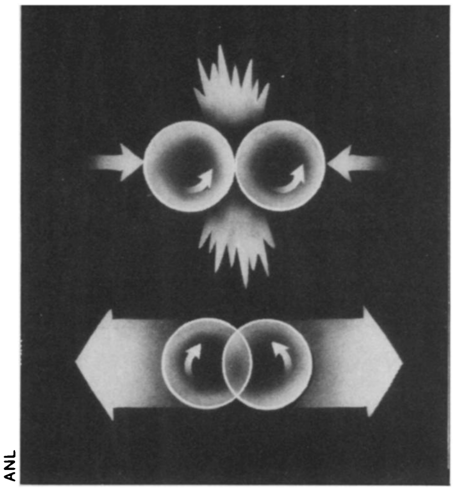
SCIENCE NEWS OF THE WEEK

Proton Spin Surprise


ANL

Spin was one of the first characteristics of subatomic particles that physicists came across. Ubiquitous and plain, it plays small but important roles in atomic and nuclear structure. Generally spin is expected to be responsible for effects that appear more or less like fine tuning. After all, the amount of energy involved in altering the orientation of a spin is small compared to other effects involving the same particle. The spins of protons were expected to have only a small effect on the way one proton bounces off another. Surprise. Spin turns out to have a large and philosophically rather curious effect on how protons bounce.

The experiment that sprung the surprise was done at Argonne National Laboratory near Chicago by J. R. O'Fallon, L. G. Ratner and P. F. Schultz of Argonne; K. Abe, R. C. Fernow, A. D. Krisch, T. A. Mulera, A. J. Salthouse, B. Sandler and K. M. Terwilliger of the University of Michigan; D. G. Crabb of Oxford University, and P. H. Hansen of the Niels Bohr Institute in Copenhagen. Their report is in the Sept. 19 PHYSICAL REVIEW LETTERS.

In the Zero Gradient Synchrotron, Argonne has the world's most energetic facility for producing beams of polarized protons—that is, protons with their spins all oriented more or less in the same direction. Ordinarily the protons in an accelerator's beam have their spins oriented randomly. To polarize them takes special arrangements, but to separate the effects of spin from other factors in a collision experimenters must know which way the spins in the proton beam are going.

The polarized proton beam was struck against a liquid hydrogen target. In the collisions between the beam protons and those in the target, the effects of spin were most pronounced when the bouncing proton came off at a large angle to its original direction. Runs were made at energies of 11.75 billion electron-volts and at the ZGS's maximum of 13.4 billion electron-volts. The combination of high energy and high scattering angle indicates that something rather deep inside the target proton is responsible for the observed effect. That is, rather simply, that protons bounce well off each other when their spins are parallel (axes in the same direction, turning the same way). When the spins are antiparallel (clockwise versus counter-clockwise, for instance), the protons don't even seem to notice each other. They appear to pass right through each other as if they were transparent. Bang! Wow! Balloon full of question marks. The physicists and philosophers who have been asking questions about the materiality of matter will have fun with that.

Meanwhile, leaving natural philosophers to cogitate, the results pose immediate problems to particle theorists. As Krisch told SCIENCE NEWS, the results show clearly that there are some sort of components inside the proton. If that were all, it would be simple. There is other experimental evidence (from different experiments) that supports two different models of the interior of the proton. One of these sees the proton as a hard spinning core surrounded by a softer cloud of charged matter. The other is the famous quark-parton model, which sees the proton as composed of three point-like bodies called quarks.

The quark model is, of course, the beau ideal of current particle theory. It explains not only the proton but nearly all of the more than 100 known particles. Quark theorists have been quite clever in adjusting the theory to cover a number of recent discoveries, some expected, some unexpected. There are theorists who see the quark theory in serious trouble over these proton spin results, because it would have to be the spins of the quarks that were responsible, and quark spins have not taken an important place in the theory before now. However, Krisch points out that the theorists are only beginning to consider what the effects of quark spin might be, and they may be able to come up with a consistent explanation for this. Officially the experimenters do not claim the experiment supports one model for the proton interior over the other. What they do say is that spin has to be important in whichever one is chosen. If everything comes out consistent with the quark model, however, the experiment might say something about the size of quarks. According to Krisch, the highest perpendicular-momentum data translate to a quark diameter of approximately one-third of a fermi.

With such a surprising result at what is nowadays a rather moderate energy, the experimenters are naturally eager to try higher energies in the hope of seeing deeper into the structure of protons and the role of spin in that structure. At the moment there is no location in the world where polarized protons with higher energies are available, but the members of the group are trying to stir interest at other laboratories in the difficult techniques of polarizing proton beams. □

Life on Mars is still a question

Last October, with the Viking landers barely three months into their search for signs of biological activity on Mars, a reporter covering the mission was asked by a friend, "Was it sad when they didn't find life?" Yet there had been no such finding—the issue had been far too complex, ever since the first stunning data curves were recorded in July (SN: 8/7/76, p. 84), for any easy answer. Today, the quandry still exists.

More than a year has passed; the second lander reached the Martian surface on September 3, 1976, following the July 20 arrival of its predecessor. But, as inferred from scientists speaking at a three-day symposium on the question in Boston last week, a lot more work remains to be done.

Opinions are easy enough to come by. Richard S. Young, chief Viking program scientist and director of planetary biology programs for NASA, told the New York Times after the meeting that "we now feel that the biology scenario explaining the Viking results is an extremely unlikely one." On the other side of the fence, Gilbert V. Levin of Biospherics, Inc., in charge of one of the three kinds of biology instruments on the landers, maintains that since many months of attempts at an abiologic explanation have failed to produce an accepted one, "it looks more like biology now than it did a year ago." Numerous such appraisals on both sides have been made during the months since the data began to accumulate. At last week's symposium, which included the Viking experimenters as well as others attempting to account for the results in the laboratory, the "negative" side seemed dominant.

Some researchers, however, feel that both opinions, at this stage of the investigation, are meaningless. It has been said, for example, that "we've explained two of the experiments, so there's only one-third of the way left to go." Yet, points out one Viking scientist, explaining the third part (which, judging from interviews, is not always the same part) may well require totally revamping the explanations of the first two. "It negates all the planning that went into the concept of three differing experiments," he says, particularly since the experiments were, in a sense, designed to operate by conflicting principles (such as oxidation and