Presented at the meeting of the
APS Division of Particles & Fields
Seattle, Washington Aug. 26-29, 1975.

Conf-750858--14

BNL-20574

Total Cross Sections of K^-p and K^-d from 411 to 1065 MeV/c*

A.S. Carroll, I-H. Chiang, T.F. Kycia, K.K. Li,
P.O. Mazur, D.N. Michael, P. Mockett,† D.C. Rahm and R. Rubinstein‡

Brookhaven National Laboratory, Upton, N.Y. 11973

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ABSTRACT

Total cross sections of K^-p and K^-d have been measured between 411 and 1065 MeV/c with high statistical precision. In addition to the well known $\Lambda(1690)$, $\Sigma(1765)$ and the $\Sigma(1670)$, the data show indications of several possible structures in both $I = 0$ and $I = 1$ isotopic spin states.

There existed considerable discrepency in the K^-N total cross section data at around 650 MeV/c laboratory momentum where the data of Bugg et al[1] and of Bowen et al[2] overlapped. In order to resolve this discrepancy and to look for possible new structures, we have made a high precision measurement of the total cross sections of K^- on hydrogen and deuterium in the range of laboratory momentum from 411 to 1065 MeV/c.

This was a conventional good geometry transmission experiment using a low energy separated beam at the Brookhaven AGS. Details of the experiment have been published elsewhere.[3] Data were taken at 12.5 and 25 MeV/c intervals with statistical precision of about $\pm$ 0.1 mb. They were analyzed using the procedure as described in previous experiments.[4] The partial cross section as measured by each counter was corrected for decay loss and Coulomb effects. The cross sections were then obtained by using a quadratic fit in extrapolating to zero solid angle.

The cross sections with experimental resolution not yet unfolded are shown in Figs.1 and 2. Shown also are the data from Refs.1,2,and 4. The agreements with the data of Bugg et al are good down to about 650 Mev/c. However, there appears a systematic difference between the present data and that of Bowen et al at low energy. The previously observed structures at laboratory momentum of about 800 and 1030 MeV/c in $\sigma_T(K^-p)$, and about 750 and 1000 MeV/c in $\sigma_T(K^-d)$ are clearly seen. In addition, there are indications of structures at about 600 and 900 in $\sigma_T(K^-p)$, and at about 550 and 850 in $\sigma_T(K^-d)$.

The cross sections of the pure isotopic spin state were computed using the same procedure as in Ref. 4. Results are shown in Fig. 3. The lack of data below about 400 MeV/c made the computation rather uncertain at the very low energy end. In the $I = 0$ cross section the rapid fall of the $\Lambda(1520)$ and the rise of the $\Lambda(1820)$ and the $\Lambda(1690)$ are clearly seen. There are indications for structure at about 680 and 870 MeV/c. The $I = 1$ cross sections show the well known $\Sigma(1765)$ and the $\Sigma(1670)$. It also shows indications for structures at about 540, 600, 660 and 830 MeV/c.

After subtracting the background of the form $A+B/p+Cp$ and the contributions from the $\Lambda(1520)$ and $\Lambda(1820)$ in the $I = 0$, and from the $\Sigma(1765)$ in the $I = 1$ isotopic spin states, the results are shown in Fig. 4. The data were then

*Work performed under the auspices of the Energy Research & Development Administratio
†Present address: University of Washington, Seattle, Washington 98105.
‡Present address: Fermi National Accelerator Laboratory, Batavia, Illinois 60510

fitted to Breit-Wigner functions assuming structures existed at the above mentioned momenta. The results of the fit are shown in Table 1. The heights and widths from such a fit are very sensitive to the background used. It should be pointed out also that except for the Λ(1690), Σ(1580) and the Σ(1670), the other structures appear only after the effect of the Fermi motion in the deuteron was unfolded, and so are less certain.

The fitted parameters of the Λ(1690) agree very well with previous results.[5] The extended energy range and more data points in this experiment allowed a better determination of the parameters of the Σ(1670) which seems to be wider than previously reported.[1] The preliminary results on the Σ(1580) were reported earlier.[6] Since then, a resonance Σ(1580) with spin parity of $\frac{3}{2}^-$ has been reported.[7] Based on the quark shell model and observed structures, Dalitz and Horgan predicted the existence of the structures Λ(1576), Λ(1661), Λ(1715), Σ(1570), Σ(1635), Σ(1656) and Σ(1756)[8] in this energy range.

I	Laboratory Momentum (MeV/c)	Total c.m. energy (MeV)	$4\pi\lambda\!\!\!^{-2}$ (mb)	Height (mb)	(J + 1/2)x	Full Width (MeV)
0	788	1694 ± 4	25.68	12.3	0.48	36 ± 5
1	739	1671 ± 4	28.41	6.5	0.23	59 ± 10
0	875	1735 ± 5	21.85	6.3	0.29	26 ± 8
1	546	1583 ± 4	46.71	2.3	0.05	20 ± 7
0	685	1646 ± 7	32.05	~ 1.3	~ 0.04	~ 25
1	602	1608 ± 5	39.65	~ 1.6	~ 0.04	~ 25
1	657	1633 ± 10	34.33	~ 1.0	~ 0.03	~ 20
1	833	1715 ± 10	23.56	~ 6.1	~ 0.25	~ 20

Table 1. Parameters of structures as derived from best fit to data using a background of A+B/p+Cp and Breit-Wigner shape to all structures.

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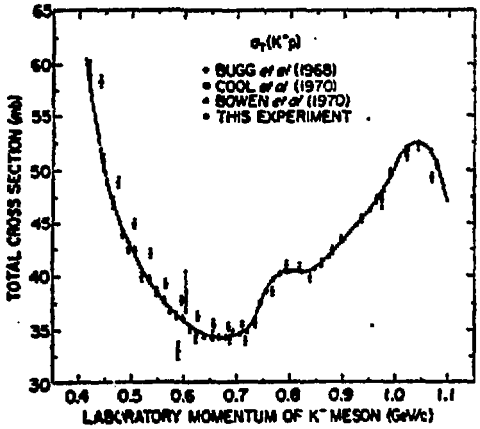

Fig. 1. K^-p total cross sections

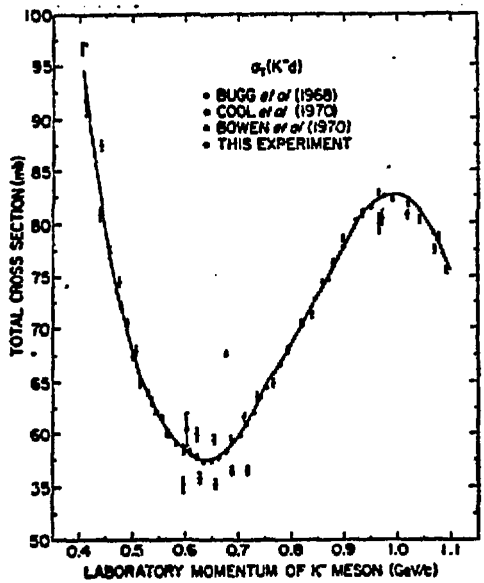

Fig. 2. K^-d total cross sections

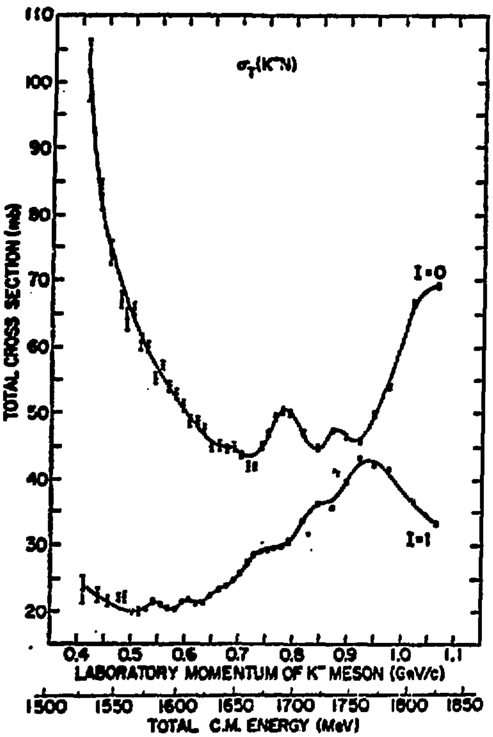

Fig. 3. Total cross sections of the I=0 and I=1 isotopic spin states for the $\bar{K}N$ system. Curves are results of the best fit to the data assuming a Breit-Wigner shape for the structures and a background of A+B/p+Cp.

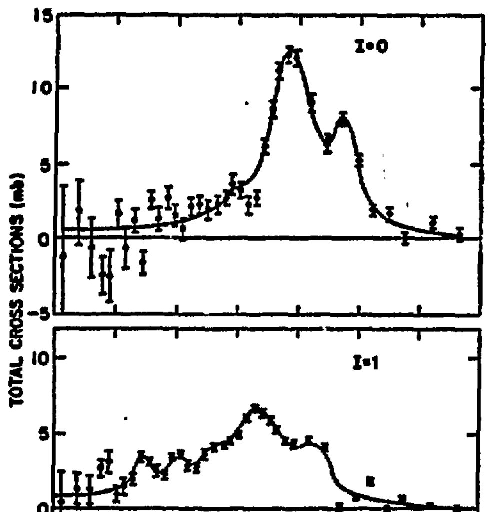

Fig. 4. Results of subtracting the background and the contributions from the Λ(1520) and Λ(1820) in the I=0, and from the Σ(1765) in the I=1 isotopic spin states. Curves are best fit to data assuming a Breit-Wigner shape to all structures.