REPORT ON $\bar{p}p \to K\bar{K}$ AT LOW MOMENTUM

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In this note we report some preliminary results for the reaction:

$$\bar{p}p \to K^+K^- \tag{1}$$

with incident $\bar{p}$ momentum between 300 and 800 MeV/c. These data are part of a bubble chamber study of $\bar{p}p$ interactions at low momentum currently in progress at the University of Wisconsin. Several papers have already appeared on the subject[1)] and we refer to them for the description of the bubble chamber exposure and other experimental details.

The cross-section distribution for reaction (1) is presented in Fig. 1 together with the cross-sections for the following reactions[2)]:

$$\bar{p}p \to K_S^oK_L^o \tag{2}$$

$$\bar{p}p \to K_S^oK_S^o + K_L^oK_L^o \tag{3}$$

$$\bar{p}n \to K^-K^o \tag{4}$$

Our data for reaction (1) are based on a sample of 106 events and have not been corrected for scanning efficiency. The good agreement between our data and the available measurements in the same momentum range corroborate our estimate that such correction should be small.

The data presented in Fig. 1 show some interesting features:

a) Around 300 MeV/c the cross-section for $K_S^oK_L^o$ is equal to that for K^+K^- within errors, while the cross-section for $K_S^oK_S^o + K_L^oK_L^o$ is very small and consistent with being zero.

b) Above 1000 MeV/c the cross-section for $K_S^oK_S^o + K_L^oK_L^o$ rises slowly to the value of the cross-section for $K_S^oK_L^o$.

c) Between 300 and 800 MeV/c something remarkable occurs:
the cross-section for $K_S^oK_L^o$ shows a very sharp structure which has been interpreted elsewhere[1d)] as evidence for a new vector meson with mass 1970 MeV and width 35 MeV[3].
The cross-section for K^+K^- presents a peak around 500 MeV/c just where the $K_S^oK_L^o$ cross-section has a sharp dip.

Each partial wave amplitude for the reactions (1), (2), (3) is of the form:

$$A(\bar{p}p \rightarrow K^+K^-) = A_1^+ + A_0^+ + A_1^- + A_0^-$$

$$A(\bar{p}p \rightarrow K_S^oK_L^o) = A_1^- - A_0^-$$

$$A(\bar{p}p \rightarrow K_S^oK_S^o + K_L^oK_L^o) = A_1^+ - A_0^+$$

where the subscripts stand for the isospin and the superscripts for the C parity. In the $\bar{p}$ momentum range under consideration (300 - 800 MeV/c) the cross-section for reaction (3) is negligible. Therefore, either all the C = +1 amplitudes vanish or the I = 1, C = + amplitudes cancel the I = 0, C = +1 amplitudes in each partial wave. The presence of C = +1 amplitudes would be revealed in reaction (1) by a sizable forward-backward asymmetry. Our data shown in Fig. 2 do not support any significant asymmetry, thus the C = +1 amplitudes are apparently negligible below 800 MeV/c.

Studies of $\bar{p}p$ annihilation at rest show that the rates for reaction (1) and (2) are approximately equal. Furthermore, as noted above, the cross-sections for these reactions are equal at 300 MeV/c. Hence, either one of the C = -1 I-spin amplitudes is negligible or they are 90^o out of phase in each partial wave. At rest the $\bar{p}p$ annihilation rate into $\bar{K}K$ is $1.8 \pm .2 \times 10^{-3}$ while the rate for $\bar{p}n$ annihilation into K^-K^o is[4] $3.2 \pm .8 \times 10^{-3}$. This would indicate that at rest these annihilations occur from a pure I = 1 state since for this case we would expect a value of 2 for the ratio $\bar{p}n \rightarrow K^-K^o/\bar{p}p \rightarrow \bar{K}K$. It is therefore plausible to assume that reactions (1) and (2) below 300 MeV/c are dominated by the isospin 1 amplitude.

With these assumptions the structures observed in the cross-section distribution for reaction (1) and (2) can be interpreted as due to a resonance with isospin zero interfering with a background with isospin one. In support of this interpretation the momentum depen dence of the ratios:

$$R_1 = (\sigma(\bar{p}p \rightarrow K^+K^-) + \sigma(\bar{p}p \rightarrow K^o\bar{K}^o))/\sigma_A$$

$$R_2 = (\sigma(\bar{p}p \rightarrow K^+K^-) - \sigma(\bar{p}p \rightarrow K^o\bar{K}^o))/\sigma_A$$

is given in Fig. 3 where σ_A is the annihilation cross-section. The strength of the interference is illustrated by the sharp structure in the distribution of R_2 while R_1 has a reasonably smooth behavior.

The data for reaction (1) have been fitted to a series of Legendre polynomials. The ratio a_1/a_0 is consistent with zero, Fig. 4, while a_2/a_0 shows a peak around 700 MeV/c implying the presence of at least a $^3D_1$ wave and/or interference with higher partial waves. Given the statistical limitations of the data we cannot determine the spin of this resonance.

This situation may be resolved by a systematic study of reaction (1) (3) to be undertaken by us in Fall 1972 using the Argonne National Laboratory 12' hydrogen bubble chamber.

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3. The vector meson interpretation of the K_SK_L data presented in Ref. 1a must be re-examined in view of the present results.

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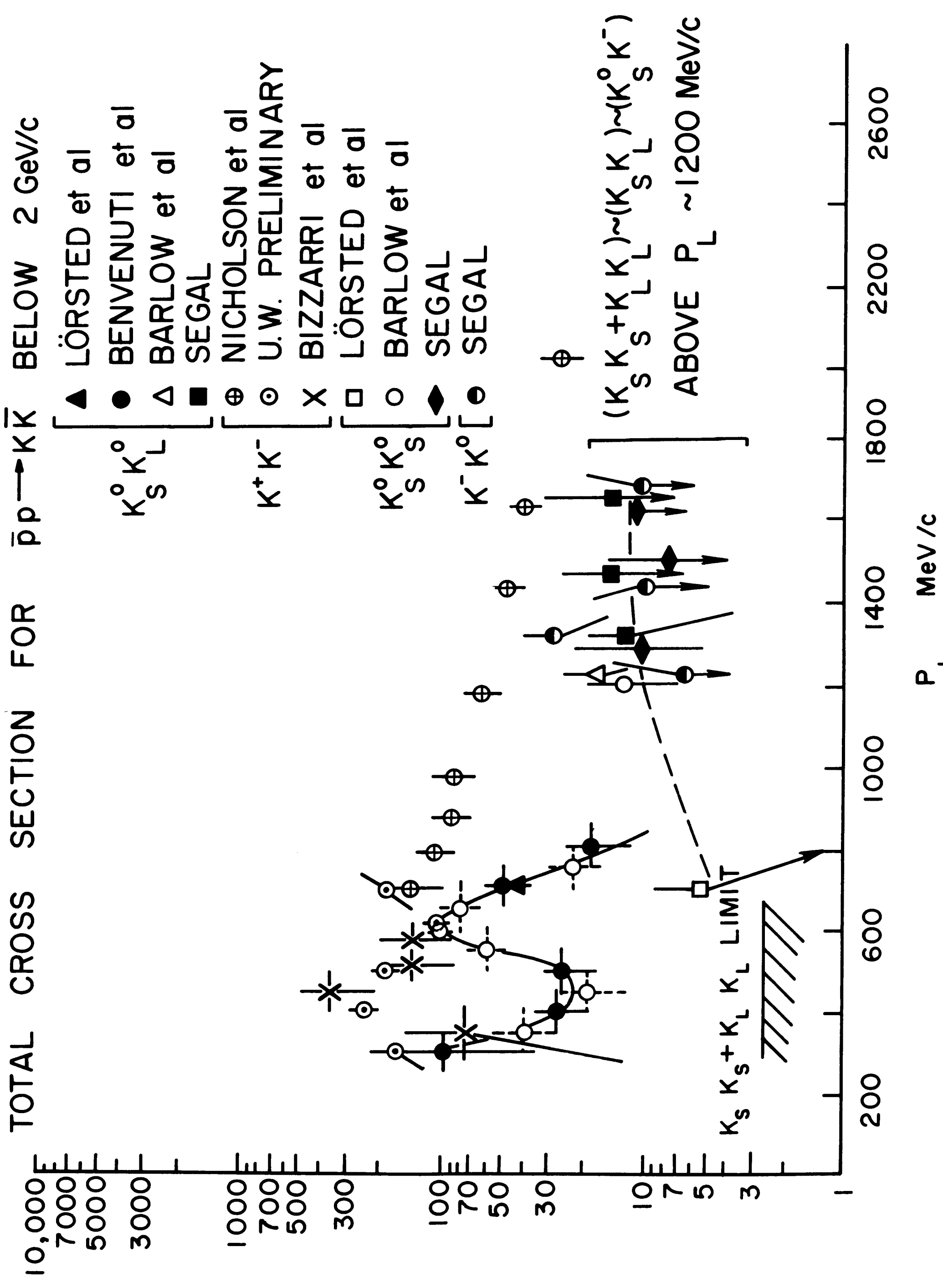

Fig. 1 Total cross-section for $\bar{p}p \rightarrow K\bar{K}$ below 2 GeV/c.

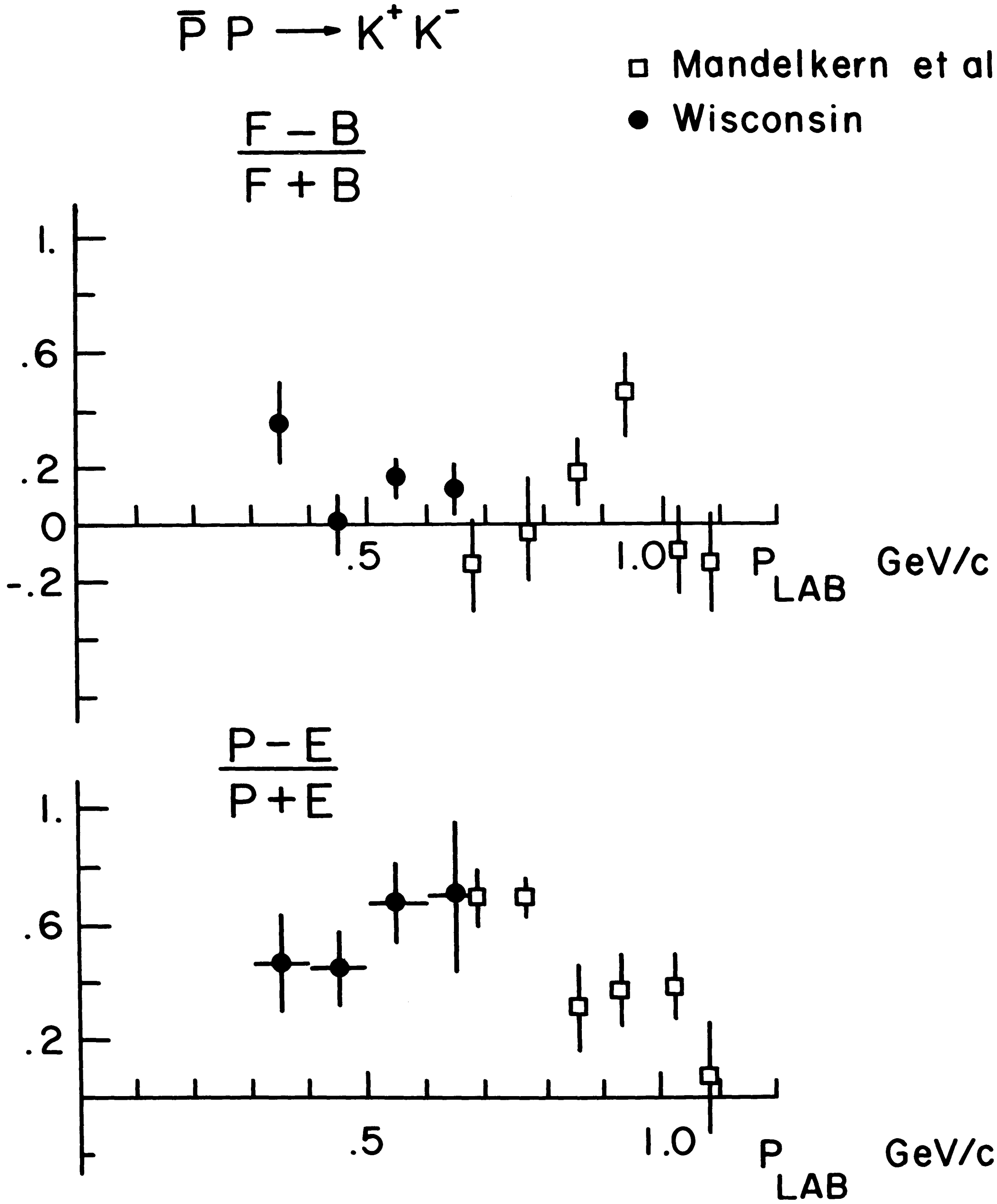

Fig. 2 Distributions of (F - B)/(F + B) and (P - E)/(P + E) ratios for $\bar{p}p \rightarrow K^+K^-$ data from this work and from Ref. 2e.

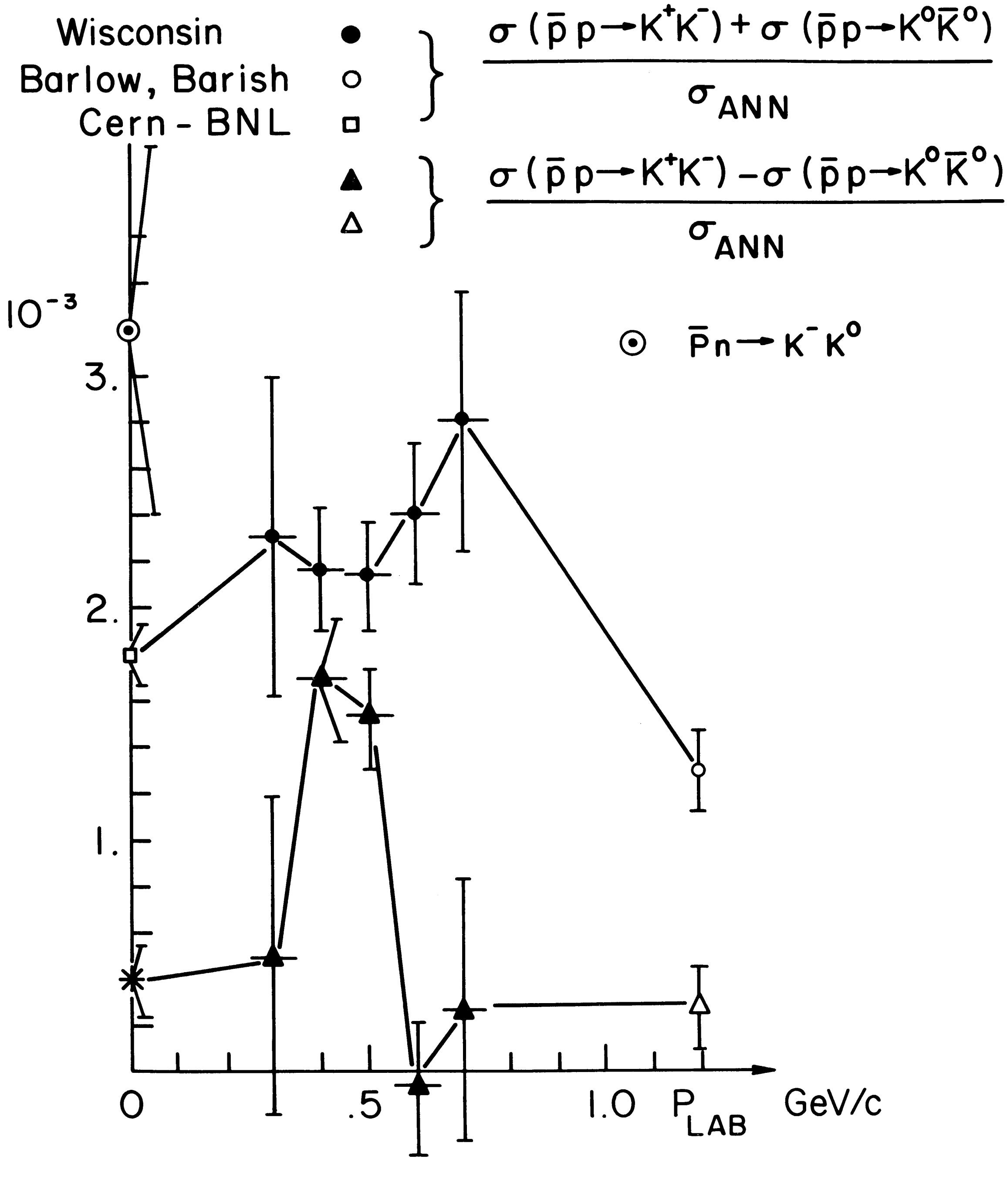

Fig. 3 Distributions of $(\sigma(\bar{p}p \to K^+K^-) + \sigma\ \bar{p}p \to K^0\bar{K}^0))/\sigma_{ANN}$ and of $(\sigma(\bar{p}p \to K^+K^-) - \sigma(\bar{p}p \to K^0K^0))/\sigma_{ANN}$.

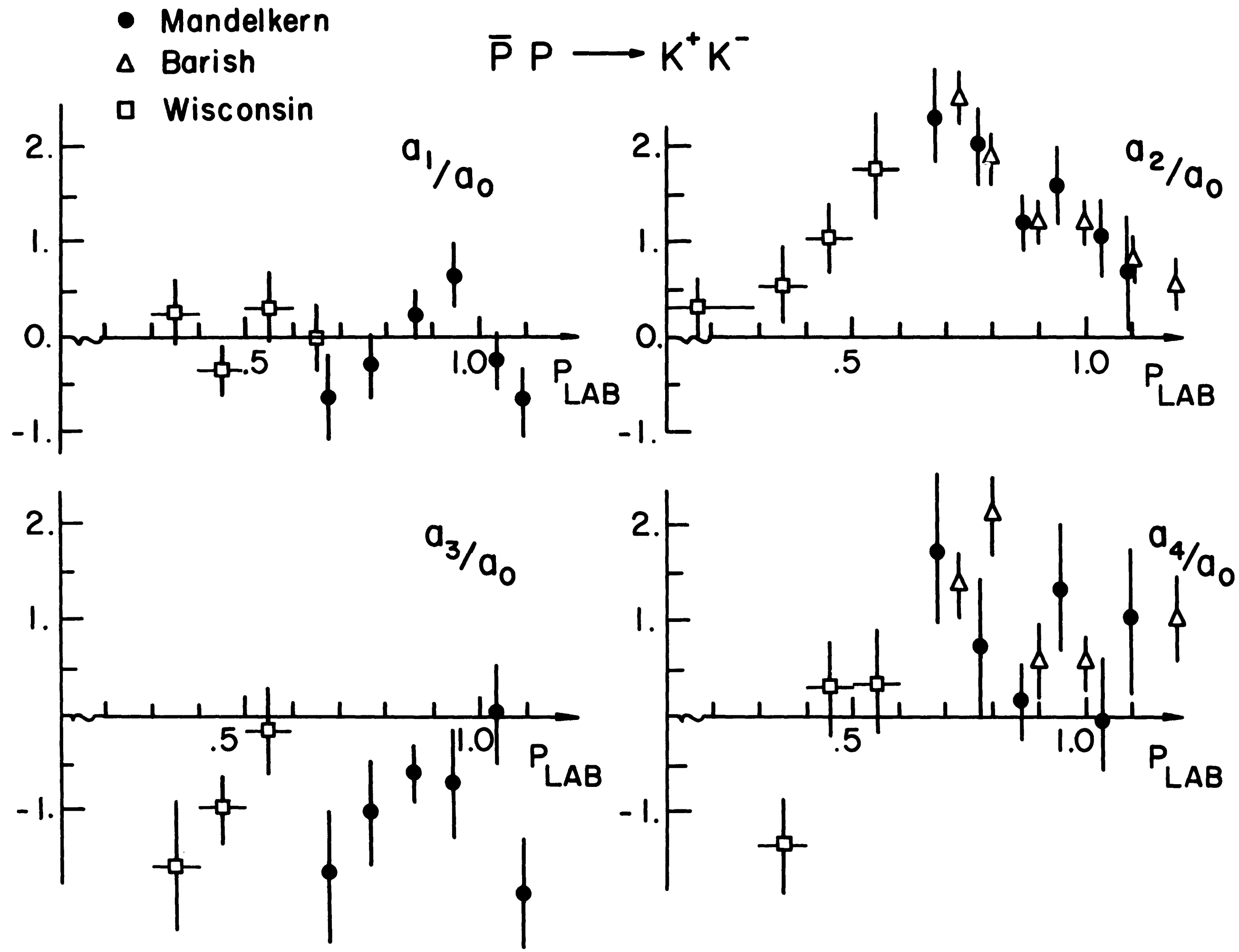

Fig. 4 Legendre coefficients for $\bar{p}p \rightarrow K^+K^-$ data from this experiment and from Ref. 2b and 2e.