the universe—the gravitational force holds galaxies and other astronomical systems together, the electromagnetic force holds atoms and molecules together, and the strong or nuclear force holds atomic nuclei together.

In studying forces, physicists have concluded that they are exerted between particles by exchanging a third, intermediate particle. The theory of weak interaction that has so far evolved demands that it, too, have a special particle to serve as carrier.

The intermediate particle for the strong interaction is the Yukawa pion. The intermediate for electromagnetic forces is the photon or light particle, and that for gravity is called the graviton. The intermediate for the weak forces is the intermediate vector boson.

Pions and photons are seen every day in large numbers. But nobody has ever positively identified an intermediate boson. Nobody has ever seen a graviton either, but that is not so serious to particle physicists since gravitational force is so weak that single gravitons are much too insignificant to be detected.

The intermediate boson, however, is something the particle men have wanted badly to find. They have looked literally high and low, and at energies in between, in many experiments at accelerators, without success.

Now, despite Dr. Bergeson's caution, they sense promise.

The experiment at the University of Utah originally intended to look for cosmic neutrinos—elusive particles thought to be present in cosmic rays. The experiment is a large array of detectors that record muons, which are supposed to be produced when neutrinos interact with matter. The detectors are buried deep underground in a mine near the University of Utah, to shield them from unwanted particles that could ruin readings.

When the muons were counted and analyzed, Dr. Bergeson reports, the result was widely different from what had been predicted, taking into account all known means of muon production including those produced from cosmic neutrinos. On this basis some physicists have concluded that intermediate bosons which theory says should decay into muons, were responsible for the difference.

Corroboration is being sought elsewhere.

At the end of March Texas A&M University announced that some of its physicists, in association with physicists from the University of Toulouse, were about to install counters in a tunnel under Mont Blanc to test the idea that intermediate bosons are responsible for the muons (SN: 3/9 p. 240).

Dr. Bergeson took the conservative position in his APS report. The evidence shows definitely that "a new parent" for the muons has to exist, he says, but one should not jump to the conclusion that it is the intermediate boson. Those who would like to believe so should check the theoretically predicted rate at which intermediate bosons would produce muons very carefully against the experimental evidence.

MORE HASTE . . .

A space leap forward

The first and only unmanned test flight last Jan. 22 of the Apollo lunar module was hardly an unqualified success (SN: 2/3 p. 114). Among other difficulties, the vehicle's descent engine, which is the one that will finally lower two U.S. astronauts to the moon's surface, shut off after only four of a planned 39 seconds. Apollo officials, however, decided that the difficulties could be overcome in ground tests, and recommended to space agency head James E. Webb that he cancel the proposed second unmanned flight test. Which he did last month.

A similar recommendation was made to Webb last week on the only remaining unmanned flight. If the officials' recommendations still carry as much weight as they did a month ago, the next Apollo flight will carry astronauts, the first U.S. spacemen to fly since James Lovell and Edwin Aldrin orbited the earth aboard Gemini 12 in November 1966. Webb must balance speed against safety in his decision; presumably the recommendation will be accepted.

Webb has strong reason to go along with his advisers. Besides saving an estimated $200 million, the elimination of a third unmanned Saturn 5 mission could save two or three months in getting Apollo astronauts into space.

There have been two unmanned test flights of Apollo's giant Saturn 5 booster; the first was a jewel, but the second, last April 4, was marred by three major engine failures. Originally, the space agency had said that two successes would be necessary to qualify the Saturn 5 for carrying men, but now, as with the Lunar Module flight, the officials believe that they can straighten out the booster troubles as well on the ground and go ahead with a manned flight.

DRUGS

Why addicts relapse

Evidence is coming to light which may challenge most of the assumptions on which the treatment of drug addicts is based. It is beginning to appear that, at least physiologically, once an addict always an addict.

Cures for the addict's condition often are not designed with the patient very much in mind. The most famous is the cold-turkey cure, in which the unfortunate victim is suddenly and totally deprived of his drug then locked in a room to suffer the pangs of withdrawal.

The theory is that once the addict or alcoholic has gotten past withdrawal, he will be free of his curse and can once again be an upright citizen. Fear of withdrawal symptoms is considered to be the only thing which sends the junkie back to the pusher.

This theory has never really worked. So-called detoxified patients have an alarming relapse rate. Attempts to pin the return to drugs on character or psychological factors have failed.

Science is beginning to make at least educated guesses as to why the theory doesn't work.

The question of why addicts relapse was the central theme of a symposium of the 105th annual meeting of the National Academy of Sciences last week.

Drs. Joseph Cochin and Conan Kornetsky of the Boston University School of Medicine discussed work in which they have demonstrated that a single dose of morphine produces changes in a rat detectable nine months later. They say an animal brought to full tolerance of the drug (i.e. addiction) shows detectable physical changes as much as 15 months after the last dose.

The changes consist of elevated tolerance for the drug; it takes more morphine to affect the once-dosed rat than it does in the never-dosed rat.

While the mechanism by which the drug exerts its effect is still hotly debated, Drs. Kornetsky and Cochin claim that any long-term effect must argue against the weak-will theory of relapse.

Permanent change easily could mean permanent addiction, Dr. Vincent P. Dole of Rockefeller University believes. He is involved in an experimental program in New York under which some 700 opiate addicts are being treated with a drug called methadone.

Methadone is a substitute narcotic. So long as the dose is controlled, it produces no euphoric effects while blocking the addict's craving for heroin. But enough methadone produces both addiction and euphoria, according to the U.S. Public Health Service Addiction Research Center in Lexington, Ky. The center has treated methadone addicts. Its interest now focuses on a non-narcotic block called cyclazocine.

Dr. Dole, nevertheless, says methadone has the single discernible effect, when properly administered, of blocking the addict's craving for dope.

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Furthermore, the addict who takes heroin at the same time as he is under methadone therapy will get none of heroin's effects.

Dr. Dole reports success with 90 percent of his patients. Ten percent have been discharged from treatment, usually because of complicating factors such as alcoholism, for which methadone is useless. These patients, he says, have almost all relapsed.

Dr. Dole believes the methadone treatment experience supports the idea that there is some factor of addiction that is at least semi-permanent. Even though the opiate has been totally withdrawn for periods up to five years, methadone is still needed.

Dr. Avram Goldstein, chairman of the department of pharmacology at Stanford University, cites his own work in opposing the theories of Drs. Kornetsky and Cochin. The Boston researchers hold that the persistent effects they have observed may be due to some kind of immune mechanism. Dr. Goldstein feels that the drug interferes with enzyme action and does not provoke any kind of immunity.

In direct contradiction to the others, he says his own results indicate that there is no persistent effect. His animals, brought to a state of tolerence or addiction and then cut off from the drug, return to normal at a rate similar to that at which they developed tolerance. On subsequent administration of opiates they respond as do undosed animals.

Dr. Goldstein suggested a model for the action of some narcotics. A certain enzyme acts on a given amount of precursor substance in the body to produce a certain product necessary to the organism. The drug inhibits the action of the enzyme, thus reducing the amount of the free product and causing euphoria and other symptoms.

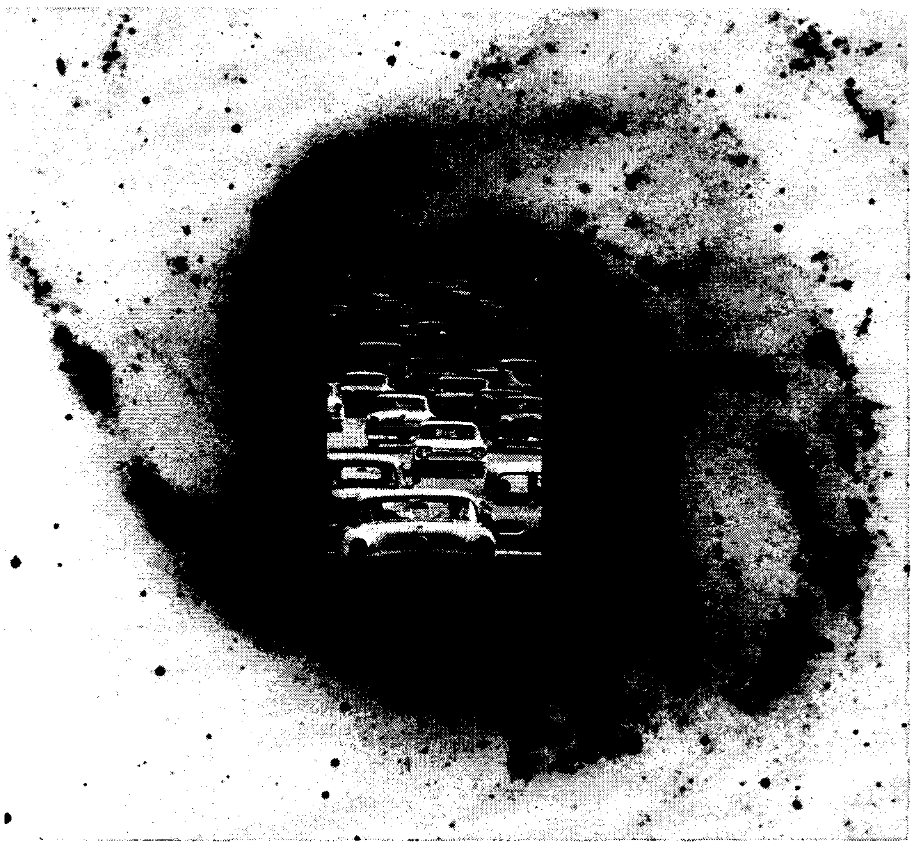
The production of enzymes generally is regulated by the amount of their product that is present in the system. If the product is reduced, the production of enzyme will be stepped up to compensate. Thus, the product returns to former levels in the presence of the drug.

In order to achieve reduction of the enzyme's product and consequent euphoria, the user therefore has to increase the drug dose to inhibit the extra enzyme production. The whole cycle starts again. Now if withdrawal is attempted there is initially a tremendous overproduction of enzyme, uninhibited by drug. This in turn results in overproduction of a product which causes withdrawal symptoms.

Finally, according to the model, the production of enzyme falls off to normal and the drug experience is forgotten, at least biochemically. The model also could serve to explain hangovers.

FLUID DYNAMICS

Galaxies, earth mantle and cars



Orderly arms of a galaxy and distempers of traffic obey similar physical laws.

Systems as seemingly diverse as spiral galaxies, the earth's upper mantle and the driver in his car actually have something in common—the way they behave can be described, at least partially, using the established laws of fluid dynamics.

A session of invited papers at the American Physical Society meeting last week was devoted to these unusual fluid systems.

The structures of hundreds of millions of spiral galaxies, of which the Milky Way is a typical example, can be pictured as giant natural laboratories of plasma physics, with each star behaving in a manner corresponding to a single electron or proton in the plasma of a terrestrial laboratory.

Dr. C. C. Lin and his collaborators at Massachusetts Institute of Technology, especially Dr. Frank H. Shu, believe such stellar systems can develop density waves through the collective behavior of the stars, very much like the waves known in laboratory plasmas.

These density waves—alternate condensation and rarefaction of star concentrations—are not observable by themselves, but can be traced by plotting the positions of brilliant young stars that have little to do with the structure of the spiral, which is maintained by the older stars. These young stars, each more than 10,000 times brighter than the sun, are distributed along the spiral arms.

The density waves travel around the Milky Way galaxy once every 450 million years, Dr. Lin has calculated, whereas the stars in the solar vicinity would have a galactic year of 200 million years.

For the earth's mantle, one of the implications of a fluid behavior is the possibility of a Rayleigh instability: The lower mantle will become hot due to the heat released by radioactive elements. The heated rocks expand and move upward, resulting in a thermally driven flow of a cellular type.

Dr. Daniel L. Turcotte of Cornell University, Ithaca, N.Y., has developed a theory that the core of each such cell has a circulating fluid flow, all at the same temperature; thermal gradients are restricted to the boundaries of the cell.

He suggests that the ascending flow in a cell is associated with the oceanic ridges. The rising hot mantle material results in volcanic activity, shallow earthquakes and high heat flow.

The mantle material then spreads away from the ridges, resulting in the