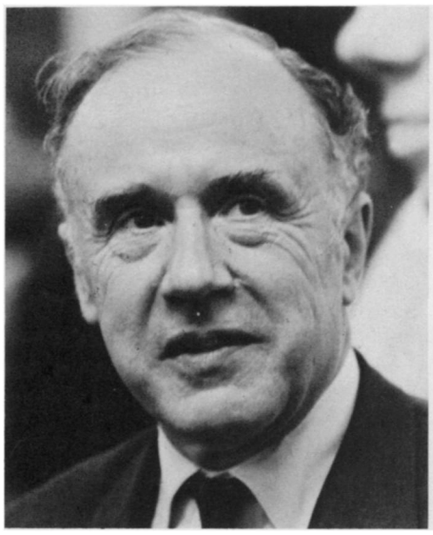
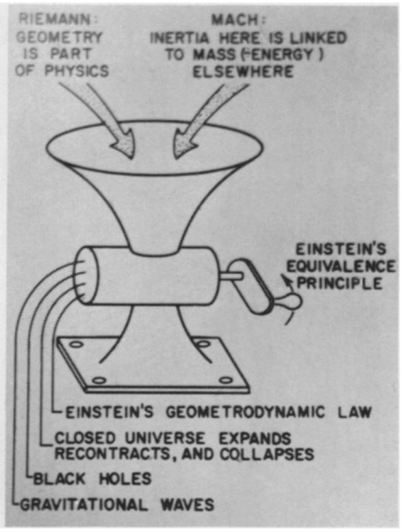
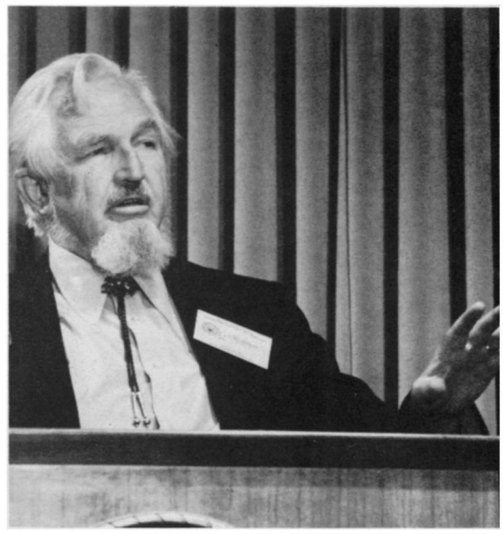




Wheeler: A new quantum principle and a new twist in Einstein's universe.



Isaacs: Sea monsters.

Frontiers of science: Physical paradoxes

A symposium in Washington last week celebrating the Naval Research Laboratory's 50th anniversary offered a procession of leading scientists recounting the brilliant potentials and frightening possibilities for mankind that lie in discoveries now taking place at the frontier of science.

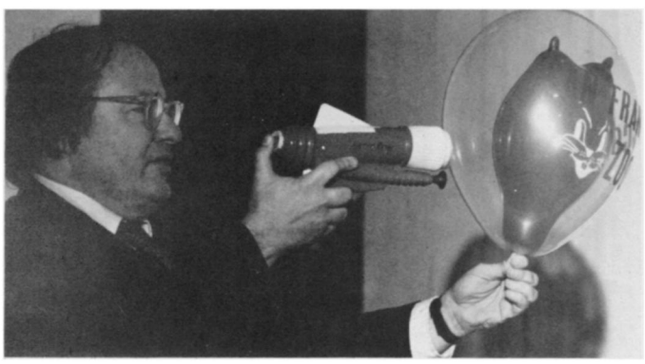
From abstract consideration of whether the universe will or will not recycle itself to an impassioned plea for sharing technological wealth with underdeveloped nations, the symposium provided rare insight into what is happening at the broad leading edge of American research, with participants expressing their hopes and fears for the future of their profession in unusually blunt terms.

Princeton physicist John A. Wheeler described the developing paradox of cosmology. Trying to understand how the universe could collapse in a finite time into a black hole, he said, is intellectually "perhaps the greatest crisis of science in history." He compared the collapse, which follows from Einstein's theory and implies that numerous physical laws would be broken or "transcended," to the behavior of atomic particles, where seemingly impossible behavior was finally explained in terms of the "quantum principle"—that at the submicroscopic level, uncertainties arise which preclude description of atomic phenomena in terms of classical physics. Predicting that a similar principle would be worked out at the supermacroscopic level of nature, Wheeler spoke of a developing "dynamic pregeometry," to deal with fluctuations of particles and fields in macrospace. Wheeler concluded that recent experimental evidence—which indicates that galaxies may contain much more mass in their faint outer stars than previously thought—tends to bear out Einstein's prediction of a "closed" universe that expands and collapses, rather than continuing its present expansion indefinitely.

John R. Pierce of Bell Telephone Laboratories predicted that development of optical fibers for communication will have a technological impact "as great as the transistor." As costs of computing equipment continue to decrease, he said, the greatest need for technological advance will be in the area of reliable data networks and terminal facilities. Cable TV will also have revolutionary impact, but in his view the greatest impact of electronics can still come from discoveries not yet made.

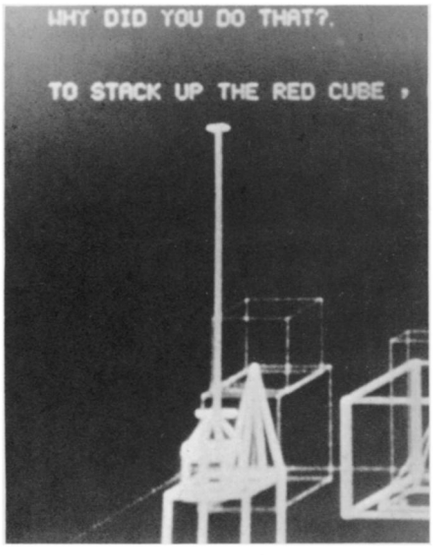
A similar prediction about new discoveries in the field of lasers came from Arthur L. Schawlow, who conducts laser research at Stanford University and as a private consultant. Laser light may one day control chemical reactions by tuning in on the energy levels of particular molecular bonds, he predicted, and he told of new developments in tunable dye lasers, including one that can produce any frequency between green and ultraviolet light. Several new materials are being used to create these lasers, he reported: "Anything will lase if you hit it hard enough." (To demonstrate the point, Schawlow displayed a picture of lasing dessert gelatin.) LIDAR (laser radar) is already being used to study dust in the atmosphere. Crude laser projectors can increase the amplitude of an image a thousandfold. Soon, laser detecting devices will be so sensitive that they will be able to discern such rare entities as positronium (a positron and electron revolving about each other) and atomic nuclei with extra quarks (should such exist). Schawlow suggested that even insect control could be carried out with lasers.

Oceanographer John D. Isaacs of the Scripps Institution of Oceanography showed his audience dramatic proof that the sunless ocean floor at the bottom of the great sea trenches is not the lifeless place it was once supposed to be. In pictures taken by remote cameras, schools of hagfish burrowed into pieces of bait, and giant sharks, five feet in diameter, thrashed about 25-gallon oil drums containing meat, as if they were toys. By studying sediment cores from

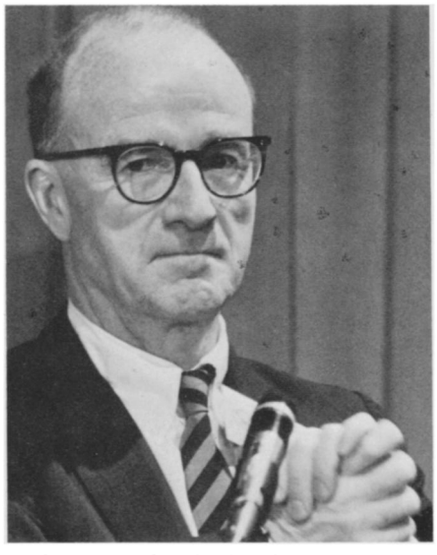


Schawlow demonstrates laser toy, bursting inner balloon but leaving outer one intact.

Photos:
John H. Douglas



Computers learn to think.



Piel: Human brotherhood.

to future possibilities

the sea bottom, Isaacs said, oceanographers are determining the effects of ocean temperatures on climate changes on land and have already discovered that the great blizzards of the 1950's and 1890's were probably caused by ocean-atmosphere interactions. Such research also determined that the sudden decline of sardines off California was not caused by overfishing, but rather appears to be part of an age-old cycle. Finally, Isaacs described efforts to breed new strains of land plants to grow in salt water so that they could be irrigated directly from the sea without the bother of desalination.

MIT professor Marvin L. Minsky revealed new aspects of the impact artificial intelligence machines may have on education by helping students learn about the thinking process. "Teachers don't talk to students about learning and thinking," he said, "it's more taboo than sex." Computers themselves are becoming so inexpensive, compared to the software that runs them, he declared, that disposable computers and computers that do their own programming must soon be developed. By studying how machines learn, cyberneticists have been able to contribute to psychology theory, with the development of artificial intelligence coming largely from military funding, where, says Minsky, "wise people realized there was more to computation than rubbing numbers together."

The NRL anniversary symposium was highlighted by two panel discussions on the energy crisis and the future of science. Philip H. Abelson, editor of SCIENCE magazine, moderated the panel on energy sources and predicted that a "major crisis, causing severe hardship, is no more than two years away." Only after the development of such a crisis, he said, would people realize the importance of research designed to end the country's dependence on oil and of the necessity to begin conserving energy now.

Philip Handler, president of the National Academy of Sciences, moderated the panel discussion of the future of science, which with unusual candor dealt with the problems of genetic engineering, a world run by automatons and the specter of population explosion. Leading French physicist Pierre Auger said the time has come to face the potentialities of changing inheritance characteristics, particularly in light of evidence that death may be a manipulable genetic characteristic. Princeton physicist Freeman J. Dyson speculated on the conditions necessary to set up truly independent, self-perpetuating automatons, as the final answer to economic problems. SCIENTIFIC AMERICAN publisher Gerard Piel delivered an impassioned plea for a sharing of technological know-how from the advanced to the underdeveloped nations—a plea echoed in turn by each of the other panelists. He also called for reasonableness in man's search for brotherhood and called the dichotomy between the scientists and humanists mischievous schizophrenia. "What men need most urgently to learn," he concluded, "is the liberating knowledge of themselves established by the work of science."

* * *

Occupying 150 buildings along the Potomac, the Naval Research Laboratory has produced a string of discoveries and developments far beyond its original charge of producing equipment for the Navy. NRL scientists discovered and developed radar, did early work on sonar, conducted the first flight of a pilotless plane and are working on various medical devices for civilian application. □

Zeroing in on the body's nerve growth factor

Thirty years ago, Rita Levi-Montalcini of Washington University found that a chemical in tumors could stimulate the growth of sensory and sympathetic nerve cells. Sensory neurons control the senses. Sympathetic neurons control involuntary actions of the body, such as the flight-or-fight response. Levi-Montalcini named the stimulatory chemical the "nerve growth factor."

Nerve growth factor (NGF) has since been found not just in tumors, but in the blood of various animals and people. For some intriguing reason snake venom and the salivary glands of the male mouse are loaded with it. NGF has been isolated from the male mouse's salivary glands and characterized. It is a typical body protein, partly resembling the hormone proinsulin. Experiments suggest that NGF plays an important role in the growth and maintenance of nerves in animals, and possibly in people too. It is also quite possible that NGF is at the root of some neurological and malignant diseases. So investigators are anxious to get at its exact biological role. Two new reports show they are making progress toward this goal.

Like NGF, the secondary hormonal messenger cyclic AMP stimulates the elongation of nerve ends. So Daniel B. Hier, Barry G. W. Arnason and Michael Young of the Harvard Medical School thought that cyclic AMP might mediate NGF's action on neurons. However, this is not the case, they report in the Oct. 5 SCIENCE.

NGF appears to act not just on sensory or sympathetic neurons in general, but on specific ones. When NGF had the option of acting on sympathetic neurons from various parts of a rabbit's body, it acted only on nerves in the neck. NGF also binds to specific sites on the membranes of target neurons that are not used by other chemicals or hormones. These discoveries, by Shailesh P. Banerjee, Solomon H. Synder and Pedro Cuatrecasas of the Johns Hopkins University School of Medicine and Lloyd A. Greene of the National Heart and Lung Institute, are reported in the September PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

All this, Greene admits, "doesn't tell us how nerve growth factor works. But it does tell us that its first step of action appears to be some membrane site, some particular receptor. How its actions are tied to the receptor, we don't know. That's a mystery." □