spin sequence:

$$E_I=\frac{\hbar^2}{2\mathcal{J}}[I(I+1)-I_0(I_0+1)];\quad I=I_0,\quad I_0+1,\quad I_0+2,\cdots,$$

where I_0 is the spin of the lowest state in the band.

If one has three adjacent states belonging to a rotational band, it should be possible to calculate I_0 (and therefore I_0+1 and I_0+2) as well as the quantum of rotation, $\hbar^2/2\mathcal{J}$. On this basis the spins of the states reached by Am^{241} α_{60} and Am^{243} α_{75} were calculated to be 2.3 and 2.8, respectively. Since the spins must be half-integral, the closest value is 5/2. This same treatment of Am^{241} data was made by Rasmussen[15] who arrived at similar conclusions for the spin numbers of the excited states. It should be mentioned that the calculated spin number is sensitive to the accuracy of the energies of the states. If the measured energy difference between Am^{241} α_{60} and α_{103} were 44 kev instead of 43 kev, the value obtained for I_0 would have been 2.8 instead of 2.3.

From shell-model considerations, the ground states of Np^{237} and Np^{239} are assigned odd parity. Since the 60-kev and 75-kev transitions are $E1$, the levels belonging to the rotational band have even parity. The spin and parity assignments made on this basis are shown in Fig. 1. The spin number 5/2 for the ground state of Np^{237} is a measured value.[16]

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Cross Sections for *p-p* Scattering at 330 and 225 Mev*

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The total cross sections for scattering of high-energy protons by protons have been directly measured at the full and at one reduced energy of the Berkeley synchrocyclotron. Attenuation of the external proton beam in liquid hydrogen was measured with standard counting techniques in order to check, by an independent method, the results obtained in previous differential scattering experiments.

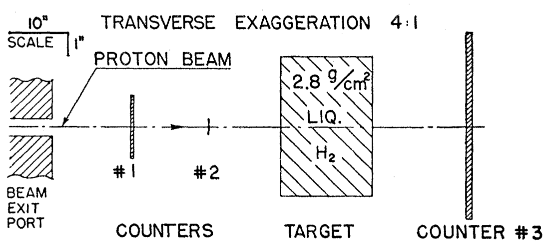

Fig. 1. Schematic diagram of the experimental geometry.

Figure 1 shows the experimental setup. The counting rate of counters 1–2–3 in coincidence was subtracted from the 1–2 coincidence rate and divided by the latter to obtain the attenuation occurring between counters 2 and 3. The difference in this quantity for the target filled with liquid hydrogen and for the empty target is attributed to scattering of the beam through an angle greater than the average half-angle subtended by the rear counter (No. 3).

The experiments were made with the full-energy beam (340 Mev) and at an energy of 240 Mev. Reduction of the beam energy was achieved by inserting $7\frac{1}{8}$ inches of beryllium in the path of the emerging beam before the existing analyzing magnet inside the shielding. Counting difficulties arising from the low duty cycle of the synchrocyclotron were minimized by holding the average external beam level below 10 protons per second. The use of scintillation counters ensured counting efficiencies of substantially 100 percent and also allowed a pulse-height investigation of beam homogeneity. The target is constructed of polystyrene foam.

Thus we have measured directly the attenuation f and may calculate:

$$\sigma_{\text{obs}}=\frac{M(f_H-f_B)}{\rho t[1-\frac{1}{2}(f_H+f_B)]},$$

where the subscripts H and B refer to target filled and empty, respectively, M is the mass of the hydrogen atom, and ρt is the surface density of the liquid hydrogen in the target. The small values of f obtained (not exceeding 0.05) justify the degree of approximation involved in the equation. σ_{obs} is related to the differential scattering cross section through the expression

$$\sigma_{\text{obs}}=\int_{\theta_{\min}}^{90°}\frac{d\sigma}{d\Omega}2\pi\sin\theta d\theta=2\pi\cos\theta_{\min}\left\langle\frac{d\sigma}{d\Omega}\right\rangle_{\text{Av}},$$

where $\theta_{\min}$ is the average half-angle subtended by the rear counter in the center-of-mass system and was varied around 18° in this experiment. It should be noted that this angle is too large to include the Rutherford scattering at either energy, or the small contribution from the inelastic reaction $p+p\rightarrow\pi^++d$ at the full energy. The values obtained were

Mean energy (Mev)	$\langle d\sigma/d\Omega\rangle_{\text{Av}}$ in units of 10^{-27} cm²/sterad
330	3.72 ± 0.15
225	3.56 ± 0.15

The errors shown include statistical and target-thickness uncertainties.

Since previous differential scattering work has shown, for the energies considered here, that $d\sigma/d\Omega$ is essentially constant over the range of angles included in σ_{obs}, $\langle d\sigma/d\Omega\rangle_{\text{Av}}$ may be compared directly with the corresponding differential data. In this comparison our experimental results are consistent with those of a previous paper[1] and those of Marshall *et al.*,[2] but seem at variance with the results of Oxley and Schamberger[3] and Towler.[4]

Extension of this method to a lower energy is planned in the near future, after which a complete report will be submitted.

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Neutral-to-Charge Ratio in High-Energy Interactions*

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One of the problems of primary interest in the study of elementary particles is the determination of their production efficiency as a function of energy. At energies well removed from threshold, cosmic rays furnish the only source of high-energy