflict-of-interest situations that would have prevented qualified astronomers from serving on the Panel." It said that quality and competition should govern the geographical decisions, but, since the panel consisted entirely of university or foundation-supported astronomers, it was perhaps inevitable that it should offer the opinion that "there is already danger of an imbalance between the strong federal support given to the national center for radio astronomy [supported by the National Science Foundation at Green Bank, West Virginia], on the one hand, and, on the other hand, the support given to the varied activities in the same field in the universities."

In addition to Whitford, the members of the panel are:

R. N. Bracewell, Radio Astronomy Institute, Radioscience Laboratory, Stanford University;

Frank D. Drake, department of astronomy, Cornell University;

Frederick T. Haddock, Jr., Radio Astronomy Observatory, University of Michigan;

William Liller, department of astronomy, Harvard University;

W. W. Morgan, Yerkes Observatory, University of Chicago;

Bruce H. Rule, California Institute of Technology; and

Allan R. Sandage, Mt. Wilson and Palomar Observatories, California Institute of Technology, Carnegie Institution of Washington.—D. S. Greenberg

Sartre: French Philosopher Is Model of Literary Intellectual by "Two Cultures" Definition

By rejecting this year's Nobel prize for literature even before it was awarded him, the French philosopher and man of letters Jean-Paul Sartre not only caused a furor in the press but provided a footnote to the Two Cultures discussion.

Sartre's work and his fame in the past two decades emphasize the degree to which science and traditional forms of philosophy have diverged, and also how the split continues to be reflected in contemporary philosophy.

Since World War II, Sartre has maintained an international reputation as the chief exponent of one form of existentialism. He ended his career as a professional philosopher in 1942, but continues to work at the technical exposition of his ideas. Sartre is better known, however, as a novelist, playwright, literary critic, giver of contro-