

Spin Conference

The Soviet scientists have pursued their studies of primary cosmic radiation to the maximum energies which, today, represent about 10^{20} electronvolts.

The discovery of the relation between the intensity of primary cosmic radiation at an energy of more than 10^{18} or 10^{19} electronvolts and the direction in which the particles arrive has produced an important new result. Lower energy cosmic rays are diffused in virtually every direction in the galaxy, which may be explained by the confusion of the trajectories of the charged particles in the galactic magnetic fields. The analysis of the experimental data obtained on cosmic rays at the highest energies demanded the combination of measurements made by several large installations in the world.

The first convincing communication concerning the heterogeneous nature of the diffusion of cosmic rays at ultra-high energies was published in the joint paper by the Soviet physicist Dmitri Krassilnikov and his Scottish colleague A. Watson. The flux of cosmic rays in the extreme high energy range arising from the central sector of the galaxy is twice as small as that from the opposite direction. There are excess particles in the flow from the centre of the mass of galaxies closest to our planet. It could be that the high energies of the cosmic rays so far observed are truly limited in the galactic cosmic rays.

(NPA)

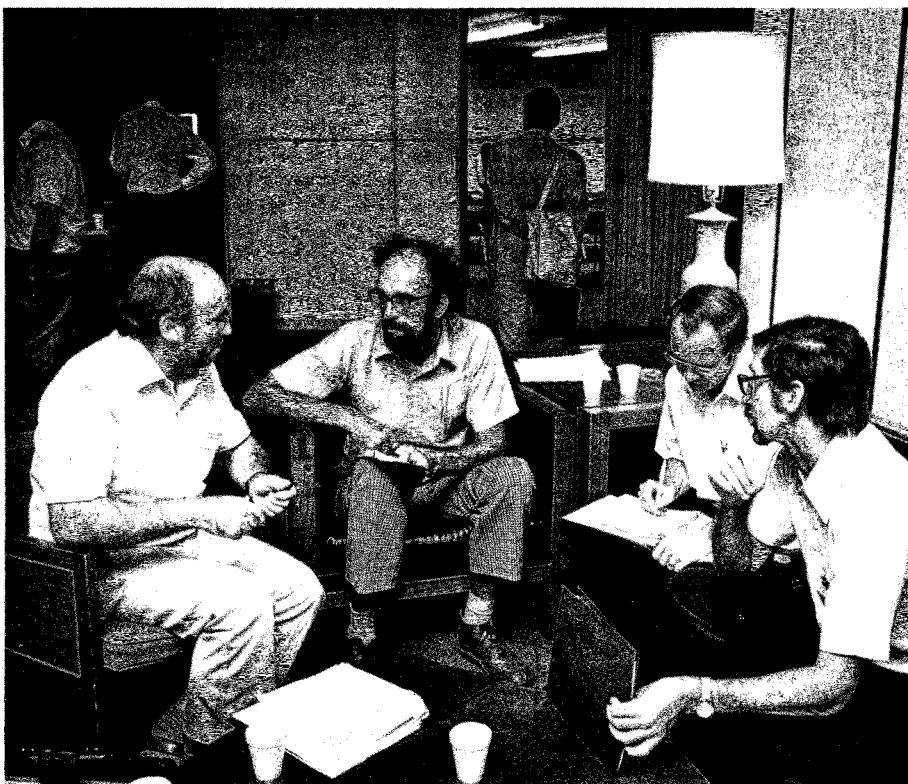
Several participants at the polarized target workshop at the recent International Spin Symposium held at Brookhaven: left to right, Geoff Court of Liverpool, Don Crabb of Michigan, Dan Hill of Argonne and Rick Fernow of Brookhaven.

(Photos Brookhaven)

The 5th International Symposium on High Energy Spin Physics met in September at Brookhaven under the leadership of G.M. Bunce and the sponsorship of the International Spin Committee, chaired by A.D. Krisch of Michigan. The symposium has evolved to include a number of diverse specialities: theory, including parity violations and proposed quantum chromodynamics (QCD) tests with polarized beams; experiment, including the large spin effects discovered in high transverse momentum elastic scattering and hyperon production, dibaryons, and magnetic moments; acceleration and storage of polarized protons and electrons; and development of polarized sources and targets. Over 200 physicists from throughout the world discussed the many large, unusual, and unexplained spin effects which have been discovered in various experiments. The symposium brought

together people who prepare polarized beams and targets with people who do high energy spin experiments and with people who predict what will happen or, with hindsight, explain what happened. Studying spin has been a rewarding but often difficult program, where it is often necessary to know something about many fields besides high energy physics.

The symposium opened with a welcome by Brookhaven Director Nick Samios, who remarked on the appropriateness of holding the conference at Brookhaven, where spin effects will soon be studied in depth with the AGS polarized proton beam. Other early remarks were made by C.N. Yang of Stony Brook, who chaired the first session, and L.H. Thomas, Professor emeritus at North Carolina State University, who offered his recollections of a weekend's work in 1925 that led to his

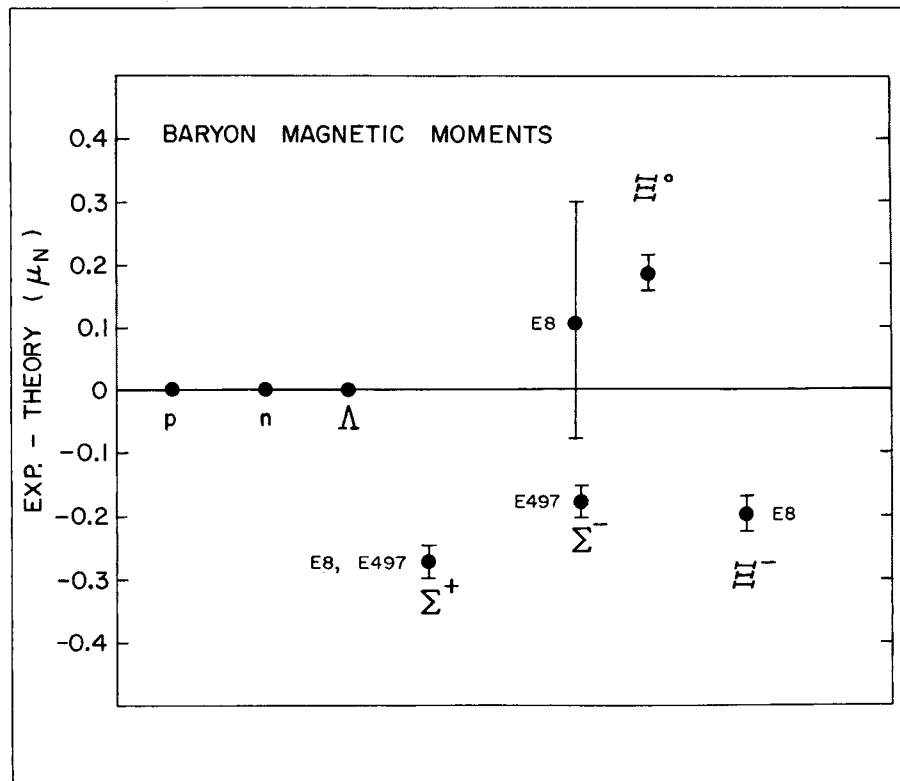


discovery of the Thomas precessional frequency. Yang commented: 'We know something about the effects of spin and we know how to use spin as a tool; but... what is (intrinsic) spin? The whole story isn't in yet'.

The conference included 60 invited talks for both plenary and parallel sessions, and three workshops on theory, on polarized proton acceleration, and on polarized targets. The workshops featured considerable give and take and many contributed papers were presented within the informality of the workshops.

The many new results presented included three measurements of the negative sigma hyperon's magnetic moment, two of the positive sigma's moment, and one of the negative ksi's moment. With many of the experimenters and theorists who have studied baryon moments present, there was a very lively parallel session. L. Pondrom of Wisconsin summarized the situation by applying the quark model to predict the hyperon moments using the proton, neutron, and lambda moments as input. The hyperon moments are typically a quarter of a nuclear magneton away from simple calculations. Few patches are available that don't end up with more parameters than data. In any case, experiments are now much better than theory and Pondrom stressed that many experimenters would like to understand the relationship between the quark mass and the quark moments obtained from these baryon moments. For the future, C. Rebbi of Brookhaven mentioned recent attempts by theorists to predict moments using lattice gauge calculations. Results have so far come within a factor of two.

There were several new results on hyperon polarization, and theoretical discussion centred on how to explain this with QCD. The effect, first re-



The baryon magnetic moment puzzle. Using the observed proton, neutron and lambda moments as input, the predictions for other hyperons do not agree with the observed values. The vertical scale is in nuclear magnetons and E8 and E497 refer to Fermilab experiments.

ported in 1976 for lambdas at Fermilab, has now been seen with other hyperons at CERN (ISR and PS), Brookhaven, Fermilab and now KEK. It is remarkably independent of energy, and now apparently transverse momentum as well. B. Lundberg of the Wisconsin / Michigan / Rutgers / Minnesota group reported a large lambda polarization at 3.5 GeV transverse momentum, the same as seen at 1 GeV. This is not predicted by QCD and is difficult to explain, particularly as it persists to large transverse momentum.

One of the highlights of the symposium was a talk by R.D. Kulsrud of the Princeton Plasma Physics Laboratory. He described the possibility of improving fusion in a Tokamak by polarizing the deuterium and tritium nuclei. The idea was recently suggested by M. Goldhaber of Brookhaven and looks very promising. By polarizing the nuclei the fusion rate

may be enhanced by about 50 per cent and the neutron background reduced by perhaps a factor of ten. Many of the techniques developed by the symposium participants might be applicable, and there was pleasure and considerable surprise that spin might help to produce energy.

New dibaryon results came from Saturne, SIN, Los Alamos, Argonne, and Dubna. This exciting topic, which started with the early Argonne experiment, has become one of the liveliest areas of intermediate energy physics. A session on parity violation discussed a new Los Alamos result for the total cross-section of longitudinally polarized protons incident on a water target, a Zurich measurement of parity violation in nuclear physics, and atomic parity violation. The earlier large result at 6 GeV from an experiment at Argonne is a factor of ten higher than both lower energy data and theoretic-

International Spin Committee members Gus Voss (left) and Alan Krisch enjoy some lighter spin moments.



cal estimates and may imply an energy dependence of parity violation.

A number of theoretical suggestions for testing quantum chromodynamics were put forward, as discussed in the theory workshop chaired by K. Heller of Minnesota and J. Soffer of Marseille. Polarization in hyperon production is still a topical subject and, according to the Lund picture, its underlying mechanism is caused by colour confinement. The large and still unexplained spin-dependent asymmetries in high transverse momentum proton-proton elastic scattering was another very active topic of discussion. The importance of producing phases in perturbative QCD was reaffirmed with the new 'Coulomb-Chromophase Model' which generates a natural energy dependent phase for Drell-Yan processes and for proton-proton elastic scattering. Spin experiments can reveal the existence of such a phase, which is calculable. A vast list of QCD predictions for the large transverse momentum production of various particles now shows the importance of using polarized beams at high energies to learn about spin properties of hadron constituents and to test the electroweak theory.

There was also considerable interest in colliding polarized electrons on polarized protons to study the spin structure of the proton. J. D. Bjorken

of Fermilab stressed that the polarization carried by the quarks, antiquarks and gluons could be studied at the proposed HERA machine at DESY using polarized protons, while polarized electrons allow searches for right-handed currents. There are plans at Stanford to use the proposed SLC linear collider with polarized electrons to produce polarized Z^0 intermediate bosons, which should show increased charge asymmetries. Spin tests would be highly sensitive to any heavier such bosons. Polarized electrons also offer the most sensitive measurement of the electroweak mixing parameter (the Weinberg angle).

These experiments require intense polarized lepton beams and the polarization must be maintained at high energy. G. A. Voss of DESY discussed the electron polarization workshop at DESY last spring. He also described the polarized colliding electron-positron beams at PETRA where polarization of about 80 per cent has recently been achieved with good luminosity at the maximum energy. For protons, a device called a Siberian snake should maintain the polarization within a storage ring up to about 1 TeV, according to E. D. Courant of Brookhaven. High intensity and high energy are both important, and a polarized atomic hydrogen source discussed in an elegant lecture by D. Kleppner of MIT is

a strong candidate to provide polarized intensities equivalent to unpolarized proton sources. T. O. Niinikoski of CERN in summarizing the technical side said 'It looks very promising that polarized luminosities will be the same as for unpolarized beams.'

The Workshop on Polarized Proton Targets was organized by D. G. Crabb of Michigan and D. A. Hill of Argonne. One active topic of discussion was the increasing use of dilution refrigerators in polarized targets. There was also a very lively discussion on chemically undoped ammonia beads which become polarizable when irradiated. These are now widely used and have high hydrogen content and can be used in high intensity beams. The Workshop participants recalled that this concept was first suggested at the 1978 workshop at Argonne in response to the battering that polarized targets were getting from high intensity beams.

There was also a workshop on polarized proton acceleration organized by Y. Y. Lee of Brookhaven and K. M. Terwilliger of Michigan. This concentrated on spin precession and depolarizing resonances in proton synchrotrons. There were new and surprising data from Saturne II at Saclay which has successfully crossed both imperfection and intrinsic resonances using adiabatic spin flipping (see July/August 1982 issue, page 231). The data were inconsistent with the conventional understanding of spin flip phenomena. When polarized protons were accelerated through strong resonances, the spin of the particles reversed as theory predicted; however, when the resonance strength was increased, they observed depolarization, contradicting simple accelerator theory. The Workshop concluded with a recommendation to the Saturne administration: