meson contribution to the K^+-K^0 mass difference of -4.2 MeV, corresponding to $X=2.4$ MeV.

In conclusion, the scalar meson contribution to the K^+-K^0 mass difference has the right sign to agree with experiment, and, curiously, taken alone it also has the right magnitude. However, when the scalar meson contribution is combined with the other contributions, the sign, but somewhat less than half the magnitude, of the K^+-K^0 mass difference is accounted for. The predicted π^+-π^0 mass difference remains unchanged when the scalar meson contribution is included, and hence the agreement between theory and experiment obtained by previous authors persists.

We started out to explain the π- and K-meson mass differences simultaneously, by exploiting the supermultiplet properties of all particles participating in the interactions, and it is clear that we have been less than perfectly successful: The π-meson mass difference remains much better understood than the K-meson mass difference. If the scalar meson contribution were larger, we would indeed have a satisfactory explanation of both mass differences. One way that this could arise would be if the *nontadpole* contribution to the *intermultiplet* mass differences, neglected in finding the coefficients in Table III, were in fact substantial. The successes of the tadpole theory persist if these nontadpole contributions have octet transformation properties and if, in addition, they preserve the ratio $(\Xi-N)/(\Sigma-\Lambda)$ found in nature. Subject to these constraints, such nontadpole contributions improve our theory either if they split the mesons in the direction opposite to that observed in nature, or if they split the baryons in the same direction as that observed in nature, or if they do both. If nontadpole contributions with these signs exist, that would mean that we had underestimated the ratio of the scalar-meson–pseudoscalar-meson coupling to the scalar-meson–baryon couplings, and therefore had underestimated the tadpole contribution to the K-meson mass difference.

As was shown in Sec. IV, it is possible but very difficult for higher mass intermediate states to conspire to yield the experimental K-meson mass difference without upsetting the π-meson agreement. The tadpole theory, refined in the manner just described, presents an alternative mechanism for explaining the K^+-K^0 mass difference to the same accuracy as the π^+-π^0 mass difference.

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Deuteron Stripping at 3.54 GeV/*c*†

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This paper presents the angle and momentum distributions for protons stripped from deuterons at 3.54 GeV/*c* by aluminum, copper, and lead. The parameters of interest are summarized in the table. Roughly, the results are consistent with a cross section about $\frac{1}{2}$ geometric (where $r=1.22A^{1/3}\times10^{-13}$ cm) and a momentum distribution obtained by transforming the deuteron internal-momentum distribution to the laboratory frame. The results are: d^+ momentum, 3.54 ± 0.100 GeV/*c*; p^+ momentum, 1.77 ± 0.100 GeV/*c*; angle spread (full width at half-maximum) 3°; σ_s(Al), 290 mb±25%; σ_s(Cu), 550 mb±25%; σ_s(Pb), 950 mb±25%.

THIS paper presents the angle and momentum distributions for protons stripped from deuterons at 3.54 GeV/*c* by aluminum, copper, and lead. The parameters of interest are summarized in Table I. Roughly, the results are consistent with a cross section about $\frac{1}{2}$ geometric (where $r=1.22A^{1/3}\times10^{-13}$ cm) and momentum and angle distributions obtained by transforming the deuteron internal-momentum distribution to the laboratory frame (as though the deuteron were a decaying particle).

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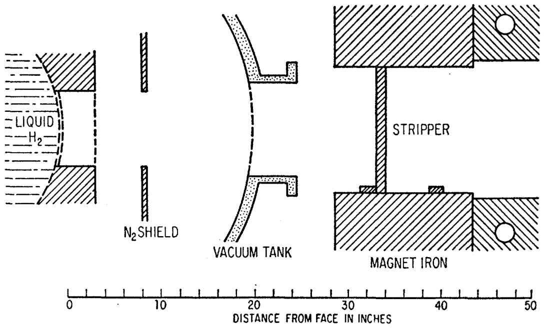

FIG. 1. Schematic drawing of the geometry of bubble chamber (liquid hydrogen) and stripping target (stripper).

TABLE I. Observed cross sections σ_{st} for deuteron stripping at 3.5 GeV/*c* by Al, Cu, and Pb.

Element	Thickness (cm)	Ratio $\frac{\text{stripped protons}}{\text{emerging deuterons}}$	σ_{st} (mb)	
Al	5.9	1/9.1	290	±25%
Al	11	1/5.8		
Cu	2.5	1/8.6	550	
Pb	2.5	1/7.4	950	
Pb	5.1	1/11.8		

The deuterons were produced at the internal target of the AGS and were separated in the Yale-BNL separated beam. The contamination of nondeuterons is estimated to be negligible from a study of the counting rate as a function of separator tuning. Referring to Fig. 1, the deuterons were made to collide with a stripper plate, four feet from the center of the bubble chamber (indicated in Fig. 1 as "liquid H₂").

5000 pictures were taken altogether, using various strippers. Since the tracks of stripped protons were not

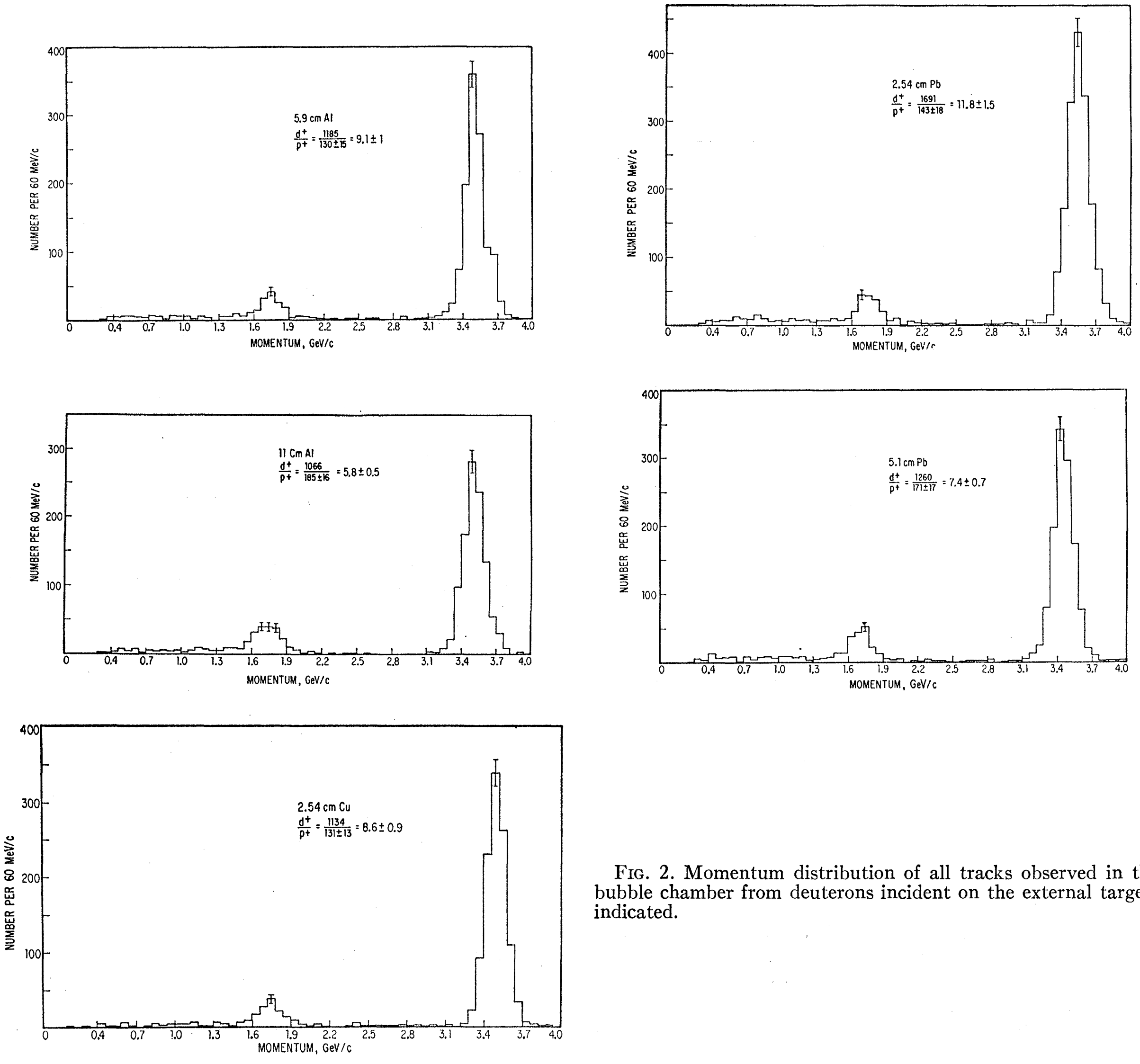

FIG. 2. Momentum distribution of all tracks observed in the bubble chamber from deuterons incident on the external targets indicated.

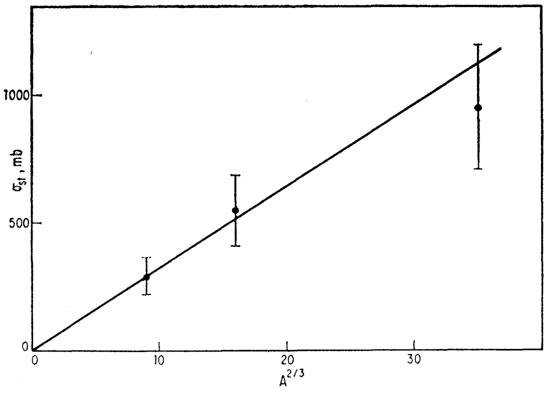

FIG. 3. A plot of σ_{st} versus $A^{2/3}$.

easily distinguished from the deuteron beam on the scanning table, two procedures were used. One procedure was to select pictures with 15 tracks or fewer and measure every track, including beam tracks. This procedure precludes bias but it is too costly in time. The second procedure was to select stripped p^+ on the scanning table with the aid of curvature templates, the difficulty being that some of the stripped protons might have been missed, or that the curvature selection might have introduced an artificial peak at the expected momentum value. The two procedures actually gave equivalent results.

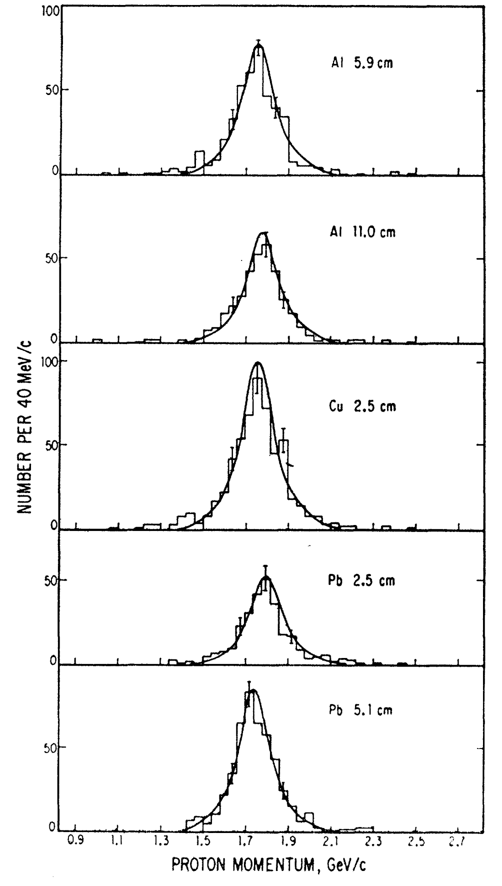

FIG. 4. Momentum distributions of stripped protons. The solid curve is the distribution of proton momenta in the laboratory expected from a deuteron "decaying" in flight with an internal momentum distribution given by the Hulthén function.

The stripped protons have a momentum distribution well separated from the deuterons and the protons from other reactions. The stripped proton distribution is shown in Fig. 2. Table I shows the obtained cross sections, which have been computed taking into account (approximately) the absorption of deuterons and protons while crossing the stripper plate. The stripping cross sections σ_{st} are about one-half the geometric cross section of the nuclei, thus they vary with A as $A^{2/3}$, as shown in Fig. 3. It is notable that σ_{st} (experimental) is about twice as large as that computed by Serber.[1] The fact that such a calculation was intended for a deuteron energy of 200 MeV does not seem to be the reason for the discrepancy. Perhaps the model of the sharply defined, opaque nucleus is the cause of the difference. Possibly, the nucleus has an appreciable area where, perhaps because of low nucleonic density, the stripping process can occur without the absorption of one of the two nucleons. As a consequence, the ratio of σ (absorption of nucleon)/σ_{st} would be different from the value of Serber. It is also possible that this kind of stripping—somewhat similar to that described by Glauber[2]—would produce stripped protons with a momentum spread less than that produced by collisions involving the dense region of the nucleus. In the Serber model, the *minimum* spread expected is that caused by the internal momentum distribution in the deuteron. It is notable that our experimental distribution is *no more* spread than that, as shown in Fig. 4, where the internal momentum (P) distribution of the deuteron is taken to be $|(P^2+ME)^{-1}-(P^2+49ME)^{-1}|^2$ (M = nucleon mass; E = binding energy). Our values for σ_{st} are in substantial agreement with those of the Birmingham group.[3] Our data are not accurate enough to decide on the possible contribution of stripping due to collisions with the Coulomb field of the nucleus. Computing this contribution with the method of Weizsäcker-Williams, we estimate it to be about 20% of the experimental σ_{st} value, for Pb.

The differential cross section for stripping near zero degrees is about 65, 100, and 230 barns per steradian for Al, Cu, and Pb, respectively. Figure 5 shows the angular distributions of the data of Fig. 2 within the range 1.2 to 2.5 GeV/c. The zero is defined as the average of the proton angles. The deuteron beam itself is not suitable as a reference direction because the deuterons and protons bend a different amount in the fringing field between the stripper and the chamber. The protons are

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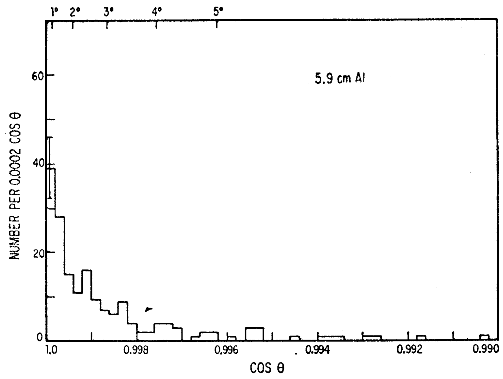
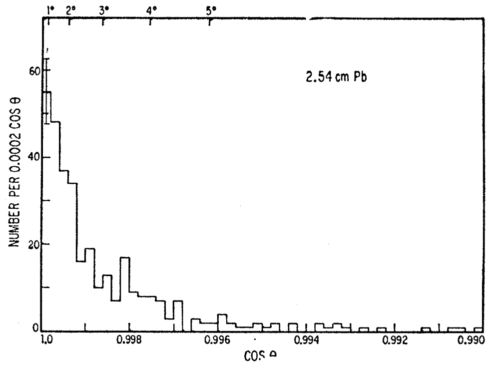
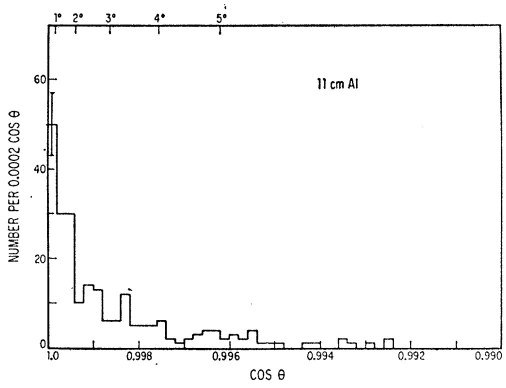
[1] R. Serber, Phys. Rev. **72**, 1008 (1947).

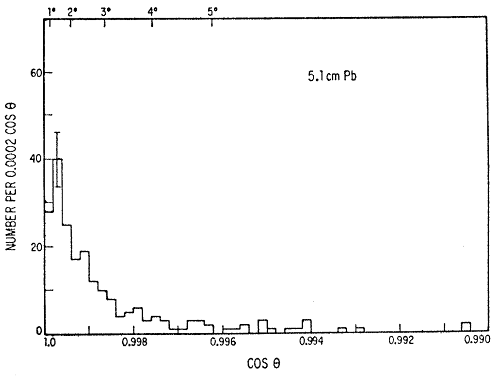
[2] R. J. Glauber, Phys. Rev. **99**, 1515 (1955).

[3] K. R. Chapman, G. Martelli, H. B. van der Raay, D. H. Reading, and R. Rubenstein, Phys. Letters **1**, 168 (1962), and J. D. Jafar, H. B. van der Raay, D. G. Ryan, J. A. Stiegelmair and R. K. Tandon (to be published).









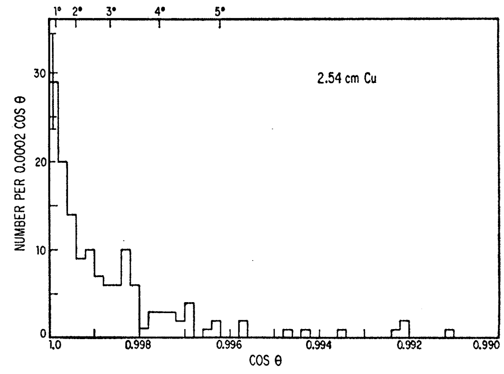


FIG. 5. Angular distribution of stripped protons. The reference direction is defined as the average of the proton directions.

seen to peak forward strongly. These distributions, of course, are broadened by the deuteron beam spread (about 1° full width at half-maximum), the multiple scattering in the stripper (1° to 2° full width), the Coulomb scattering during the stripping collision ($<1°$), and the dispersion (resulting from the momentum spread) when the protons pass through the fringing field of the bubble chamber (about 1°).

If deuterons were accelerated in the AGS (this possibility was the stimulus for the present research) it would, of course, be possible to use stripped neutrons within a narrow solid angle. There the spectrum of the neutrons might be somewhat better (narrower) than the distribution shown in our Fig. 2.

It is a pleasure to thank Dr. Ralph Shutt and his group for the use of the 20-in. bubble chamber.