RESEARCH FACILITIES AND PROGRAMS

Fusion research in the US

Research on controlled thermonuclear fusion in the United States is "declining in stature relative to that of the rest of the world." So remarked the Controlled Thermonuclear Research Review Panel in its recent report to the Atomic Energy Commission and the Joint Congressional Committee on Atomic Energy. Although the panel had praise for the work that is being done or has been done on controlled thermonuclear research (CTR) in the United States, it was concerned that the program was neither large enough nor moving as rapidly as it ought and concluded that it would "deteriorate rapidly to a secondary role if the present static budget of the AEC is continued."

The report points out that during the early period of CTR investigations this country held a commanding position. Four years ago, the United States effort in terms of weighted expenditure and personnel in the field represented nearly one half the total world effort and its contribution to progress (not otherwise defined in the report) was well over half the total. Today, the US effort is about one fifth the world total and the contribution approximately one third. During those four years, the AEC budget for fusion remained "essentially static and largely inflexible," a circumstance that both discouraged the influx of new people with fresh ideas and caused a lack of speed and flexibility in adapting and acquiring equipment to test new ideas. Meanwhile, programs in Western Europe, the USSR and Japan have gone ahead with new equipment, and vigorous, youthful staff. The panel was worried that: "After carrying through with the difficult groundwork and making major contributions to the foundation we shall be in a relatively poor position to reap rewards as they come."

To remedy the situation, the panel proposes that the AEC adopt and promote a fiscal policy that would double the number of scientists and engineers engaged in CTR under AEC auspices in five years. AEC was advised to take immediate steps toward formation of a national center for plasma studies and nuclear-fusion research. The national center should have an identity of its own and should be free of all security restrictions so that it could engage in cooperative ventures with other nations conducting programs in the field.

It should have close links to other fusion laboratories maintained by frequent visits and by exchange of personnel for periods of one to two years. The center should also have close ties to one or more universities and should play an important role in teaching and preparation of students for CTR careers.

The panel made detailed investigations of CTR programs in four major AEC-supported laboratories (Princeton, Oak Ridge, Los Alamos, Livermore). It recommended that for the immediate future AEC continue to rely on the four large laboratories for the bulk of CTR effort, that it support energetically a number of current experiments and novel excursions and that it "exercise courageous management in terminating and redirecting approaches which reach the point of diminishing return." The panel commended most but not all current fusion efforts of the four laboratories. It urged enlarged theoretical and engineering support.

Other CTR programs are under way in laboratories not directly related to AEC, including the Naval Research Laboratory, General Atomic, General Electric, Aerojet-General Nucleonics. Their programs received the panel's commendation for their valuable additions to the total effort. But AEC was warned that it could not rely on outside sources to carry the burden of research "in this difficult and time consuming field." AEC should strive "to set the pace and capitalize on the good fortune of having active collaborators."

The panel began its work under the chairmanship of the late Samuel K. Allison of the University of Chicago. After his death, R. G. Herb of the University of Wisconsin succeeded to the chair. Besides Herb, the report was signed by Peter L. Auer of the Department of Defense, Gordon S. Brown of MIT, S. J. Buchsbaum of Bell Telephone Laboratories, David D. Jacobus of Harvard, Thomas H. Johnson of Raytheon, and Eugene N. Parker of the University of Chicago.

A bang, not a whimper?

Speakers at a recent session of invited papers before the American Physical Society (28 Jan.) discussed the question whether in its remote past our present universe may have been a small "cosmic fireball," which, among other things, burned deuterium into helium at a temperature of about 10^{10}°K. R. H. Dicke first suggested that black-body radiation from the fireball may still exist as microwaves. The theory was discussed subsequently by Dicke and three other Princeton professors (P. J. E. Peebles, P. G. Roll, and D. T. Wilkinson) in the 1 July 1965 issue of the *Astrophysical Journal* [142, 414 (1965)] in connection with new observational evidence reported by Arno A. Penzias and Robert W. Wilson of Bell Laboratories in the same issue. The observations showed background radiation at 7.5 cm with an antenna temperature of around 3°K above contributions from the atmosphere and the antenna itself. Some time later Roll and Wilkinson (*Phys. Rev. Letters*, in press) found a temperature of about 3.0°K at a wavelength of 3.2 cm. Both determinations fit the spectrum of a black body of about 3°K, and it is proposed that this spectrum may represent the greatly redshifted radiation of the cosmic fireball. The speakers at the meeting were Peebles, Wilkinson and Wilson.

The observations reported so far show the intensity rising with decreasing wavelength (see illustration). This would be surprising even if they did not also fit the