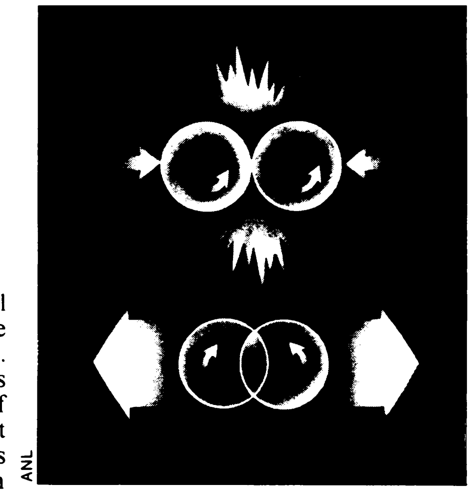
SCIENCE NEWS OF THE WEEK

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 reduction reactions, or with and without terrestrial nutrients).

The tendency to lean one way or the other on the question of Martian life, according to Cornell astronomer and Viking team member Carl Sagan, represents "an intolerance for ambiguity." There are questions for which a partial solution can reasonably be expected to yield valid expectations for the final answer, he says, "but this isn't one."

At the symposium, sponsored by NASA and by the National Academy of Sciences' Space Science Board, several researchers presented results of laboratory experiments attempting to account for aspects of the Viking results. But there were also indications that lack of information-exchange and of coordination has plagued the overall effort. Equipment set-ups were questioned, data were disputed and at least two participants have since said that it will take better organization of the quest, which now spans the United States and beyond.

"I think that [that realization] is the best thing to come out [of the meeting]," says Ichtiaque Rasool, NASA deputy associate administrator for science, who agrees that "the question ... has not been resolved." A "coordinated type of study is needed," he says, and Richard Young is now exploring possible ways to accomplish that. Whether the result will be some kind of centralized panel, charged with making sure that all the researchers know what the others are doing and how, is not yet determined, but even some scientists who have made past statements on the "negative" side have agreed that a well-thought-out approach could help.

There is a further fear among some scientists, including Levin, Sagan and others, that premature views about "leaning away from biology" could lead to a reduction in efforts to find a real answer. Not even Levin, who has long been the "optimist" among the Viking principal biologists, argues that there is life on Mars. He does, however, lament what he calls "a schizophrenia," in which, although the question is unresolved, NASA officials and others "make statements in a non-scientific way ... that the chances for life are unlikely."

One complaint of those who worry that the question is not being kept open is the oft-cited failure of the Viking landers to detect any organic material in the Martian surface material. Some members of Viking's organic-analysis team are said to be angry that they are being "used as a crutch" by some of the biologists, since the instrument, a gas chromatograph/mass spectrometer, is a far less sensitive detector of organic activity than at least one of the biology instruments. The GCMS, says Levin, could see as few as 1 million *E. coli* cells per gram of soil, yet samples have been found in earth's Mojave desert with as few as 100,000—obviously present, yet they would be invisible to the GCMS. □

Breast cancer screening: How, who, when

Breast cancer is the leading cancer killer of women in the United States. But it is much easier to save lives if breast cancer is diagnosed early. Consequently, the National Cancer Institute would like to routinely screen asymptomatic women for this disease in the hope of detecting it in its earliest stages. In fact, since 1973, 250,000 American women have been screened at NCI breast cancer screening demonstration projects at 27 medical centers.

Soon after these projects got off the ground, however, they became embroiled in a controversy: Which screening techniques are effective and safe, and at what age should women be screened (SN: 8/7/76, p. 90)? Last week the NCI convened a three-day meeting to present the latest scientific information on these and related questions and to have a panel of clinicians, lawyers, ethicists and concerned citizens attempt to come up with some answers to them. The panel was headed by Samuel Thier, chairman of internal medicine at Yale University.

The meeting was important for two reasons. It was the first time that the National Institutes of Health had ever organized a meeting to develop a consensus on an issue of clinical significance. Or as NIH Director Donald S. Fredrickson put it, "This is an experiment to quicken decisions about scientific matters with social dimensions." Also, the panel's conclusions and recommendations should influence the health of American women during the next decade. The NCI is taking women's needs and safety into consideration before it decides whether the breast cancer demonstration projects should live out their remaining two-to-three year projected term or whether any other breast cancer screening policy should be implemented.

A number of important findings came out at the meeting:

- The demonstration projects show that early detection of breast cancer is definitely possible. So far, nearly 2,500 cancers have been detected, and 70 percent of them were in the earliest stages.
- Thermography (the use of heat to detect early breast cancers) is not particularly effective in its present stage of technology, the NCI breast cancer demonstration projects show. In contrast, mammography (the use of X-rays to detect early breast tumors) is highly effective, particularly when combined with palpation (manual exploration of the breasts for cancerous lumps). However, mammography undoubtedly also carries the risk of causing—as well as of detecting—breast cancer because cumulative X-ray exposure, at least in doses higher than those used in mammography, has triggered breast cancer (SN: 8/7/76, p. 90).

The question, then, is whether the benefits of early detection by mammography outweigh the potential risks. The only other American breast cancer screening program conducted to date—by the Health Insurance Plan of New York during the 1960s—has shown that mammography, combined with palpation, can help save the lives of breast cancer victims past the age of 50. However, it has not demonstrated the same effectiveness for victims younger than the age of 50. What's more, breast cancer is more likely to occur in women older than the age of 50, and these women will probably be exposed to fewer X-ray screenings than younger women with a longer life ahead of them. Thus, the benefits of mammography appear to outweigh the risks only for women beyond the age of 50, at least in the absence of more firm data on the question. Nonetheless, the levels of radiation used in mammography have fallen sharply since the NCI projects were launched in 1973, and one-fourth of all cancers detected by mammography in the projects have been in women younger than the age of 50. "This raises the important possibility that screening may, in fact, be beneficial under the age of 50 years and that mammography may be a significant factor at all ages," declare Oliver H. Beahrs, a surgeon at the Mayo Clinic, and other scientists who assessed the NCI projects and reported their findings last week.

Based on these and other data, the panel arrived at several conclusions and recommendations:

- The NCI demonstration projects should be completed—at least the routine screening of women past the age of 50. However, women between the ages of 40 and 49 should be screened only if they have a family history of breast cancer, and women from the ages of 35 to 39 should be screened only if they have already had breast cancer. (Similar interim guidelines, in fact, have been in effect since May.)
- Certain ethical mandates should be imposed on the projects since they are partly experimental in nature. These include the use of informed consent forms (already in effect since the summer of 1976) and the requirement that any diagnoses of breast lesions less than one centimeter in diameter be reviewed by two pathologists, rather than one, before treatment is decided on. (About 50 NCI project participants have had their breasts removed unnecessarily because of incorrect diagnoses, the Beahrs group has found.)
- Scientific studies or other efforts should be made to determine the benefit-versus-risk ratio for mammography among women younger than the age of 50 and to explore the true potential of less dangerous detection techniques such as thermography. □