

activities to support of basic research and science education.) Others have been sceptical about the ability of science and technology to provide solutions in the short term to complex social problems and another frequently heard criticism was that the Foundation has used the trendiness of the RANN programme as a means of swinging extra funds from Congress.

But there are signs that the Foundation has taken steps over the past year to come to grips with many of these criticisms. New guidance for RANN is coming from an inter-agency committee under the chairmanship of Edward E. David jun., the President's science adviser, and NSF officials cite the fact that many eminent scientists are now supported by the RANN programme as evidence of its scientific respectability. Moreover, the programme stands a better chance of emerging more or less unscathed from the appropriations process on Capitol Hill because there has been a shift in emphasis compared with the Foundation's budget request last year, with research on energy production, regional environmental systems and municipal systems and services chief objects of much of the new concentration of effort.

Dr Eggers explained to the committee last week that the thrusts of the RANN programme have received a searching review by the National Science Board, advisory committees of the Foundation and the new RANN coordinating committee. In deciding whether a specific project should be supported, factors such as its importance to national needs, whether science and technology can have "a unique and substantial impact on the problem", and whether it is ripe for a focused research effort, are taken into account. The RANN coordinating committee, which is composed of representatives from six other federal departments and agencies, also decides whether the NSF is the best agency for the job.

The upshot of this review is that energy research carries off the bulk of the funding designed for advanced technology applications (the RANN programme is divided into five sections—advanced technology applications, environmental systems and resources, social systems and human resources, exploratory research and problem assessment, and the intergovernmental science programme), and projects on earthquake engineering and fire research are also set for an injection of funds. The energy research programme includes some long lead-time projects, such as research into solar power utilization on a large scale, together with studies aimed at defining energy needs, while the earthquake engineering programme will include design studies of an earthquake simulator approximately 100 feet square.

## OUTER PLANETS

# From Jupiter to Saturn

by our Washington Correspondent

THE National Aeronautics and Space Administration last week formally announced that it intends to launch two Mariner class spacecraft in 1977 to fly by Jupiter and then Saturn. These missions will replace the grand tour of the outer planets, scrapped by NASA for budgetary reasons, which would have taken spacecraft close to all the outermost planets during the 1970s and 1980s.

Announcing NASA's plans for the Jupiter/Saturn mission during budget hearings held by the House Committee on Science and Astronautics, Dr John Naugle, associate administrator for space science, pointed out that although the mission is still not completely defined, it is expected to cost about \$360 million compared with the estimated cost of \$900 million for the full blown grand tour. Since NASA is under orders to keep its budget at about the \$3,000 million level for the next few years, funds for the grand tour were cut out of the agency's 1973 budget request and the Mariner flyby of Jupiter and Saturn is perhaps the most ambitious outer planetary mission that planetary scientists could hope for.

Launched by a Titan/Centaur rocket, the spacecraft should fly by Jupiter about 18 months after setting off and, accelerated and deflected by Jupiter's gravitational field, it will reach Saturn two years later. Although the mission's objectives might be altered by data relayed back from Jupiter by Pioneers F and G, they will almost certainly include taking a close look at satellites of both planets and at the enigmatic rings of Saturn. Of special interest is Titan, a satellite of Saturn which is about the same size as Mercury and which is the only planetary satellite in the solar system known to have an atmosphere. There is also a possibility that the trajectory of the second spacecraft will be altered in mid-course to take account of data radioed back from Saturn by the first.

Like the Pioneer spacecraft, the proposed Mariner flybys will derive their power from radioisotope thermoelectric generators because they will fly too far from the Sun to use solar power and because the length of the mission precludes the use of any other type of battery. The spacecraft will each be able to carry more than 100 pounds of scientific instruments, including television cameras—the Pioneer spacecraft has the capacity for only 65 pounds of instruments.

A statement put out by NASA last week points out that the decision to opt for Mariner class flybys of Jupiter and

Saturn does not preclude sending Pioneer spacecraft to orbit Jupiter and Saturn in the late 1970s. The Space Science Board of the National Academy of Sciences has, in two successive reports last year, emphasized the need for maintaining a solid research programme on Jupiter and to a lesser extent Saturn, whatever decisions are taken about the grand tour, but there is some doubt about the risk of orbiting Jupiter. The problem is the largely unknown danger to scientific instruments from the large radiation bands around the planet, but the hazards may be better known when results from Pioneer F are analysed.

The announcement of the Mariner flybys last week has been greeted with general approval by planetary scientists, although the approval has been tinged with disappointment at the scrapping of the grand tour. Dr Naugle said, for example, that the proposal has been "warmly endorsed" by the Space Science Board as a "strong and flexible programme which is a reasonable next step in planetary exploration". The Space Science Board had advised NASA early last year that the original concept of the grand tour should not be undertaken unless the total space science budget were increased considerably. NASA nevertheless went ahead and asked for \$30 million to proceed with designs of a thermoelectric outer-planetary spacecraft (TOPS) in its budget request for 1972. But Congress cut the request to \$20 million and instructed the agency to take another look at its plans for outer planetary spaceflight, whereupon a second panel of the Space Science Board was convened and reported in November last year (see *Nature*, 234, 246; 1971). This second panel warmly endorsed the grand tour concept, but suggested that if insufficient funds are available it should not be allowed to crowd out intensive studies of Jupiter and Saturn.

Dr Francis S. Johnson of the University of Texas, who was chairman of the second Space Science Board panel, said last week that although he is disappointed that NASA's budget could not accommodate the grand tour, the Mariner class flybys of Jupiter and Saturn should help to answer some of the more important questions about those two planets. But Dr Carl Sagan, of Cornell University, said that he is "very disappointed" about the decision to scrap the grand tour. He pointed out that there is a good argument for taking a quick look at the outermost planets because of the possibility of finding something completely unexpected. He added that the self-repairing and testing computer that was to have been developed for the TOPS spacecraft would have had great potential value for application in different fields.