S9. Attenuation of α-γ Angular Correlation of Am^{241} in Liquid-Film Sources.* S. RABOY, T. B. NOVEY, AND V. E. KROHN, *Argonne National Laboratory.*—The anisotropy, $[W(180°)/W(90°)]-1$, of the delayed coincidences from Am^{241} has been measured in $1N HClO_4$ liquid-film sources[1] as a function of the time delay between the emission of the alpha particle and the 60-kev gamma ray. The results show a time-dependent attenuation consistent with the theory of random fluctuations of the electric quadrupole interaction in liquid media, and indicate $A_2=0.14\pm0.03$ and $\lambda_2=(14\pm3)\times10^6$ sec^{-1} in the theoretical formula,[2,3] $w(\theta,t)=[1+A_2\exp(-\lambda_2 t)P_2(\cos\theta)]\exp(-t/\tau_N)$.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

[1] T. B. Novey, Phys. Rev. **96**, 547 (1954).
[2] A. Abragam and R. V. Pond, Phys. Rev. **92**, 943 (1953).
[3] F. Coester, Phys. Rev. **93**, 1304 (1954).

S10. Gyromagnetic Ratio of 6×10^{-8} sec Np^{237} by Angular-Correlation Techniques.* V. E. KROHN, T. B. NOVEY, AND S. RABOY, *Argonne National Laboratory.*—The gyromagnetic ratio of the 6×10^{-8} sec state of Np^{237} has been obtained from measurement of the Am^{241} $\alpha-\gamma$ angular-correlation pattern as a function of a magnetic field applied perpendicularly to the plane defined by the detectors and the $HClO_4$ liquid-film sources. The result obtained was $g=+0.8\pm0.2$ nuclear units.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

S11. Angular Correlation in the Decay of Co^{56}.† J. P. HURLEY, S. W. RUDMAN, AND P. S. JASTRAM, *Washington University.*—The angular correlation distribution has been measured for the cascaded 1.25- and 0.84-Mev gamma rays which follow the decay of Co^{56}, by use of a coincidence spectrometer which combines short resolving time with energy selection, and which permits the coincidence rates corresponding to three different angles to be measured concurrently. Besides the 1.25-Mev photon, four other gamma rays, all of higher energy, are known to be in coincidence with the 0.84-Mev branch. Their contribution to the angular correlation is collectively determined by comparing coincidence rates with the discriminator window set alternately on and just above the 1.25-Mev line. Upon subtraction of the competing rates, the net angular correlation is found to be in good agreement with that computed on the basis of spin assignments of 0–2–4 for the ground state, 0.84- and 2.09-Mev levels in Fe^{56}, with both gamma rays quadrupole.

† Supported in part by the joint program of the Office of Naval Research and the Atomic Energy Commission.

S12. Polarization Correlation in the Decay of Co^{56}.† G. T. WOOD* AND P. S. JASTRAM, *Washington University.*—The polarization-direction correlation has been measured for the 1.25–0.84 Mev gamma-ray cascade which follows the decay of Co^{56}, employing Compton scattering from a liquid scintillator for the polarization detector. A sodium iodide crystal was used for the scintillator in the polarization-insensitive channel in order to provide energy resolution. By setting the discriminator in this channel to select the 1.25-Mev photon, and accepting only those pulses in the scattering counter which corresponded in height to approximately 90-degree deflection of the 0.84-Mev quantum, contributions to the prompt coincidence rates due to competing branches in the Co^{56} decay and other modes of counter-to-counter scattering were effectively eliminated. Using the angular correlation coefficients indicated by the results of the preceding paper, we found the polarization of the 0.84-Mev photon to conform, both in magnitude and direction, with electric quadripole radiation, and, accordingly to lead to an assignment of even parity for the first excited state in Fe^{56}. Similar measurements on other gamma rays in the decay scheme are in progress.

† Supported in part by the joint program of the Office of Naval Research and the U. S. Atomic Energy Commission.
* University Fellow in Physics.

SATURDAY MORNING AT 9:30

New Yorker, North Ballroom

(G. T. REYNOLDS, presiding)

Mesons

T1. Electron Spectrum from Muon Decay. H. J. BRAMSON, *Hughes Aircraft Corporation.*—Work is in progress on bringing into consistent form the results of the many experiments to ascertain the decay spectrum of the mu meson. Using the parameter ρ of the Michel theory to characterize the electron spectrum and adopting the recent value of the mu meson mass reported by Birnbaum and Barkas, a statistically "best" value of ρ from experiments based on the range, momentum, and scattering of the electron will be presented.

T2. Pion-Pair Production in a Nuclear Emulsion. HERMAN YAGODA, *National Institutes of Health.*—The tracks of a π^+ and π^- meson are observed to diverge from a common origin without any other associated tracks. Both particles terminate their range within the confines of a single 1500-micron thick emulsion exposed to cosmic radiation in the stratosphere, and exhibit typical $\pi-\mu$ decay and σ-star formation. The energies of the mesons are 18.0 and 18.7 Mev, respectively, and the angle between the tracks is 120°. The Q value of the event, computed as a two-body decay, is 27.9 Mev. This is not consistent with the decay of neutral theta or zeta mesons. The event may have originated from the decay of a neutral tau meson, $\tau^0\rightarrow\pi^0+\pi^++\pi^-$ for which the Q could vary between 0 and 80 Mev. Other possibilities are the materialization of a pion-pair by photon-Coulomb field interaction, or the collision of a high-energy neutron with a surface neutron of one of the emulsion nuclei.

T3. Photoproduction of Neutral Mesons in H and D.* H. H. BINGHAM, J. C. KECK, AND A. V. TOLLESTRUP, *California Institute of Technology.*—The production of neutral mesons by photons on hydrogen and deuterium is being investigated using the technique of counting the decay photons. A low-temperature high-pressure gas target is exposed to bremsstrahlung from the Caltech synchrotron. The decay photons from neutral mesons are detected in a telescope of three liquid scintillation counters of which the first is in anticoincidence and the second and third in coincidence. A 3/16 in. lead converter is placed alternately before or behind the anticoincidence counter; the difference in counting rate is assumed due to neutral particles, primarily photons, converted in the lead. Counts due to low-energy

photons and neutrons are suppressed by placing an aluminum absorber between the second and third counters. The coincidence resolving time is 10^{-8} sec and both accidental counts and deadtime losses are carefully monitored with a view to obtaining precise results. Measurements are being made at laboratory angles of 30°, 73°, and 140° for synchrotron energies of 300, 400, and 500 Mev. Except at 30°, backgrounds run with the target evacuated are less than three percent. A preliminary reduction of the 73° data gives D to H yield ratios of 1.79 ±0.09, 1.80±0.09, 1.70±0.09 at synchrotron energies of 500, 400, and 300 Mev, respectively.

* This work was supported in part by the U. S. Atomic Energy Commission.

T4. Photoproduction of π^+ Mesons from Hydrogen near Threshold.* J. E. LEISS,† S. PENNER, AND C. S. ROBINSON, *University of Illinois.*—A preliminary experiment[1] has been repeated using a liquid hydrogen target and improved counter geometry. Mesons produced in hydrogen are stopped in a carbon absorber surrounding the target, and the resulting decay positrons counted. The activation curves obtained have been analyzed for the total cross section at 2-Mev intervals from threshold to 180 Mev. The absolute counting efficiency was calculated using a Monte Carlo method and the Illiac digital computer. The maximum uncertainty in this calculated efficiency is believed less than 10 percent. The total cross section σ_T is well fitted by $\sigma T/4\pi\chi=[(1.60\pm0.1)+(1.20\pm0.56)\eta^2]\times10^{-29}$ cm² where the notation is that of Bernardini and Goldwasser.[2] The 90° center-of-mass cross section[3] is well fitted by $\sigma 90°/\chi=[(1.56\pm0.06)+(1.48\pm0.19)\eta^2]\times10^{-29}$ cm²/sterad. The renormalized symmetric coupling constant g and the coupling constant of the Chew cut-off theory f are determined to be $g^2=11.7\pm0.7$ and $f^2=0.069\pm0.004$. The connection with the s-wave scattering phase shifts will be discussed.

* Supported in part by U. S. Office of Naval Research, U. S. Atomic Energy Commission, and National Science Foundation.
† Now at National Bureau of Standards, Washington, D. C.
[1] C. S. Robinson and J. E. Leiss, Phys. Rev. **95**, 638(A) (1954).
[2] G. Bernardini and E. L. Goldwasser, Phys. Rev. **95**, 857 (1954).
[3] J. E. Leiss and C. S. Robinson, Phys. Rev. **95**, 638(A) (1954).

T5. Negative Pions from Neutron Bombardment of Deuterons. MYRON W. KNAPP AND WILSON M. POWELL, *University of California, Berkeley.*—In order to obtain information on the neutron-neutron interaction, a cloud chamber filled with deuterium gas was bombarded with the neutron beam of the Berkeley 184-inch synchrocyclotron. The spectrum[1] of the neutron beam, which is produced by 340-Mev protons on a $2\frac{1}{2}$ inch lithium deuteride target, is peaked at 300 Mev and extends to 340 Mev. The three reactions $d(n,\pi^-p)d$, $d(n,\pi^-pn)p$, and $d(n,\pi^-)\mathrm{He}^3$ were studied. A total of 310 events was examined; the three reactions contributed 208, 80, and 22 events, respectively. Laboratory system angular distributions and energy spectra of the mesons will be presented. This work was performed under the auspices of the United States Atomic Energy Commission.

[1] John De Pangher, Jr., Phys. Rev. **95**, 578 (1954).

T6. Elastic Scattering of Pi Mesons from Nuclei. I.* ROSS WILLIAMS,† WINSLOW BAKER, AIHUD PEVSNER,‡ AND JAMES RAINWATER, *Columbia University.*—The elastic scattering of 78±4 Mev π^- and π^+ mesons from copper has been measured between 20° and 170° with an angular resolution varying from 4° to 10°. A multiple system of double and triple coincidences between four scintillation counters was used to reduce background to a low level. These experimental results, as well as results for the angular distribution of the elastic scattering of 80 and 130-Mev mesons by lithium,[1] will be compared with the shapes predicted by various theories.

* Supported by the joint program of the U. S. Atomic Energy Commission and U. S. Office of Naval Research.
† Now at Paul Rosenberg Associates.
‡ Now at Massachusetts Institute of Technology.
[1] Williams, Pevsner, Rainwater, and Lindenbaum, Phys. Rev. **94**, 765(A) (1954).

T7. Elastic Scattering of Pi Mesons from Nuclei. II.* W. F. BAKER, R. E. WILLIAMS,† AND J. RAINWATER, *Columbia University.*—In order to obtain a quick survey of some of the main features of the elastic (plus near elastic) scattering of ~78-Mev π^+ and π^- mesons for $\theta\geq\sim75°$, the differential scattering cross sections of a number of elements have been measured at a few selected angles. The elements range in Z from 3 to 82 to test the gross dependence on nuclear size. A few different angles were used to see if the dependence of the cross section on A and on the sign of the meson charge varies in a regular or an anomalous manner as the angle of scattering is varied. The results will be presented and their significance discussed.

* Supported by the joint program of the U. S. Atomic Energy Commission and the U. S. Office of Naval Research.
† Now at Paul Rosenberg Associates.

T8. Positive Pion Scattering by Hydrogen at 189 Mev.* U. KRUSE, H. L. ANDERSON, W. C. DAVIDON, AND M. GLICKSMAN, *The University of Chicago.*—Measurements of the angular distribution of positive pions scattered by liquid hydrogen have been carried out at energy 189 Mev. These were for the purpose of making a phase shift analysis carried out to complement the negative pion measurements by Glicksman[1] at 187 Mev. The differential cross sections in millibarns per steradian in the center of mass system were as follows:

Center of mass angle χ (degrees)	Differential cross section (mb/sterad)
40.3	23.3±1.6
75.7	9.0±0.9
106.6	8.9±1.0
133.4	15.7±1.5
157.1	25.6±2.7

Numerical integration of these results gave 195.0±10.8 mb for the total cross section. The same cross section was determined in an independent way by means of a transmission measurement, with the result, 194.1±5.2 mb.

* Research supported by a joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.
[1] M. Glicksman, Phys. Rev. **95**, 1045 (1954).

T9. Absorption of Pions in Carbon and Nitrogen.* P. AMMIRAJU, M. RINEHART, K. C. ROGERS, AND L. M. LEDERMAN, *Columbia University.*—Negative pions were moderated and brought to rest in the gas of the Nevis diffusion cloud chamber, filled consecutively with 2 atmos of ethylene (C_2H_4) and 2 atmos of nitrogen. Using residual range *vs* curvature as criteria for distinguishing stopping π^- and μ^- mesons, we find 88±2 percent of the muon stopping in C_2H_4 undergo β decay. Fifty (±20) percent of the muon absorptions lead to charged particle emission. The star prong distribution of the observed pion stars in ethylene and nitrogen are

Light Nucleus \ No. of Prongs	0	1	2	3	4	5
Carbon (386 stars)	11.7	15.0	24.9	38.8	9.1	0.5
Nitrogen (255 stars)	13.3	17.7	18.8	32.9	14.9	2.4

In carbon, the dominant 3-prong reaction is $\pi^-+C^{12}\rightarrow2\alpha+1p+3n$, while the 4-prong stars predominantly follow the reaction: $\pi^-+C^{12}\rightarrow1\alpha+3p+5n$. The 3-prong stars are