



NSF

Dr. McElroy: I have enjoyed it.

likewise expressed regret at McElroy's departure.

Davis commended Dr. McElroy "for the legacy which he leaves to his successors," and Dr. McElroy himself says he thinks NSF is on a good course. But the subcommittee and its parent Science and Astronautics Committee have been troubled by NSF's expressed desire to play a larger role in supporting problem-oriented research, and a broad committee inquiry into the policy issues is intended during the coming year.

Both House and Senate groups have recommended only a portion of the increase in funds NSF sought for its Research Applied to National Needs (RANN) program, while restoring most of the cuts NSF proposed in institutional support for science and science education support. But despite the internal budgetary shifts, the agency is assured of a substantial total increase in funds for fiscal 1972. The House on June 30 approved an NSF appropriation of \$585 million, \$71 million more than the agency received last year. This week the Senate, as a result of an amendment offered by Sen. Edward M. Kennedy (D-Mass.) and two others, voted an appropriation of \$648 million, \$25 million more than NSF requested. House-Senate conferees were to meet later in the week or early next week. □

DRUG DETOXIFICATION

Isolation of liver enzyme

A liver enzyme essential not just for steroid and lipid metabolism but also for the detoxification of a wide spectrum of foreign compounds—marijuana, alcohol, pesticides and sundry drugs—has drawn increasing attention from biochemists in the past few years. The enzyme is called Cytochrome P-450. Cytochromes, like hemoglobins, are red-pigment proteins that participate in cell oxidation reac-

tions. The "P" stands for "pigment," and the "450" for the wavelength (in nanometers) most strongly absorbed by a combination of the enzyme and carbon monoxide.

It had been known for some time that a liver pigment reacts with carbon monoxide, and some Japanese scientists first identified it by spectral methods in 1962 and named it Cytochrome P-450, but no one had managed to isolate a biologically active enzyme. Nearly all other known liver cell enzymes (some hundred) are located in the liver cell cytoplasm and are soluble and so are easily isolated. But Cytochrome P-450 is tightly bound to the inner membrane network of the liver cell. Now, a biochemistry team at the University of Michigan Medical Center at Ann Arbor, headed by Dr. Minor Coon, has succeeded in isolating the entrenched red enzyme.

Actually Dr. Coon and his colleagues have managed to extract not only a catalytically active P-450 from the liver cell membrane, but also a phospholipid and a reductase enzyme. Apparently the triumvirate is needed to attack foreign compounds; P-450 cannot go it alone. Dr. Coon's team found this to be the case after applying the isolated compounds separately on foreign material in a tissue sample.

Dr. Coon sees the discovery of the phospholipid's role in the action of Cytochrome P-450 as almost as crucial as the isolation of P-450. For, while it is known that 40 percent of the endoplasmic reticulum is comprised of fatty molecules, no one suspected that these molecules might participate in the liver cell's war against foreign materials.

The Ann Arbor biochemists will next attempt to identify the precise structure of Cytochrome P-450. Such characterization, they believe, could eventually assist physicians in drug therapy. "Drug administration at this time is pretty hit-and-miss," Dr. Coon explains. "A physician can only guess in advance how much of a drug to give. A heavy drinker, for example, will have built up large amounts of P-450 to detoxify the large quantities of alcohol he consumes, and if the doctor doesn't know he's a heavy drinker, the amount of drug given will probably be quickly detoxified and produce less than the desired effect on the patient." But if the Michigan researchers can figure out P-450's structure, they may then be able to devise a method whereby physicians can analyze patients for Cytochrome P-450 activity prior to drug therapy, thereby better estimating an effective drug dosage.

Characterization could also eventually show up inherited P-450 structural differences in the population. □

SIMPLER AT HIGH ENERGY

Proton-proton collisions

About a year and a half ago Dr. Richard P. Feynman presented a new suggestion about the probabilities of forming new particles in certain kinds of collisions at high energy. If true, it would give hope that the general laws governing particle behavior under the influence of the strong nuclear force are simpler than was feared and may be easier to dig out of the mountains of data being accumulated. Dr. Feynman's suggestion has now been confirmed, for protons, by one of the first experiments with the new Intersecting Storage Rings at the CERN laboratory in Geneva.

Basically, his proposal is that for what he calls inclusive experiments the probability of producing new particles becomes independent of energy when the energy gets very high. (At about the same time Dr. C. N. Yang of the State University of New York at Stony Brook made a similar suggestion.)

An inclusive experiment is one in which the experimenters look for one particular resulting particle with specified properties, although the collision also produces a variety of other particles. This is often written schematically as A plus B yields C plus anything else. About 95 percent of all proton-proton experiments, a most important class of interaction, are inclusive.

The interactions studied in the CERN ISR are proton plus proton yields pi meson plus anything else. The experimental set-up measured the rates at which pi mesons with different amounts of forward momentum were produced. From this the cross sections could be calculated. When they were compared graphically with results previously obtained at lower energies, all the points fell on the same curve. This, says a CERN spokesman, is a striking confirmation of Dr. Feynman's prediction. The experimental data are reported by Drs. L. G. Ratner of Argonne National Laboratory, R. J. Ellis and G. Vannini of the University of Bologna and B. A. Babcock, A. D. Krisch and J. B. Roberts of the University of Michigan in the July 5 PHYSICAL REVIEW LETTERS.

Some effects of Dr. Feynman's idea can be observed even at much lower energies. One corollary question is whether the nature of the incoming particle makes a great difference in the results. Do the results of various kinds of particles striking a proton show similar patterns? This was tested at Brookhaven National Laboratory by Drs. M. S. Chen, R. R. Kinsey, T. W. Morris, R. S. Panvini, L. L. Wang and T. F. Wong of Brookhaven, S. L. Stone, T. Ferbel, P. Slattery and B. Werner of the University of Rochester and J. W. Elbert and A. R. Erwin of the Univer-

sity of Wisconsin at Madison.

They studied interactions in which positive pi mesons, positive K mesons, negative pi mesons and protons were struck against proton targets. The results in each case contained negative pi mesons plus anything else. The data show that all the experiments agree with each other except those where negative pi mesons are the impinging particle. The experimenters say this disagreement may support a prediction by Dr. Chan Hong-Mo and others of Stony Brook that particular combinations of properties of the colliding particles can influence the result at low energies.

All in all the recent results enhance the hope that simple principles under-

lie the complexities of particle physics. The strong nuclear interaction, which dominates the proceedings in all these collisions, has been one of the most intractable topics in the history of physics. These experiments yield the hope that at high energies, at least, it follows behavior patterns susceptible to description by simple models.

In the minds of physicists the results also underscore the need for higher and higher energy experiments, whether with storage rings or with stationary targets to find out what that putative simple model is. Since the strong interaction is the force that holds atomic nuclei together, an understanding of it is fundamental to understanding the structure of matter. □

the booster until 1981 (SN: 7/17/71, p. 41).

Comparison of the two studies is difficult because they are based on different assumptions about the space program for the next 20 years. The STG report used by Rand included the cost not only for the shuttle and the tug (the tug would be used to take payloads from the shuttle orbit to synchronous orbit), but also for a space station and base, a lunar station and base, and a lunar tug. The Rand authors conclude that all of this would cost NASA \$94 billion to \$97 billion between now and 1990, and cost the military \$41 billion to \$44 billion. If NASA does only the space station, base and shuttle, the cost would be less for NASA (\$77 billion to \$81 billion) but more for the military (\$42 billion to \$46 billion).

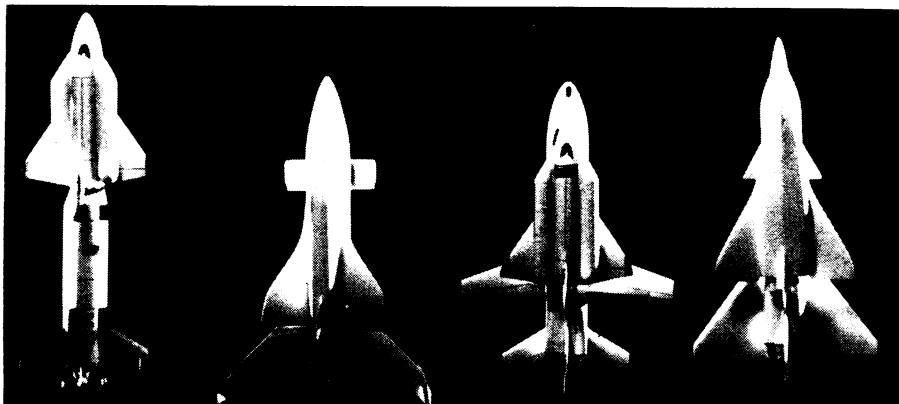
The Rand authors used a two-stage (booster and orbiter), reusable shuttle that could carry 50,000 pounds to orbit, have a 100-flight lifetime and a two-week turn-around period. Most of their conclusions were based on the predicted amount of shuttle traffic, the total of which was slightly higher than in the Mathematica report. It is also significant to note that the Rand report did not evaluate precise payload savings. The authors concluded that the shuttle would cost \$9 billion and show a net undiscounted transportation cost saving of only \$2.8 billion by 1990. The civilian space budget would peak to \$7 billion in 1975 under the Rand plan. Significantly Rand also concluded that heavy traffic favors the shuttle and that a large shuttle was more economical than a small one (50,000 pounds or 25,000 pounds payload). The Rand study did not consider payload effects. It concluded that the shuttle was hard to justify.

Mondale described the Rand report as "devastating" to the shuttle. Pro-shuttle Senators said the Rand report was based on two-year-old data and pointed out that the Mathematica study was the result of 12 to 16 man-years and a \$600,000 contract and the Rand report only 2 or 3 man-years and a \$40,000 contract.

The Mathematica study considered only shuttle and tug developments. Mathematica used a 10 percent discount rate for the next 20 years—a rate assigned by the Government to low priority items; the higher the discount rate the more a project has to do before the private sector sees a return on its tax investment. (For example, most Government projects have a zero percent to five percent discount rate.) Yet even with this high discount rate Mathematica concluded that to develop a shuttle and tug and buy the fleet (3 or 4 orbiters and 4 or 5 boosters) would cost only \$12.8

SPACE-PROGRAM OPTIONS

Shuttle is weathering the storm



NASA

Choice lies ahead: Four different proposed configurations for the shuttle.

The dropping of \$200 million Saturn boosters into the Atlantic Ocean every time the United States launches men into space is not generally regarded as the most frugal sort of action. In the space program, "reusable" has become a magic word.

The National Aeronautics and Space Administration wants to build, for economic reasons, a reusable booster to take men and reusable hardware into earth's orbit. But the space shuttle, as this transportation system is called (SN: 8/29/70, p. 178), has been the object of criticism from a small group of Senators who believe it will be not an object of thrift but a multibillion-dollar program designed to perpetuate the manned space program. NASA's budget of \$3 billion, even though it is about one twenty-fifth the Defense Department's, is still an enticing target for proponents of "new priorities"; NASA has found it has had to scrutinize every dollar.

The Senate amendment this year to delete the shuttle's \$80 million from the NASA budget was defeated again, however, by an even greater margin than last year. In the Senate vote to

authorize funds for NASA, the anti-shuttle amendment lost 62 to 22. This week, the Senate voted to actually appropriate NASA funds, but the sponsors of the amendment—Senators Walter F. Mondale (D-Minn.), William Proxmire (D-Wis.), Clifford P. Case (R-N.J.) and Jacob K. Javits (R-N.Y.)—decided not to try to introduce it into the appropriations bill because of the size of the earlier defeat.

Muddying the already murky waters of the political debate were two vaguely contradicting cost-analysis studies of the shuttle. One study, released in May by Mondale, was written in 1970 by four Rand Corp. analysts under contract to the Air Force. The study was based on the 1969 Space Task Group (STG) report and 1969 shuttle statistics (the STG report is no longer considered feasible by NASA and has been largely dropped). The other study, done by Mathematica, Inc., was completed this May for NASA and was based on current data. Mathematica is now doing another cost study of the "phased approach" announced by NASA last month of developing the orbiter first and delaying the development of