However, it is clear that most people who examine problems in detail will develop their own opinions on desirable action. Needless to say, it is difficult for CEI members to keep their views hidden during their public activities. "In a way I may delude myself that I don't reveal my own bias when I speak to a group," Malcolm Peterson comments. "When I refuse to take a position, sometimes the audience gets madder than hell. They say, 'You scientists are all alike, you never take a stand on anything.' They leave disgruntled."

CEI's Objectivity

Although CEI may try hard to remain cool and objective, it usually discusses issues about which scientists find it difficult to be dispassionate. As Walter Bauer said, "Every problem we take up is controversial. There is no need for information on a noncontroversial problem." John Fowler has written about the beginning period of the committee: "The misleading press releases and Pollyanna view of fallout coming from the AEC needed our criticism." The committee has had a number of disagreements with the AEC and the Federal Radiation Council and no doubt will continue to criticize federal agencies when it believes that the government is distorting facts. Some CEI members talk of the national need for organized countervailing expertise to question government scientists. Peterson illustrates the spirit which characterizes CEI when he says, "The establishment often squelches debate." The CEI is committed to promoting debate.

Those who come into contact with the committee sometimes wonder just how free of value judgments CEI's statements are. At one point in an argument conducted in *Scientist and Citizen* over Project Harbor, a NAS–NRC report on civil defense, project director Eugene P. Wigner called upon the committee's Scientific Advisory Board to ". . . shed its nonpolitical pretense . . ."

Charles Copley, the St. Louis Air Pollution Control Commissioner, is one official who believes that CEI is, on the whole, of benefit to the city. But he also qualifies his praise: "They like to look on themselves as people who dispense scientific facts . . . but I'm not sure they really sustain the position that they just give the facts." Copley complimented CEI for engaging in "a lot of good research" but said that the committee likes to make "dire predictions" and puts "too much emphasis on what may happen." Copley said that there is some feeling in St. Louis that committee members let their political feelings interfere with their work in CEI.

In its early years, when CEI was challenging governmental information on fallout, there were those in St. Louis who regarded the committee as a left-wing organization. Now, there is not as much discussion of the committee's political composition. In an interview, Commoner said that many members would be "liberal Democrats" but that "some are Boy-Scout Republicans who are concerned with what's right; they are the kind governed by a strict morality." Commoner said that his group is not interested in influencing the legislative process but rather wishes to reach the public directly. "There is a big difference between us and the power-structure boys," Commoner said. In his opinion, "the Boston crowd" tends to ignore the public but in St. Louis, "we get into the PTA's, the Negro slums, the high schools; we get a feeling of how you can reach people on what concerns them."

During its almost 10 years of operation, the St. Louis scientific information group seems to have had some impact on the city, and, through *Scientist and Citizen*, on national discussion of various public issues. But, as the leaders of CEI would readily admit, no scientist should expect his educational work to perform overnight miracles in the citizenry.

At the 1963 National Conference for Scientific Information, Commoner talked about the condition of the scientist who takes his information role seriously: "After an evening discussing fallout or civil defense . . . with 50 or less members of the Young Couples' Club of the Baptist Church in Outer Suburbia, the scientist emerges into the night air, begins the long ride home, and thinks to himself—'At the rate of 50 per evening, how long will it take to educate the people of the United States?' The only honest answer to that question is, 'A long time.' "

—BRYCE NELSON

Radio Astronomy: Dicke Panel Reaches Its Conclusions

The National Science Foundation's high-level screening of radio astronomy proposals which would cost at least $130 million has turned out to be friendly but severe. On Monday 21 August, NSF announced that its specially convened radio astronomy panel of eight scientists under the chairmanship of Princeton University physicist Robert H. Dicke had advised NSF Director Leland J. Haworth to accept immediately only two proposals out of the six discussed before the panel in 4 days of hearings during the week of 24 July (*Science*, 18 August 1967).

The two projects recommended are probably the simplest and least expensive. Such a result would surprise nobody at a time when the Johnson administration feels it must impose increasingly strict limits on non-Vietnam spending, even for urban programs; but the reasoning in the Dicke panel's succinct and eloquent report is less fiscal than technical.

The report looked forward specifically to later instruments of greater resolution and sensitivity—and cost. For NSF and for its patrons in the executive and legislative branches, the panel spelled out its reasoning in simple language:

"It has been evident for several years that major—even 'breakthrough' improvements of radio telescopes costing 20 to 50 million dollars are within present engineering capability. Those improvements represent increases of orders of magnitude in both resolution and sensitivity. Resolution allows the radio astronomer to separate one object from another and, further, to map the characteristic features of a given object. Sensitivity allows faint and distant objects to be observed. The combination of recognition of characteristic features and observation of the faintest objects offers a reasonable expectation that the new radio telescopes can observe the 'boundedness' of our

universe—the most fundamental measurement in the determination of the true cosmology."

For such work, the panel pointed out, two basic classes of radio telescopes are needed: large, single-dish antennas for sensitive observations of the characteristics of single objects like stars, galaxies, and planets, and large arrays to resolve many faint, distant objects "now only dimly perceived."

The Dicke panel argued that "a one-hundred-fold improvement in both resolution and sensitivity is so great and its feasibility so recent, that an ordered development must take place if we are not to run the risks inherent in too rapid acceptance of final construction designs.

"The feasibility of these improvements, documented in several technically sound proposals, is extraordinarily exciting. It is the panel's intention that the recommended ordered development not be construed as hesitation. The panel recognizes the long-term need, feasibility, and expected contributions from these instruments but also recognizes the limitations in available funding and differences in the immediacy of the various proposals. Urgency is derived from the universally accepted desirability of a vast increase in astrophysical knowledge. The science that is stimulated by this knowledge—whether it be physics, astronomy or cosmology—will be greatly strengthened."

With language like this, the Dicke panel sought to keep options open for American radio astronomers, while urging postponement of two large instruments and vetoing another.

The Dicke panel of optical and radio astronomers, theoreticians and electronic experts made its recommendations after hearing many of the American leaders in radio astronomy argue, in each other's presence, the merits of various dishes and arrays of antennas.

One of the two proposals recommended for immediate acceptance (provided that there be "an adequate operating budget" and that 50 percent of the facility's observing time be "nationally available to qualified visitors") was an improvement of the surface of the hemispherical 300-meter antenna at Arecibo, Puerto Rico, administered by Cornell University. The new surface of the antenna, which follows that of the valley and which can be steered to some extent by adjustments of feeds suspended on wires over the center of the dish, would permit Arecibo astronomers to extend their radio and radar work from a present optimum frequency of 68 centimeters (440 megacycles) to 10 centimeters (3000 megacycles). The estimated cost is $3 million.

The other is the addition of seven 40-meter dish antennas to one now being completed at the California Institute of Technology's observatory at Owens Valley to form an L-shaped array at a cost of $15 million. Acceptance of this proposal, the panel said, "will take care of the immediate needs for a large array."

Dicke and his colleagues urged the postponement of the proposal by the Northeast Radio Observatory Corporation (a consortium of 12 New York and New England institutions) for a 135-meter, fully steerable, parabolic dish antenna enclosed in a steel and plastic radome, and of the proposal by the National Radio Astronomy Observatory at Green Bank, W.Va., for an array of 36 dishes, each of 25 meters diameter, disposed along three 21-kilometer arms of a "Y" made of railroad tracks for moving the dishes.

The estimated cost of the NEROC proposal was $27.8 million, and that of NRAO's Very Large Array was $52 million.

The Dicke panel rejected one proposal outright, that of the Associates for Radio Astronomy (Caltech, Stanford, and the Universities of California and Michigan) for a 100-meter fully steerable dish antenna without a protective radome; this dish antenna would be quite similar to one now being constructed by the University of Bonn, Germany, with support from the Volkswagen Foundation. The proposal was rejected on the grounds that "more revolutionary possibilities" are inherent in the Arecibo and NEROC proposals.

A sixth proposal, for a dish antenna, was discussed before the panel in July. This one came from the Committee on Institutional Cooperation formed by the "Big Ten" Midwest universities and the University of Chicago. The Midwest group is studying two different types of antennas, one of them enclosed, for research on the upper atmosphere and ionosphere. This proposal has not been submitted to the astronomy section of NSF, but rather to the aeronomy section. The discussion of the Midwest project before the Dicke panel was "for information only."

In considering single dishes, Dicke and his colleagues found themselves interested in the large size of fully steerable dishes that can be put under the light steel and plastic radomes studied by NEROC; unexpectedly they were even more impressed with the potentials of large, fixed, spherical dishes like the one at Arecibo.

"It is imperative," the panel said in its report, "that there be definitive studies" of the concept "since this approach may lead to instruments of the largest collecting area."

The panel acknowledged that single dishes of the Arecibo type have limited coverage of the sky. Arecibo's range is from minus four to plus 40 degrees in declination and, because the dish turns with the earth, it cannot follow an object for more than two hours.

Even so, the panel argued, "the resolution to be expected from this instrument, with an effective aperture of 600 feet and operating at 50-cm or shorter wavelength, is . . . a spectacular advance in large-dish radio and radar astronomy."

Hence, studies of the Arecibo concept should compare its effectiveness with that of the NEROC design, and ascertain (i) whether even larger dishes could be built; (ii), if the dishes could operate at 5 centimeters; and (iii) if building several such instruments at different latitudes or at different angles to the vertical would be a good way to get full coverage of the sky.

Despite their acknowledgement of NEROC's "success" in proving out the idea of a radome-enclosed telescope, the panel said it "should be deferred until more is known of the capabilities of the Arecibo-type dish."

The panel said that NEROC's proposed 135-meter dish inside a radome would be equivalent to a freestanding 125-meter dish operating at 5 centimeters (the largest fully steerable dish today is the 77-meter instrument at Jodrell Bank in England, and its effectiveness even at 21 centimeters is limited). But the "radome-enclosed dish should have more reliable performance and a lighter, hence less expensive, construction."

Dicke and his co-panelists, however, made note of the British plans to build a 125-meter dish and the German construction of a 100-meter dish already underway. Thus 135 meters "would not represent a conspicuous leap into a wholly new range of resolving power or sensitivity."

The panel expressed interest in a radome-enclosed dish of around 200 meters and said that even larger dishes probably could be built if materials, and not cost, were the limit.

This discussion left backers of the NEROC proposal fairly pleased. They had managed to present a convincing argument for the radome-enclosed telescope and felt that the arguments for fully steerable parabolic dishes will hold up well in competition with the spherical Arecibo type.

In its treatment of arrays, the Dicke panel made it clear that a very large and costly array is part of any long-term U.S. program for radio astronomy.

"While it is too soon to make a decision as to the exact form a very large array should take, the ultimate need for such an array is evident. The proposal by the National Radio Astronomy Observatory for a one-second-of-arc resolution Very Large Array (VLA) . . . is a promising approach . . . and the panel urges continued funding of this design study."

The panel also said that NRAO and cooperating observatories should be supported in the work they are already doing to examine single radio sources with widely separated telescopes calibrated with very accurate atomic clocks. One such study, by NRAO and Lincoln Laboratory (a participant in NEROC) was reported by J. M. Moran *et al.* (*Science*, 11 August, p. 676).

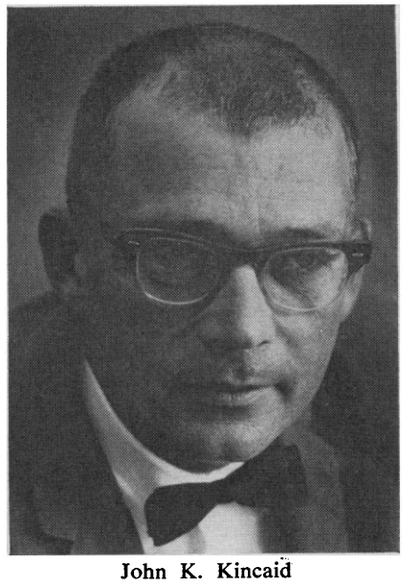
Such "long-baseline interferometry" is already giving a foretaste of the one-second-of-arc accuracy that the proposed NRAO array was designed to achieve. One second is about 1 part in 1.3 million of a circle. Such accuracy is regularly achieved by large optical telescopes with apertures measured in centimeters rather than in meters.

While the NRAO-design studies proceed, operation of the Owens Valley array of eight dishes should give accuracies of about 5 seconds of arc. The Dicke panel pointed out that this accuracy is "1/400th of the apparent diameter of the moon as seen from the earth."

These ideas and the others expressed by the Dicke panel are sure to excite much discussion at the International Astronomical Union meeting in Prague at the end of August and at an international conference on large radio dishes this fall in Cambridge, Massachusetts. It is clear that the Panel's report constitutes only round one of a full-dress discussion of the future of American radio astronomy.

—VICTOR K. MCELHENY

Top Federal Science Posts Filled



John K. Kincaid

Milner B. Schaefer

Appointments to two major science advisory positions in Federal agencies were recently announced.

John F. Kincaid, vice president for research and development of the International Minerals and Chemicals Company, Chicago, was named to the post of assistant secretary of Commerce for science and technology. He succeeds J. Herbert Hollomon, who resigned to become president of the University of Oklahoma (*Science*, 26 May). Before joining IMCC, Kincaid held the position of research staff member of the Central Research Program, Institute for Defense Analyses. Kincaid is an explosives expert and recipient of a Presidential certificate in 1948 for his contribution to national defense. Allen V. Astin, director of the National Bureau of Standards, will continue to act as interim assistant secretary, while congressional confirmation of Kincaid's appointment is pending.

The second appointment is that of Milner B. Schaefer, director of the Institute for Marine Resources, University of California, San Diego, who has been named science adviser to Secretary of the Interior Stewart L. Udall. Schaefer, who served as technical assistant in oceanography for the Office of Science and Technology from 1965 to 1966, will succeed Thomas F. Bates, who is returning to Pennsylvania State University to be vice president for planning. Schaefer's successor at IMR will be Henry W. Menard, a member of the IMR geology department.—G.P.

APPOINTMENTS

John G. Duba, commissioner of development and planning for the City of Chicago, to head of the civil engineering department, Polytechnic Institute of Brooklyn. . . . **Ian E. Bush**, senior scientist, Worcester Foundation for Experimental Biology, to chairman of the department of physiology, Medical College of Virginia. . . . **Roman Solecki**, teacher in the Institute of Basic Technical Research of the Polish Academy of Sciences, to the University of Connecticut. He will teach under a National Science Foundation program for senior foreign scientists.