with current algebra, has been a remarkably fertile source of important physical results. Every high-energy physicist knows the Adler-Weisberger sum rule giving the correct ratio of the axial-vector and vector coupling constants of beta decay. If a sum rule can be continued to appropriate time-like values of q_1^2 and q_2^2 (in the usual notation), a new kind of sum rule emerges, the "superconvergent" sum rule.

J. J. J. Kokkedee's lectures on "High Energy Scattering of Hadrons" discussed elastic scattering for incident-particle laboratory momentum less than 4 GeV/c in the region of small momentum transfer (forward diffraction peak). Experimental data are available for proton-proton, proton-neutron, antiproton-proton, antiproton-neutron, (positive and negative) kaon-proton and (positive and negative) kaon-neutron reactions. The quark model[5] and the combination of Regge-pole model and current algebra[6] have been quite successful in predicting relations between the various meson-baryon and baryon-baryon cross sections.

Paolo Budini (Trieste) discussed "Algebraic Formulation of Dynamic Problems." This budding procedure uses the "noninvariance" or "dynamic" groups that allow mass splittings from the beginning. Besides nonunitary representations of finite order, recently unitary representations of infinite order have been introduced by several authors. These latter representations were introduced very early (1932!) by Majorana.

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Florida Conferees Discuss Nucleon-Nucleon Interaction

Elastic and inelastic scattering, especially with polarized targets and polarized beams, and related matters like charge symmetry currently occupy the attention of nucleon-nucleon experimentalists. Meanwhile the theorists are looking at elastic-scattering phase shifts, soft-core potentials and various theoretical models. Subjects of this kind came under attack last March at the University of Florida when 93 physicists, 26 of them from foreign countries, met in a conference on nucleon-nucleon interactions.

Experimental. Yuri Kazarinov described recent Dubna measurements of proton-proton and neutron-proton scattering in the 600–650-MeV range. Thanks largely to a long series of proton-proton measurements at Dubna, the scattering matrix for isotopic spin $I = 1$ at 650 MeV is now known with some reliability. Data for the neutron-proton system at this energy are still woefully incomplete, but recent Dubna experiments have included some neutron-proton triple-scattering measurements.

In one of three papers from France A. Michaelowitz (Orsay) described measurements of σ, P and D at 150 MeV and polarization and correlation measurements at 600 MeV. Y. Ducros described P and C_{NN} measurements on polarized targets with the proton synchrotron Saturne at 0.5 and 1.2 GeV. (σ is cross section; P is polarization; D is depolarization and C is spin correlation.)

Philippe Catillon described his 10–25-MeV correlation measurements at Saclay with a polarized target and a polarized cyclotron beam. A new high-current polarized-ion source for the cyclotron will soon be in operation at Saclay.

The conference heard of some other proton-proton work. N. Hoshizaki (Kyoto) reported a new measurement of the 50-MeV differential cross section, and A. Beretvas (Chicago) described recent C_{NN} measurements from 305 to 415 MeV. David Cheng discussed past and future measurements on the Berkeley 184-inch (465-cm) cyclotron. Future Berkeley work will include polarized-target measurements and "conventional" triple-scattering measurements with a polarized beam and an unpolarized target.

The Harwell synchrocyclotron is still actively used for proton-proton and neutron-proton measurements below 150 MeV. C. Whitehead described accurate proton-proton measurements of σ, P and D at 98 MeV and new total neutron-proton cross section measurements below 5 MeV.

Elastic scattering. Five speakers presented phase-shift analyses of nucleon-nucleon elastic scattering data: John K. Perring (Harwell), proton-proton at 50 MeV and both proton-proton and neutron-proton at 25 and 140 MeV; Hoshizaki, proton-proton at 50 MeV; Kazarinov, 9.7, 14.5 and 18.2 MeV; Malcolm MacGregor (Livermore), a recent energy-dependent reanalysis of proton-proton data from 10 to 400 MeV; Gregory Breit (Yale), energy-dependent proton-proton and neutron-proton analyses.

Summarizing these papers one can say that the $I = 1$ phase shifts from 10 to 400 MeV are now well known, and all groups get essentially the same result; $I = 0$ phase shifts are only qualitatively known, and neutron-proton data are barely sufficient to permit a combined proton-proton and neutron-proton phase-shift analysis under assumption of charge independence. The pion-nucleon coupling constant from energy-dependent analyses at Yale and Livermore agrees within the 5% experimental error with the value from pion-nucleon scattering.

One paper from Dubna and two from Florida (by G. Darewych and S. Dutta) discussed nucleon-nucleon-scattering representation with a potential. The innovation is to use a soft core, which appears to give a good fit to nucleon-nucleon elastic scattering and has advantages in going off the

energy shell for nuclear-matter calculations. (A shell is a locus in four-dimensional space on which energy and momentum are conserved.)

Neutrons and charges. Ivo Slaus (Yugoslavia) reviewed experiments designed to measure low-energy neutron-neutron interaction. Although most data support charge symmetry to 1% or better, some appear to indicate about a 3–5% breakdown of charge independence. Leon Heller (Los Alamos) reviewed theoretical aspects of the low-energy proton-proton problem and showed the details of removing all Coulomb effects to test charge symmetry. N. R. Yoder (Michigan State) discussed charge splitting of the $^1S_0$ phase shift, and K. E. Lassila (Iowa State and Finland) discussed the effect of pion lifetimes on the one-pion-exchange potential. W. C. Dickinson (Livermore) described a proposed experiment to measure the neutron-neutron cross section with neutrons from an explosion. P. F. Donovan (Bell Labs) described an experiment carried out at Rutgers in which the final-state proton-neutron interaction from deuteron-proton or proton-deuteron scattering was used to deduce the proton-neutron scattering length. Since his results disagree with the value from free-neutron–proton scattering by several standard deviations, they appear to indicate that deduction of two-body interactions from three-body scattering may not be a valid procedure.

Theoretical models. The Florida conference showed that the dominant trend in models is to the one-boson-exchange model in one or another of many variations. Alex E. S. Green (Florida) described a one-boson model derived from general field-theoretic considerations that gives P, V, S, A and T mesons. Earl L. Lomon (MIT) discussed the boundary-condition model. David Wong (U. of California, San Diego) showed in detail how a model in which the pion gives the long-range force, a scalar (sigma) meson dominates the intermediate-range force and the rho, omega and phi mesons dominate the short range force (less than about 0.3 fermi) gives agreement with elastic nucleon-nucleon scattering data. This rationale is, of course, behind all one-boson-exchange models. R. Tamagaki (Hokkaido) surveyed the past decade of Japanese nuclear-force work, which was instrumental in development of the one-boson-exchange model.

Gabrielle Köpp (Aachen) and T. Ueda (Osaka) both discussed determination of one-boson-exchange coupling constants and masses. Fits to the nucleon-nucleon data give well determined values for the coupling constants but not particularly for the masses. With masses fixed at experimental values, coupling constants are in general agreement with values from other experiments and with predictions from unitary symmetry.

D. V. Bugg (Rutherford) presented an analysis in which real and imaginary parts of Wolfenstein amplitudes for forward scattering were computed from nucleon-nucleon phase shifts up to 660 MeV. These amplitudes were then grouped in various combinations to isolate the pole contributions from crossed channels. The analysis indicates important uncorrelated-pion-exchange effects. L. Ingber (formerly U. of California, San Diego, now Berkeley) discussed a model in which one-boson exchanges were used with the Schrödinger equation to derive a potential that fits nucleon-nucleon scattering data. Then he applied the potential to nuclear-matter calculation.

Inelastic processes. Papers at the Florida meeting on inelastic scattering fell in two categories: pion and bremsstrahlung production. Under pion production Hoshizaki discussed application of the Mandelstam model (based on dominance of the 3,3 interaction in the nucleon-nucleon-pion final state) to phase-shift analyses at 400, 660 and 970 MeV and at 2 and 3 GeV. Kazarinov, using the same model, discussed phase-shift analyses at 660 MeV. R. A. Arndt (formerly Livermore, now Virginia Polytechnic Institute) outlined use of the Amaldi model (based on the Ferrari-Selleri one-pion-exchange model) to carry out a phase-shift analysis at 660 MeV. The three groups get similar results for inelasticity in phase-shift analyses at 660 MeV. Proton-proton data at 660 MeV are just on the borderline of being sufficient for accurate values for the $I = 1$ scattering matrix with the inelasticity handled phenomenologically by means of a model. Neutron-proton data at 660 MeV do not yet permit reliable determination of the $I = 0$ matrix. A paper by Ueda, Watari and coworkers discussed pion production at 1 GeV in the context of a one-boson-exchange model unitarized by a K-matrix formalism.

Seven papers on proton-proton bremsstrahlung production were by D. L. Mason (Oak Ridge), A. H. Cromer (Northeastern), M. J. Sobel (Brooklyn College), Marvin Rich (Los Alamos), William A. Pearce (Rice), G. L. Strobel (U. of California, Davis) and John E. Brolley (Los Alamos). It now appears that a properly made proton-proton bremsstrahlung calculation is in reasonable agreement with experiment. Furthermore low-order

SIGNING IN at nucleon-nucleon conference are (from left) Eugene Wigner (Princeton), Gregory Breit (Yale), L. I. Lapidus (Dubna), and Malcolm MacGregor (Livermore).

terms predominate and rescattering corrections (as calculated, for example, by Virginia Brown, Livermore) are rather small (about 15%). One main interest in this subject, other than in eliminating spurious factors of 2 from the matrix elements, is to see whether the off-shell behavior of the bremsstrahlung process can be a guide to the off-shell behavior in nuclear matter.

Related topics. In a series of invited talks on matters related to nucleon-nucleon problems, U. Amaldi (Rome) discussed various models that can be used to represent pion production in nucleon-nucleon scattering below 1.5 GeV. Steven Moszkowski (UCLA) discussed calculation of nuclear structure with realistic nuclear forces. Elliot Leader (Cambridge) reviewed very-high-energy nucleon-nucleon scattering. Michael Moravscik (Livermore) discussed nucleon-nucleon interaction as a tool for studying general conservation laws, symmetries and scattering-matrix analyticity, and L. I. Lapidus (Dubna) discussed tests of charge, parity and time invariances with polarized targets and polarized proton and antiproton beams. R. J. N. Phillips (Harwell) surveyed nucleon-antinucleon interaction. William D. Walker (Wisconsin) reviewed the evidence on the s-wave isoscalar pion-pion system. Since all one-boson-exchange models require a strong enhancement in this channel (whether as a sigma resonance or a continuum effect) the topic is very pertinent to the nucleon-nucleon problem. E. W. Anderson (Brookhaven) surveyed nucleon isobar production in 30-GeV proton-proton collisions.

Subject matter was limited and the organizing committee (Green, MacGregor and Richard Wilson, Harvard) nearly achieved its objective of having every delegate a speaker.

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The meeting was a topical conference of the American Physical Society and had as sponsors the Air Force Office of Scientific Research, Army Research Office, US Atomic Energy Commission, Office of Naval Research, National Science Foundation and National Aeronautics and Space Administration. Proceedings have appeared in a recent issue of Reviews of Modern Physics.

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