coleptics may have an overactive acetylcholine system. These neurochemical findings, Baker says, are consistent with a theory that views narcolepsy as a disease of two parts: excessive somnolence (presumably linked to the dopamine deficiency) and disordered REM (or rapid eye movement) sleep. Narcoleptics do not get less sleep than normal persons, Baker says, but the quality of their sleep is unique. Specifically, where it normally takes 90 minutes to enter the first period of REM sleep (or dream sleep), narcoleptics seem to possess what Baker calls "a hair trigger for REM"; they go immediately into REM sleep, dreaming even during the briefest naps. The overactive acetylcholine system, Baker suggests, may be related to this hair trigger.

REM sleep, even in normal sleepers, is accompanied by almost total paralysis, presumably to prevent people from physically acting out the content of their dreams. But in narcolepsy, Baker says, the elements of REM sleep seem to be dissociated; the paralysis (called cataplexy) is triggered before sleep onset (or it persists following waking), or in the case of hallucinations, the dreaming is triggered during wakefulness — with or without paralysis. Drugs that inhibit acetylcholine activity have been shown to reduce cataplexy and to suppress REM sleep, and drugs that enhance acetylcholine activity have been used to experimentally induce dreaming and to prolong paralysis—lending support to the theory that acetylcholine (probably in cooperation with other brain chemicals) is involved in the initiation of REM sleep.

Interestingly, narcoleptic attacks are usually triggered, in both dogs and humans, by pleasurable events; human narcoleptics typically nod out at parties, and canine narcoleptics experience attacks during sex or feeding. The neurotransmitters under study are very active in the older parts of the brain that are involved in dreaming and emotional processing, Baker notes.

Preliminary trials with a drug that increases dopamine activity while at the same time inhibiting acetylcholine turnover have shown promising results, Baker says. Earlier studies at Stanford have indicated that narcolepsy is clearly a hereditary disorder carried on a single recessive gene, suggesting, according to Baker, that only one of the neurotransmitter deficiencies is inherited; the other brain abnormality most likely develops secondary to the genetic defect. Although it is unclear which comes first, Baker says, narcoleptics usually begin experiencing extreme sleepiness during adolescence, while the cataplexy typically appears in adulthood. In addition, about 20 percent of narcoleptics never experience cataplexy, suggesting that it is probably the dopamine deficiency—and the resulting somnolence—that is passed from generation to generation. — *W. Herbert*

Puzzling search for the GUTs of physics

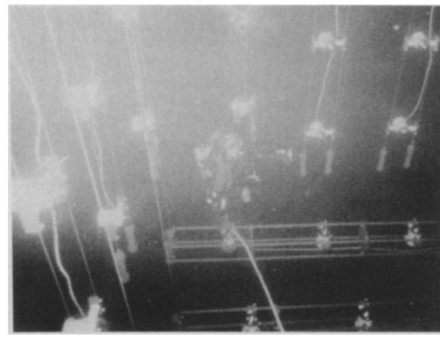
A little more than a hundred years ago James Clerk Maxwell devised a theory that united electricity and magnetism, showing the two classes of phenomena to be different aspects of an underlying unity. Since then many physicists have worked toward a totally unified field theory, one that would unite all the kinds of force in nature in a single description.

Almost exactly 100 years after Maxwell's achievement came the next successful step, the unification of electromagnetism and the forces of the weak interaction (which govern a number of radioactive processes) into what is called Glashow-Weinberg-Salam theory or "electroweak." Next on the agenda is the unification of electroweak with the strong interaction, the force that holds atomic nuclei together, in what is called a Grand Unified Theory (GUT). Several candidates have been put forward. The bad news is that several recent experimental negatives, mostly reported at the recent meeting in Baltimore of the American Physical Society, seem to rule out the simplest GUT candidate, known as minimal SU(5).

The negative reports are from experiments that look for effects predicted by minimal SU(5) and other GUT theories, but not expected by previous ununified theories.

Until GUTs came on the scene, physicists had believed that protons are absolutely stable. GUTs, however, predict proton decay. It should be extremely rare: the lifetimes calculated for protons in the various theories run around 10^{30} years.

The way to look for proton decay is to assemble a large volume of matter and wait for a proton in it to decay spontaneously. One puts the matter under a mountain or deep in a mine to shield it from the copious background of cosmic rays that would otherwise swamp the detectors. Eight thousand tons of water, 2,000 feet under Lake Erie in a Morton Salt Co. mine, form one such detector operated by what is called the Irvine-Michigan-Brookhaven collaboration. The water is in a cubical tank about 20 meters on a side. The sides of the tank are adorned with 2,000 photomultiplier tubes. If a proton in the water should decay into a positron and a pion, as minimal SU(5) says it should, the daughter particles, coming off in opposite directions, should emit cones of light, called Cerenkov light. When the cones of light reach the sides of the chamber, they should trigger two rings of phototubes. As previously reported (SN: 2/5/83, p. 85), no such events were seen in three months. G. William Foster of the University of Michigan in Ann Arbor, who reviewed the experiment at the Baltimore meeting, said that this nonappearance means that the proton has a much longer lifetime than minimal SU(5) predicts, and so it seems that theory is excluded.


IMB Collaboration

Diver adjusts phototube in IMB detector.

Other GUT theories predict proton decay into a muon and a K meson. An experiment located under Mont Blanc on the French-Swiss border has reported one of these. If that is correct, says Foster, the IMB experiment should have seen five or six. So far, he says, it has seen none it can be certain about. The statistics here are still too slim to hazard any conclusions.

Another prediction of some GUT theories—but not minimal SU(5)—is neutron oscillations. That means that a neutron may spontaneously turn itself into an antineutron or vice versa. If that happens in a nucleus, the antineutron will immediately annihilate itself with another neutron, producing a burst of pions with about two billion electron-volts energy. This will explode the nucleus, producing, in the words of Carl B. Dover of Brookhaven National Laboratory, "a spectacular experimental signature." According to Foster, the IMB experiment sees no neutron oscillations. Neither does an experiment set up in Homestake Mine in South Dakota by Michael L. Cherry of the University of Pennsylvania and four others reported in the May 2 PHYSICAL REVIEW LETTERS. The latter result enabled Dover and co-workers to calculate that the lifetime against oscillation for a neutron free in space must be more than 40 million to 60 million seconds (about 2 months).

Another prediction of GUTs is the existence of magnetic monopoles, single north or south poles existing in isolation. (Ordinary magnets are always at least dipoles). Here too there is one possible observation, by Blas Cabrera of Stanford University (SN: 5/15/82, p. 323). Cabrera has continued to experiment with better equipment but has not seen another instance. He and others continue to look.

David Cline of the University of Wisconsin in Madison intends to look for monopoles in iron ore from Minnesota. The company that owns the processing plant where the experiment will be done is not only happy to have the physicists, it foresees a commercial use of monopoles. This may not be so wild, Cline says. If monopoles and antimonopoles can be made to annihilate each other, they could be a source of energy. —*D. E. Thomsen*