state & society

Hirsch surveys fusion, geothermal and solar energy

Possible expansion of the Mirror Program at the Lawrence Livermore Laboratory and eventual termination of theta-pinch approaches to fusion power if results in that area continue to prove disappointing are among items on the current energy scene cited by Robert L. Hirsch, ERDA's new Assistant Administrator for Solar, Geothermal and Advanced Energy Systems. In a recent interview with PHYSICS TODAY, Hirsch commented on progress in fusion research and in the utilization of geothermal and solar energy. He also noted the historical background of basic-research activities in the agency and indicated his concern about the energy crisis.

Robert L. Hirsch recently assumed the position at ERDA of Assistant Administrator for Solar, Geothermal and Advanced Energy Systems. Previously Hirsch headed ERDA's fusion program.

Magnetic-confinement programs. With respect to the scope of ERDA's CTR work, Hirsch estimated that 65% of the agency's activities in this area are devoted to tokamaks and 15% each to the mirror and theta-pinch efforts, with the remainder expended on the exploration of new concepts. "Right now we're winning on two out of three," he said, because things are proceeding very well with the tokamaks and have just turned good in the mirror research; only in theta pinches have things not gone very well, he told us.

Recent excellent results from the 2X-II-B mirror machine have created considerable excitement, Hirsch said, and the Fusion Power Coordinating Committee at its recent meeting in Livermore recommended a massive scale-up of the mirror activity there. "We set out to increase the temperature," Hirsch explained, "because theory said that when you increase the temperature by the amount we were aiming for, you should get a tenfold increase in the confinement time. We hoped that would happen and verified that it does." In addition, he said, the beta for the 2X-II-B (in fusion machines, beta signifies the ratio of plasma pressure to magnetic field pressure) was pushed way up to unity and somewhat beyond, an uncommon value possible under special circumstances.

The theta pinch, a pulsed high-density approach, has not, according to Hirsch, shown adequate progress. Hirsch referred to problems with respect to stabilization of the plasma when he spoke of Scyllac at the Los Alamos Scientific Laboratory. He said ERDA has agreed

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NASA group proposes space program for next 25 years

NASA has produced a wide-ranging report that identifies possible directions for the US space program over the next 25 years. The 233-page report, "Outlook for Space: Report to the NASA Administrator by the Outlook for Space Study Group" was recently issued after a protracted delay. NASA administrator James Fletcher says that the report is already being used as a framework for more detailed planning.

The study group outlined a possible program costing $4 billion per year. The present NASA funding is $3.5 billion annually. At present, 5% of the budget goes for Earth-oriented applications, 20% for science and about 50% for development of transportation systems. Once the transportation system has been developed, not as much money would be needed for that item, the group noted. On the other hand, funds for science ought to be maintained at a level of about $500–600 million per year. But Earth-oriented activities should grow. Eventually the budget should evolve toward equal percentages for Earth-oriented activities, extraterrestrial sciences and manned activities, according to the leader of the study group's science subcommittee, Ichtiaque Rasool, who is deputy associate administrator for space science at NASA headquarters.

Themes. The study group organized space activities into 12 major "themes," seven of which deal primarily with Earth, and five of which cover extraterrestrial questions. Specific objectives were then defined within the themes.

The Earth-oriented activities are:

- production and management of food and forestry resources,
- prediction and protection of the environment,
- protection of life and property,
- energy and mineral exploration,
- transfer of information,
- use of the environment of space for scientific and commercial purposes and
- Earth sciences.

The study group consisted of 20 par-

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ticipants from NASA laboratories and centers, who met for a year beginning July 1974; only five were scientists. Rasool told us that the scientists in the group had to convince the others that scientific pursuits are one of the major needs of Man. Eventually the group concluded that science should continue to be pursued, but in a more focussed fashion.

The purpose of space science, Rasool says, is to learn the origins and future of Man. That is, as the synopsis of the report asks, "How did the Universe begin and develop? How did life originate and evolve? What is our place and destiny in the Universe?"

The five scientific themes identified by the group are:

- The nature of the universe. Rasool urges that we should be testing the "big-bang" hypothesis from space, looking at the beginning of time by large space telescopes and searching for the total mass of the universe to determine if it will really expand "forever."
- The origins and fate of matter. One would like to know what elements were formed where and how, whether or not we can eventually detect black holes and the answers to other questions in high-energy astrophysics.
- The life cycle of the Sun and stars. This theme deals with interstellar dust condensation into stars and planets, the nature and cause of solar activity and so forth.
- The evolution of the solar system. Two of the objectives identified are: How do planets, large satellites and their atmospheres evolve? How can atmospheric dynamics be quantified?
- The origins and future of life. If other planets exist, so should other civilizations, Rasool says, and we should be searching for both extraterrestrial biology and intelligence.

Plans for three possible elements of an overall program are discussed in the report. The first program element is to improve the understanding of Earth's climate so that short- and long-term changes in climate can be predicted. This program would cost $1.7 billion over a 25-year period.

The second program element is to study the evolution of the solar system with the following goals: to reconstruct the gross history of planets from their formation 5 billion years ago up to the present and to learn how an active planet like Earth functions—for example, what causes reversals in the geomagnetic field, how the continents move, why ocean currents are located where they are, and how stable is Earth's atmosphere against the changing chemistry. More basically, can we reconstruct the history of the atmosphere to determine how life on Earth originated and evolved? To this end the other planets would be studied in the context of the Earth. Through the year 2000 this second program would cost about $5.1 billion.

The third program element would exploit the human presence in near-Earth orbit and, as Rasool points out, would satisfy the urge of Man to explore and prepare him for eventual extended travel and living in space. The report urges that a permanent Space Station be built in the next ten years, which would receive logistic support from the Space Shuttle. Three or four persons would occupy the Earth-orbiting Space Station. The Space Station could cost as much as $6 billion over a 14-year period, but less expensive options are discussed.

The report identifies seven areas of national interest and evaluates the contributions of potential space activities to each of the areas. For physicists, perhaps the most interesting areas discussed are the expansion of human knowledge and exploration of the unknown. To satisfy these goals the group decided that seven objectives ranked highest: climate prediction; origin of the Universe; nature of quasars; nature of gravity; evolution of planets, large satellites and evolution of their atmospheres; search for extraterrestrial life in our solar system and detection of extraterrestrial intelligence.

"The Outlook for Space," NASA SP-386, January 1976, is available on a limited basis, as is a synopsis of the study and "A Forecast of Space Technology 1980–2000," NASA SP-387, January 1976.

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with the lab to pursue the problem vigorously for the next year and perhaps a bit longer, but a real question exists as to the future of that activity if present trends are not reversed.

Turning to tokamaks, we asked what prompted ERDA's decision to proceed with the Tokamak Fusion Test Reactor at Princeton. "We went ahead with it," Hirsch answered, "based on strong indications that tokamaks should scale somewhat as we had observed experimentally over a modest range and also as was predicted theoretically." Since the Princeton Large Torus and the Soviet T-10 have come into operation, he said, the observed confinement has been as the agency's researchers expected. Hirsch feels that the results have justified support for the TFTR. "When you're talking about a machine that's as expensive as that one," he said with a smile, "you breathe a sigh of relief when things come in to validate what you had assumed."

Hirsch was less sanguine about another Princeton tokamak, the Poloidal Divertor Experiment. Some of the Princeton lab's timetables and cost estimates have undergone revision, according to him, and "the PDX has had to take some of the brunt of things." He described the situation as a manifestation of growing pains

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Washington Bulletins

★ **Restoration of the White House science-advisory office** should give long-deferred satisfaction to those who have striven for its return ever since the ejection of the advisory apparatus from the Nixon White House in 1973. By the end of April both houses of Congress had endorsed a conference-committee report on the National Science and Technology Policy, Organization and Priorities Act of 1976, and President Gerald Ford signed it into law on 11 May. The measure provides a statutory basis for the appointment of a Presidential science adviser and calls for a survey of the Federal effort in science, technology and engineering. Interest now hangs on the President's choice for the top post.

★ **Three new panels in the Congressional Office of Technology Assessment** are being formed to evaluate national research and development policies and priorities. Harvey Brooks (Harvard University) will head the Panel on Health of the Scientific and Technical Enterprise, while the Panel on Applications of Science and Technology and the Panel on Decision Making on R&D Policies and Priorities will have as chairmen Lewis Branscomb (IBM) and Edward Wenk (University of Washington), respectively.