

## 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?

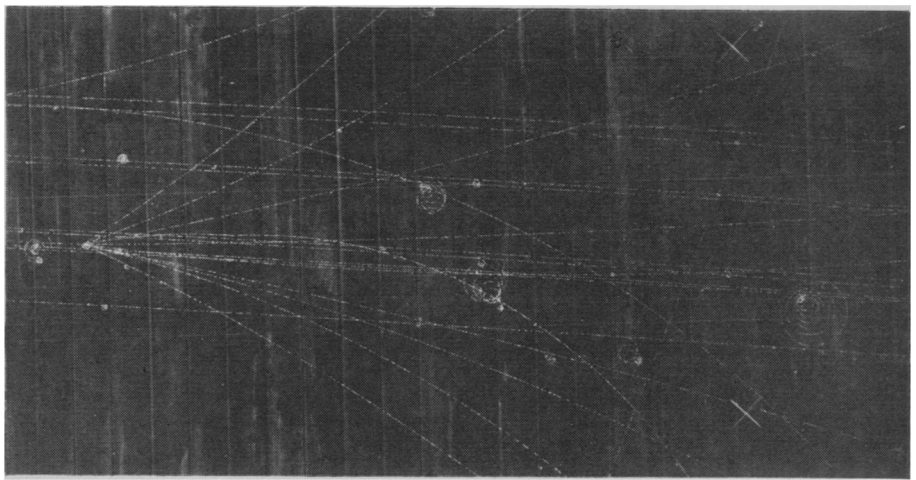
Theoretically the answer is yes. According to the most popular current theory of elementary particles each proton or neutron is made of three subparticles called quarks, which conceivably could exist independently. A claim to the discovery of a free quark has been made, but it is not generally accepted, 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 connection 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



V. P. Kenney

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

Stanford Linear Accelerator Center they have succeeded in knocking pieces off it.

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