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August 15, 1962

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# ELASTIC $K^-$-p SCATTERING BETWEEN 700 AND 1400 MeV/c*

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The $K^-$-p total cross section is known to have a peak in the T = 0 state at about 1.05 BeV/c incident $K^-$ momentum.[1,2] Two possible interpretations of this peak are:

(a) The peak is a global symmetry analogue (in the π-hyperon system) of the third π-nucleon resonance.[3] If the KΣN parity is odd, as seems likely,[4] then the resonance should be $F_{5/2}$.

(b) The peak is caused by a rapid rise in the cross section for $K^- + p \rightarrow K^{*-} + p$, via the Ball-Frazer mechanism.[5] If the $K^*$ has spin 1, then Ball and Frazer show how a large peak in the $D_{3/2}$ contribution to the $K^-$-p elastic cross section could arise.

Our experiment consisted of a study of $K^-$-p interactions in the neighborhood of the 1.05 BeV/c resonance, using spark chambers. A variable-momentum $K^-$ beam was selected using gas Cerenkov counters in a secondary beam from the Bevatron. A thin-foil cylindrical spark chamber surrounding a liquid hydrogen target was used to record the angles of the incident $K^-$ and of the outgoing reaction products. A semicylindrical chamber placed downstream, containing

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carbon and steel absorbers, was used to obtain range and polarization information. Segmented tilted mirrors placed behind the chambers provided depth information on the tracks. The incident momentum could be determined for each event to better than 1% by means of spark chambers and a bending magnet.

Of the 360 000 pictures taken during this experiment, about 5% have been scanned for elastic scatters only, by using conventional bubble chamber scanning tables. Only the angles of the three tracks and their stereo images in the small cylindrical chamber were measured for each potential elastic event. Each measured event was fitted to coplanarity and opening–angle requirements, by using a stereographic projection and kinematics tables. About 120 events each at ten different momenta were accepted as elastic scatters in this preliminary sample.

The results of this analysis are shown as center–of–mass differential cross sections in Fig. 1 a–d. These curves have been corrected for the loss of solid angle caused by the ends of the cylinder (approximately a factor of 2). No other corrections have been made. For each curve, the left–hand edge of the horizontal bar on the second point from the left corresponds to the minimum $K^-$ scattering angle accepted. The right–hand edge of the horizontal bar on each right–hand point corresponds to the minimum proton laboratory angle accepted. The points at $\cos\theta = +1$ were computed from:

$$\frac{d\sigma}{d\Omega}\ (0\ \text{deg}) = [\text{Im } F(0\ \text{deg})]^2 + [\text{Re } F(0\ \text{deg})]^2 \quad .$$

The imaginary parts were computed from known total cross sections by the optical theorem, and the real parts from forward dispersion relations. The magnitudes of the $\frac{d\sigma}{d\Omega}$ (0 deg) and the errors are in general dominated by the Im F(0 deg). The errors shown on all points are purely statistical. Corrections up to 20% on some points may have to be made eventually. Recent data from the Lawrence Radiation Laboratory 15-inch bubble chamber are shown for comparison at 1150 MeV/c.[6]

The smooth curves in Fig. 1 a-d are drawn to guide the eye. The points in the intervals $+0.8 < \cos\theta < +1.0$ have been neglected in drawing the curves, since there is reason to believe that severe corrections are required in these intervals. Note that there is a backward peak in this energy region. Also, the cross section near 90 deg seems to have a minimum near the resonance, and the forward peak has a maximum at the resonance (as expected from the total cross sections).

The total elastic cross section, obtained by integrating the curves in Fig. 1 a-d, is shown in Fig. 2 as a function of momentum. The total cross sections from references 1, 2, and 6 are shown for comparison. It can be seen that the elastic cross section follows the behavior of the total cross section. The energy behavior of the integral of $\frac{d\sigma}{d\Omega}$ backward of $\cos\theta = +0.8$ parallels closely the behavior of the total cross sections, as well. The total elastic peak in Fig. 3 is about 8 mb above a background of about 12 mb. However, the momentum resolution of ± 5% has not been unfolded from our results; hence, the total elastic peak may be slightly more pronounced than is shown in Fig. 2.

Fits of the form $\frac{d\sigma}{d\Omega} = \sum_n A_n \cos^n\theta$ were made to the data. The $\chi^2$ test requires $A_5$ to be non-zero at several momenta. The Fisher F test indicates that $A_6$ is probably not needed to fit our present sample at any momentum, although the F probabilities are not really definitive. The situation should improve when all of the data are analyzed. The $A_n$ for the best fifth-order fit are plotted as a function of incident momentum. Both $A_4$ and $A_5$ show statistically significant peaks near the resonant energy.

The best sixth-order fit yields essentially the same peak in $A_5$, but no statistically significant peak in $A_4$.

A non-zero $A_5$ demands the presence of at least F-waves. A peak in $A_5$, if G-wave and higher are neglected, indicates that the resonant state is either $P_{3/2}$, $D_{3/2}$, $D_{5/2}$, $F_{5/2}$, or $F_{7/2}$. If, in addition, $F_{7/2}$ is zero, then the resonance can only be $D_{5/2}$ or $F_{5/2}$. If the fifth order fit is sufficient, then our data—considering all of the $A_n$—are more consistent with spin 5/2 for the resonance than with spin 3/2. However, a definitive statement cannot be made at this time.

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## FIGURE CAPTIONS

Fig. 1. (a-d). Differential cross sections for different momenta.

Fig. 2. Total elastic and total cross sections as a function of momentum. The solid circles refer to the present experiment.

Fig. 3. The coefficients in the cosine series expansion as a function of momentum.

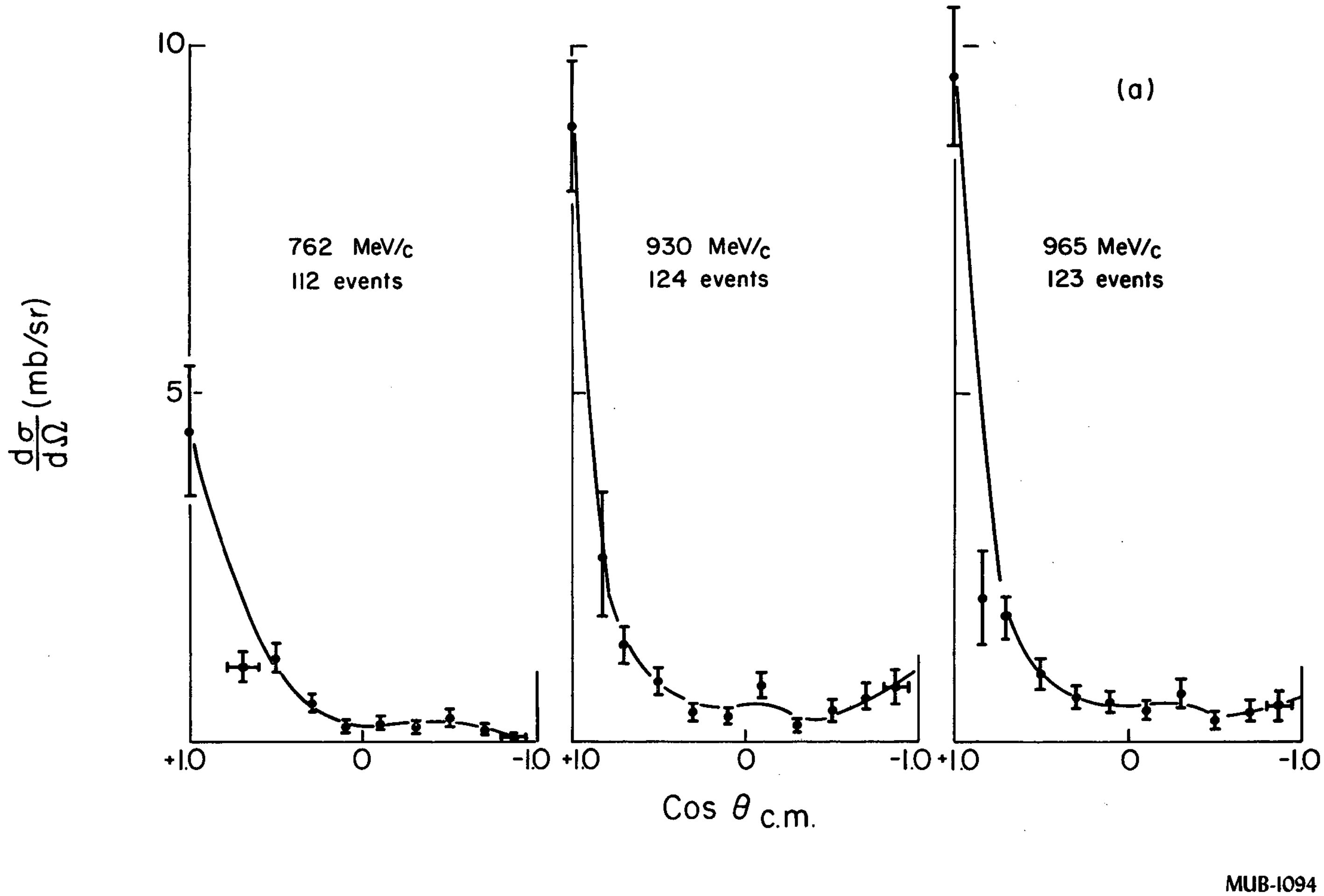

10
5
dσ/dΩ (mb/sr)
762 MeV/c
112 events
930 MeV/c
124 events
965 MeV/c
123 events
(a)
+1.0
0
-1.0
Cos θ c.m.
MUB-1094

Fig. 1a

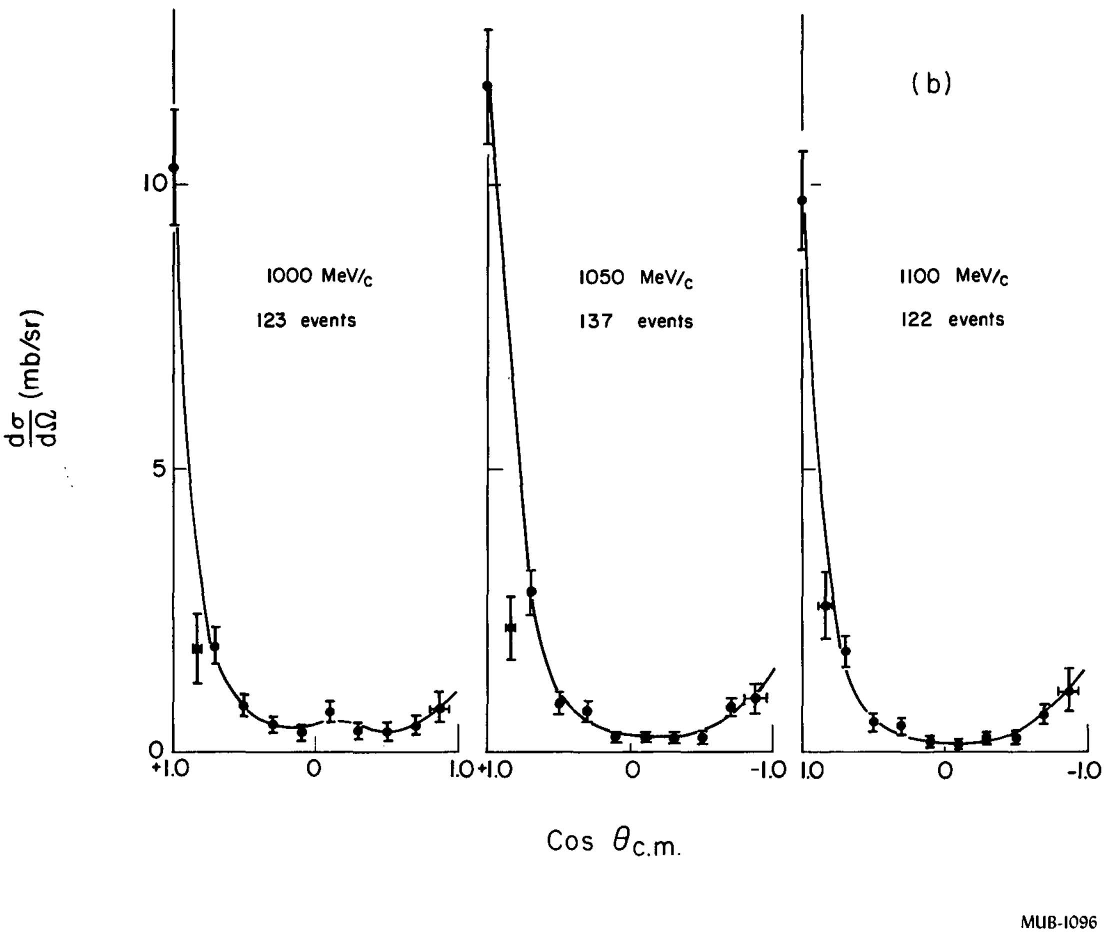
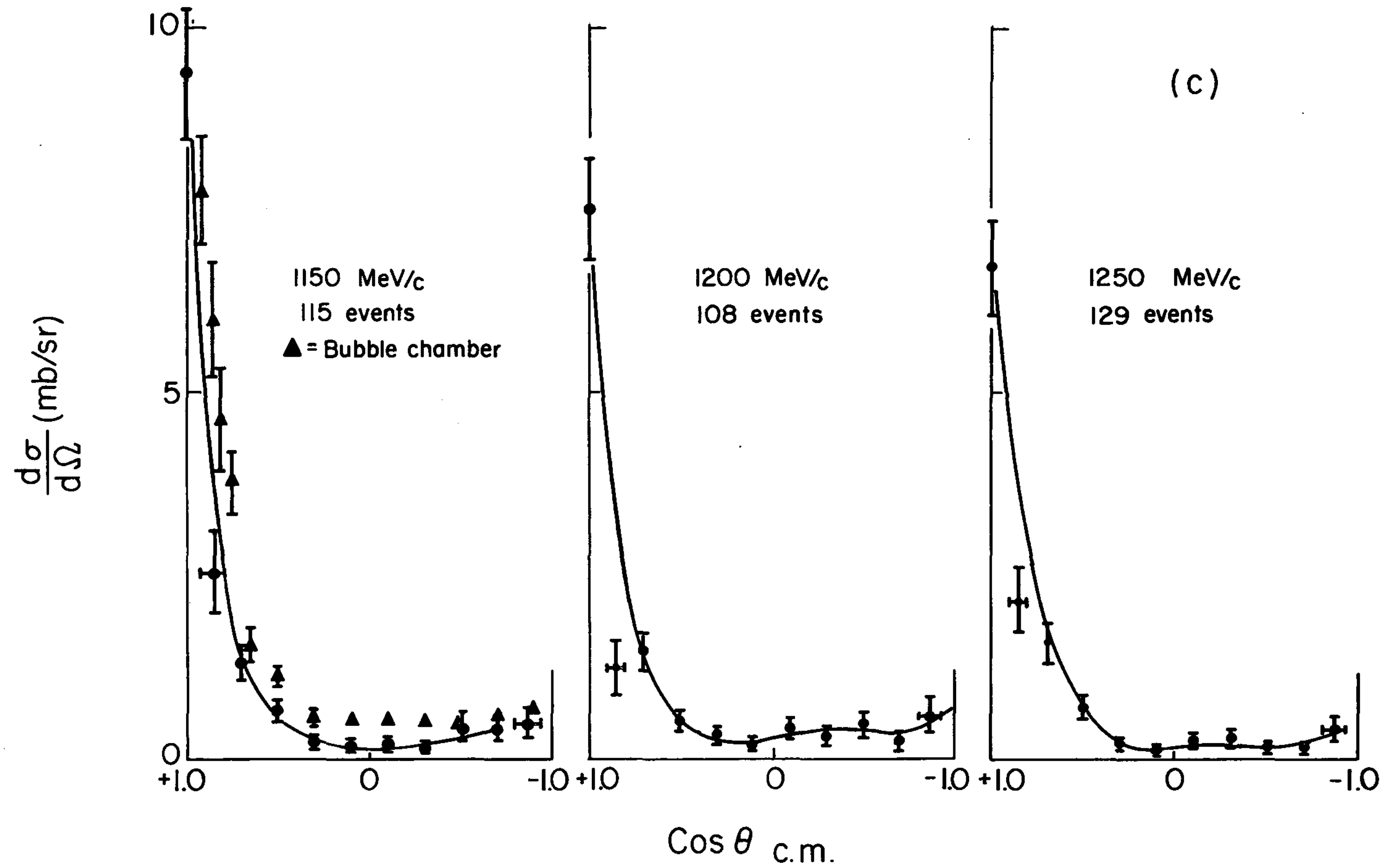

(b)
10
5
0
$\frac{d\sigma}{d\Omega}$ (mb/sr)
1000 MeV/c
123 events
1050 MeV/c
137 events
1100 MeV/c
122 events
+1.0
0
1.0
+1.0
0
-1.0
1.0
0
-1.0
Cos $\theta_{c.m.}$
MUB-1096

Fig. 1b




MUB-1095

Fig. 1c

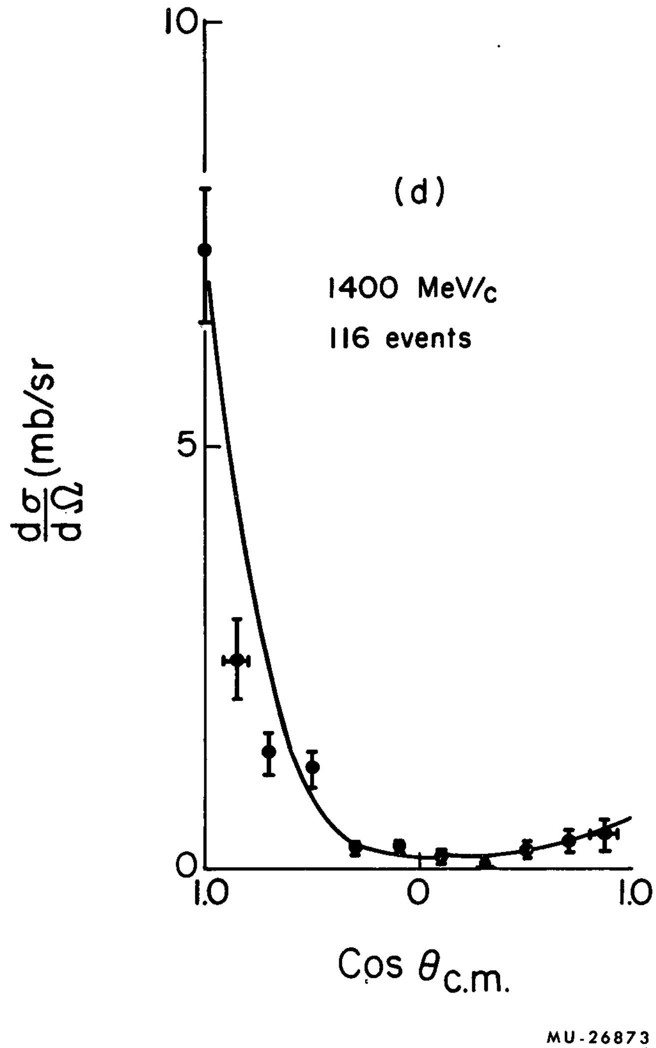
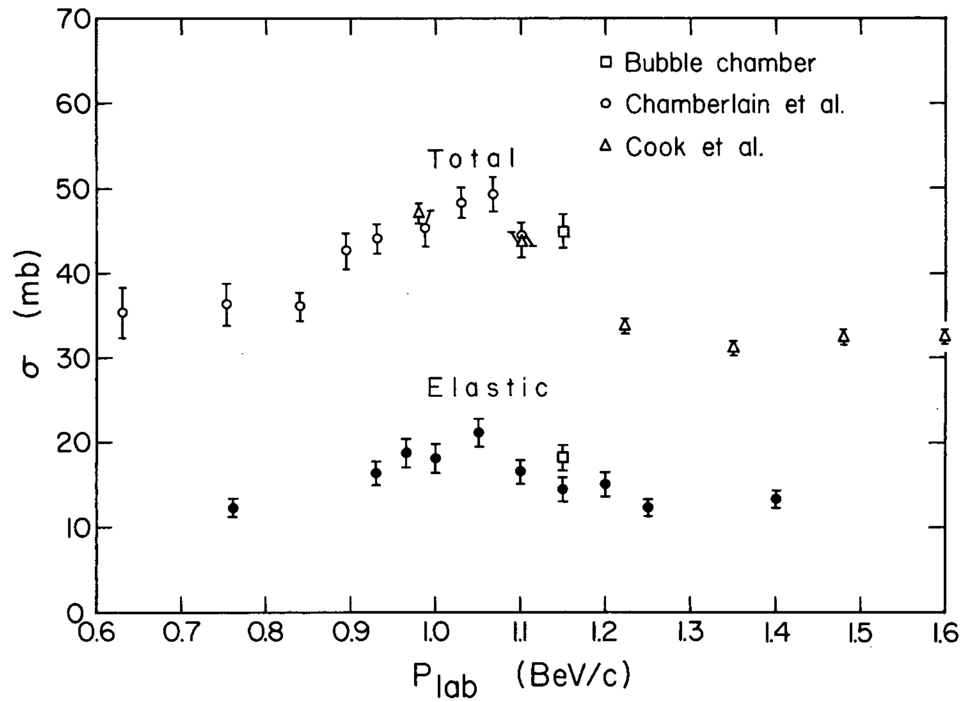



Fig. 1d




MU-26874

Fig. 2

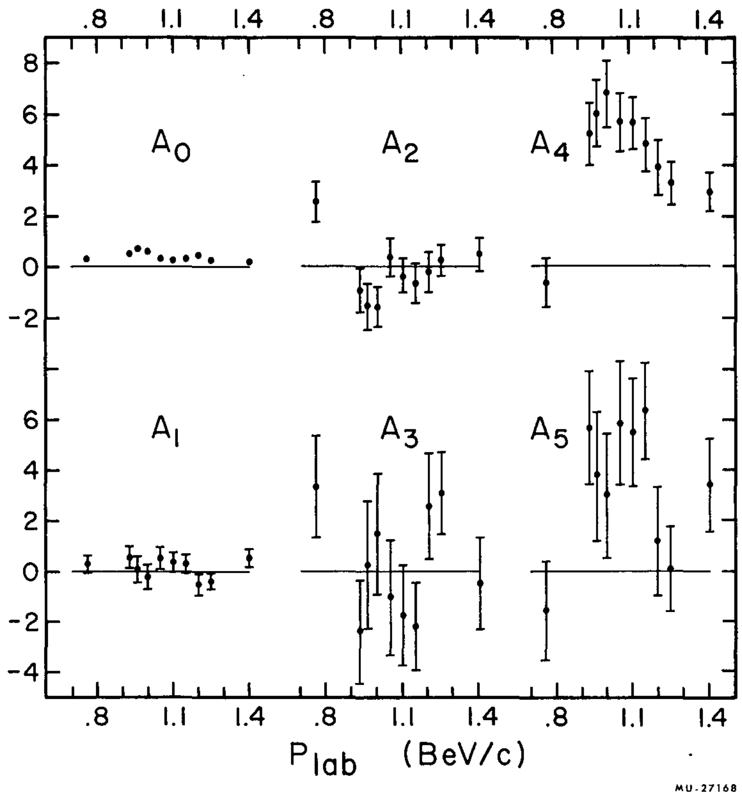



Fig. 3