INSIDE THE PROTON

Another level of structure

Every time physicists have thought they had discovered a fundamental indivisible entity, they have found out that they were fooling themselves. The word atom means indivisible, but it was already apparent at the beginning of this century that atoms can be divided into nuclei and electrons.

Then, in the 1930's it was confirmed that the nucleus can be divided into neutrons and protons.

Nowadays the question recurs on the protons and neutrons: Can a proton or neutron be divided into subparticles that have some identity or existence of their own?

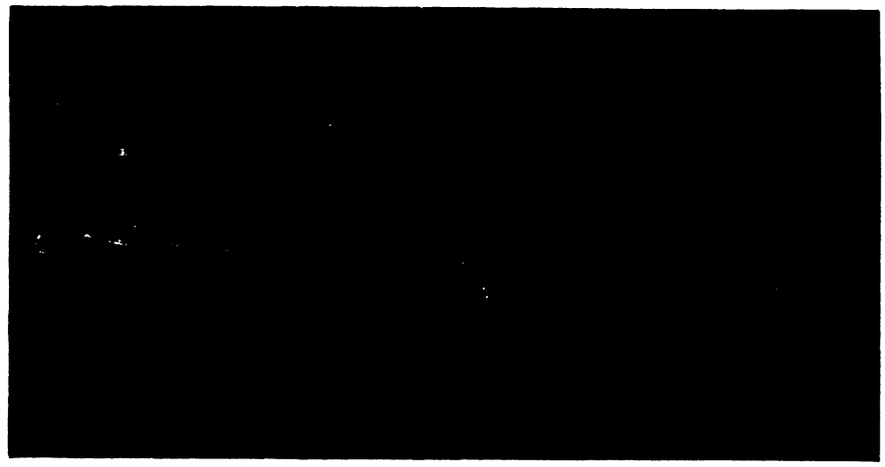
Theoretically the answer is yes. According to the most popular current theory of elementary particles each proton or neutron is made of three subparticles called quarks, which conceivably could exist independently. A claim to the discovery of a free quark has been made, but it is not generally accepted, and the consensus of physicists seems to be that no one has yet seen a quark leading an independent existence.

While some physicists have been looking for free quarks, others have been testing the hypothesis of internal structure in particles by probing the proton and neutron directly. Gradually the experimental evidence is showing that there is structure inside the neutron and proton, but whether it corresponds to that predicted by the quark theory is by no means clear.

The first such evidence came from what is called deep inelastic scattering of electrons by protons and neutrons. Deep inelastic scattering is a collision in which an impinging beam of electrons penetrates to the interior of the neutron or proton target rather than bouncing off the surface. In several experiments the electrons have come out looking as if they had bounced off distinct parts of the target instead of having their paths bent by the influence of the proton or neutron as a whole.

The people who did the inelastic scattering experiments coined the word parton as a name for the pieces of the larger particle (SN: 8/30/69, p. 164). They left the nature of the partons vague and their possible conection with quarks uncertain because the electrons do not give much information about the nature of the partons.

New experiments, in which protons were probed with pi mesons and gamma rays, were reported to last week's meeting of the American Physical Society in Washington. They not only confirm the existence of structure within the proton, but, say the reporters, Drs. V. P. Kenney of the University of Notre Dame and W. P. Swanson of the Stanford Linear Accelerator Center they have succeeded in knocking pieces off it.



V. P. Kenney

Proton fragmentation: A pion strikes a proton; a spatter of pions emerges.

Dr. Kenney's experiment, which was done at Brookhaven National Laboratory, struck high-energy pi mesons against a target of protons. When a pi meson collided with a proton, a particular pattern of pi mesons emerged from the collision. This pattern had the same shape whether the energy of the incoming pi mesons was 18.5 billion electron-volts (GeV) or 8 GeV. The sameness of the pattern is regarded as proof that the impinging pi meson penetrated deeply into the proton and found structure there.

The pi mesons that come out, says Dr. Kenney, are not particles created out of the energy of the impinging particle nor are they something emitted by the proton to meet the impinging particle. They represent, he says, pieces of the proton knocked out by the penetrating particle.

Dr. Kenney refers to this interaction as "the fragmentation of the proton." Nevertheless a particle remains behind that still has all the characteristics of a proton even though small pieces of it have been knocked away. The pi mesons are in themselves nothing unusual, and they do not reveal the nature of the structure whose existence they confirm. It could be quarks or partons or something quite different from either of those. Any structure would result in a pattern of emerging particles that did not change with energy.

The SLAC experiment sent beams of gamma rays with energies up to 18 GeV (wavelengths of 10^{-15} centimeters) against protons. Again pi mesons emerged, and again the pattern was the same regardless of the energy of the incoming gamma rays. Dr. Swanson draws the same conclusion as Dr. Kenney. "We think we're inside the proton for the first time," he says.

A further experiment, this one using mu mesons to get into protons, is planned by a group from SLAC and the University of California at Santa Cruz, says Dr. Swanson. Ultimately the use of probe particles with different characteristics may reveal more details of the nature of the proton's structure. □

PSYCHOLOGY

May Day at the APA

With a reference to the "high feelings and turbulence that attended our annual meeting in San Francisco in the wake of the Cambodian invasion and Kent State tragedy," the 124th annual meeting of the American Psychiatric Association opened this week in Washington, D.C. The speaker was APA president Dr. Robert S. Garber, director of the Carrier Clinic in Belle Mead, N.J. His topic was "The Proper Business of Psychiatry" and, as last year, the issue was again in question. Can the association discharge its social responsibilities without becoming involved in politics? In answer, Dr. Garber said, "We must bring our professional and scientific judgment to bear on the formation of public policy in areas that relate to mental health."

As he spoke, the third and most active week of the May Day demonstrations against the war in Vietnam was in full swing in Washington. It started calmly enough with a weekend-long rock concert at the Peace City encampment of the demonstrators near the Jefferson Memorial but as the crowd grew, city officials began to fear that threats to close down the Government on Monday by blocking traffic might be made good. At dawn Sunday the camping permit was withdrawn, the concert canceled and the demonstrators scattered throughout the city.

Deprived of leadership, cohesiveness and communications, the protesters were easily defeated. As they congregated at strategic traffic points throughout the city on Monday morning, police, National Guardsmen, soldiers and marines rounded up more than 7,000 of them and herded them off to jails and what some called detention camps

around the city. It was the largest number of persons ever arrested in a single event in the United States.

These actions and the overwhelming presence of helicopters, jeeps and armed troops became the major topics of conversation of the APA convention. With this virtual ringside seat on the battle, some members, in line with Dr. Garber's address, felt it their business to speak out on the possible psychological causes and effects of the situation.

Presenting their views were Dr. B. Perry Ottenberg, professor of psychiatry at the University of Pennsylvania; Dr. Milton H. Miller, head of the psychiatric institute at the University of Wisconsin; Dr. Seymour L. Halleck of the department of student health services at the University of Wisconsin, and Dr. John P. Spiegel, director of the Lemberg Center for the Study of Violence at Brandeis University. They did not speak for the APA as a whole.

The psychiatrists were generally appalled at the inconsistent action on the part of the authorities. Last week police had allowed the Vietnam veterans to camp in a city park after the Supreme Court had ruled that such camping was illegal. This week camping was authorized and then unexpectedly and forcefully denied. This, said Dr. Spiegel, is the type of action found in the homes of delinquent children. The children of inconsistent parents are tempted to test the parents' authority to the limits. These are the kinds of action, says Dr. Miller, "that strengthens the cleavage between the generations."

The psychiatrists recognized the need of the authorities to enforce order but expressed fears over the effects of heavy-handed tactics. After viewing the action at several key trouble spots, they felt that indiscriminate arrests and the dubious use of tear gas could only be harmful to the already frustrated protesters. Dr. Halleck suggested that the Government should employ the services of people like himself in these situations. Observers should be on hand to ensure the civil and psychological rights of those involved and to help work out creative solutions to the problems.

At the Tuesday business meeting of the APA Dr. Isidore Ziferstein of the neuropsychiatric institute at the University of California School of Medicine in Los Angeles said that what happened "is anti-therapeutic in terms of the mental health of our youth." He suggested that "a mature, adult response on the part of Government officials should have been to acknowledge the legitimate aims of these young people . . . and to discuss with them those issues in which they have a life-and-death interest."

He proposed that the APA adopt a resolution stating that, "We, as psychiatrists, have a responsibility to point out to our Government officials the anti health effects of such a response." His resolution was defeated. □

HARD TIMES

Drought, land and ecology

The economic, social and ecological problems of the semiarid Great Plains states are, in their own way, as serious as those of Appalachia, but not nearly so publicized. Americans remember the travails of John Steinbeck's Joads in California, but they tend to forget the drought and related economic problems of the Great Plains that drove these heroes of "Grapes of Wrath" away from their Oklahoma land.

Life on the Great Plains is still hard. And the lessons of the 1930's, although partly learned, did not sink in deeply enough totally to prevent recurrence. There was another drought in the 1950's. Then, in the summer of 1970 a new one started on the plains of Oklahoma, west Texas and eastern New Mexico. The drought continued this year, and the U.S. Department of Agriculture has now pretty much written off this year's dryland wheat crop in the affected area. Seeds did not germinate or, if they did, the parched seedlings could not survive. Although blowing dust from wind erosion does not yet equal the dustbowl of the 1930's, dust is piling up along roads and fencelines.

USDA officials are ranking the drought as the kind that occurs only once in 200 years—far worse than the one of the 1930's. But this time, they say, a considerable percentage of the farmers in the affected area will suffer only the economic loss of their crops during the period of the drought. This is primarily because these farmers used a variety of soil conservation techniques that will save their land. But there is another considerable percentage who did not; USDA says about 2.6 million acres of farmland have suffered long-term ecological damage due to the blowing away of fertile topsoil.

The conservation practices used are well-known by now. They include strip farming of land at right-angles to the prevailing wind; stubble-mulch tillage (leaving the previous crop's stubble to hold the earth in place after cultivation); planting crops such as winter rye to hold soil during this period; growing "shelter belts," lines of trees to serve as windbreaks, and putting marginal cropland into grazing.

Another technique, of course, is to abandon dryland farming and go to irrigation, and at least some of the irrigated farms in the drought-affected area are economically sound in the middle of the drought. But, Lloyd Partain, assistant administrator of USDA's Soil Conservation Service, says in some cases irrigation reservoirs are going dry, too. And in the Texas Panhandle, where much of the irrigation water comes from groundwater sources, the water table is ever declining; in the worst cases water that once was available at 300 feet is now tapped only by drilling to 800 feet.

The reasons why conservation practices were not used on the land USDA says is damaged are complex: The temptation is great to "block farm" large acreages—to plant large blocks of land without strip-cropping. This practice is encouraged by the possibility of using huge tractors and other machinery to mass produce crops, and it is exacerbated by the increasing absentee ownership by corporations formed by well-to-do urbanites who like the special tax writeoffs they get from farm losses (although this problem was somewhat lessened by the latest tax reform law).

But a good part of the problem may be due simply to the hard-scrabble kind of life lived on the Great Plains. As much as a farmer might want to follow good conservation practices, sometimes he is forced by economic necessity to make as much money as he can from this year's crop without regard to the future. Dr. Carl Kraenzel, a rural sociologist at the University of Texas at El Paso, suggests that the increasing prices of urban-produced goods and machinery the farmer must buy to stay in business are squeezing him so hard that he has little choice.

Dr. Kraenzel has formulated a concept he calls "the social cost of space," which states that not only does the aridity of areas such as the Great Plains greatly lessen their productivity compared with more humid areas, but because of underpopulation it also greatly increases other costs. For instance, a large part of the farmer's costs are for shipping machinery from urban centers and for shipping his product back to them. The nation's answer so far has been to let marginal farmers fail and move to urban areas. The drawbacks of this approach are increasingly evident.

The main damage to drought-stricken lands is loss of fertility due to the blowing away of organic materials with topsoil. The lands become even less productive, and the likelihood of failure of farms becomes greater. Dr. Kraenzel suggests the answer may be more widespread use of irrigation, the water to come through giant diversion projects from as far away as northern Canada. But environmentalists are increasingly opposed to such projects and, sometimes, to irrigation itself. □