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CONFIRMATION OF A SPIN 4, ISOSPIN 1 MESON RESONANCE IN THE $K\bar{K}$ CHARGED SYSTEM

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Abstract

We confirm the observation of the charged $K_s^oK^+$ $J^P = 4^+$, $I^G = 1^-$ state, the A2 (1950), in the reaction $\pi^\pm p \to K_s^oK^\pm p$. The negative state has been previously observed at 10 GeV/c ; we report here the observation of the positive state measured with an improved version of the spectrometer running at the CERN SPS.

A preliminary spherical harmonic moments analysis of the $K_s^oK^+$ system shows a clear negative signal at 1950 MeV in the $< Y_8^o >$ and $< Y_8^2 >$ moments, indicative of a spin 4 dominantly produced by natural parity exchange.

In a previous paper {1}, we reported the observation of a $J^P = 4^+$, $I^G = 1^-$ meson state in the $K_s^oK^-$ system observed in the reaction $\pi^-p \to K_s^oK^-p$ at 10 GeV/c. It was measured with the non magnetic two-arm spectrometer of the University of Geneva at the CERN PS. {2}.

The spectrometer is presently being used at 50GeV/c in an unseparated hadron beam at the CERN SPS. It is mainly designed to study $\pi^{\pm}$, $K^{\pm}$ and P, $\bar{P}$ induced reactions with a V^{O} topology, (the neutral particle decay being seen in the system). The description and performance of the apparatus are described elsewhere. {3}.

We have performed a preliminary analysis of about 2/3 of the data on the reaction $\pi^{+}p \to K_{S}^{O} K^{+}p$.

The event selection procedure used was the same as that described in reference {1} (10 GeV $\pi^{-}p \to K_{S}^{O}K^{-}p$ analysis) with the following criteria :

- The V_{O} decay vertex is required to be at least 100 mm downstream of the primary intersection vertex.
- The three unknown moduli of the forward track momenta are determined by a solution of the three equations of momentum conservation. Energy conservation is then required to be satisfied to within ± 10 MeV, and the reconstructed $\pi^{+}\pi^{-}$ mass is required to be within ± 20 MeV of the K^{O} mass.
- A two constraint kinematic fit is then made which requires energy conservation at both the production and decay vertices. The $P(\chi^{2})$ for this fit is required to be at least 18 %.

Our final sample consists of about 10.000 events in a momentum transfer range $0.05 \leqslant |t| \leqslant 0.80$ $(GeV/c)^{2}$ and in a $K_{S}^{O}K^{+}$ effective mass range $1.10 \leqslant M_{K^{O}K^{+}} \leqslant 2.10$ GeV/c^{2}.

The background is estimated to be ∿ 4% by interpolation of the tails of the K^{O} mass distribution. We do not see any structure in the pK^{O} effective mass, nor in the exotic pK^{+} mass, allowing us to suppress a cut in pK^{O} mass to eliminate kinematic reflections in the $K_{S}^{O}K^{+}$ mass (a cut $M_{K^{-}p} > 1.90$ GeV/c^{2} to eliminate Y^{*}'s was made in the 10 GeV/c analysis).

As in a previous analysis, the acceptance, inefficiencies and experimental resolutions are taken into account by a Monte-Carlo program.

We have calculated the acceptance-corrected spherical harmonic moments N Re $< Y_L^M >$ of the angular distribution of the K^+ in the t-channel helicity frame of the $K_S^oK^+$ system, as a function of the $K_S^oK^+$ effective mass.

From the moments with $0 \leqslant L, M \leqslant 8$, we find that the only moments significantly different from zero were those with $0 \leqslant L \leqslant 8$, $0 \leqslant M \leqslant 2$ and $< Y_4^3 >$, $< Y_4^4 >$ in the A2 mass region. These 26 corrected moments have been obtained from the overdetermined linear system of 45 equations for the uncorrected moments with $0 \leqslant L, M \leqslant 8$.

The L = 8 moments, indicative of a spin 4 object have significantly negative values in the mass region 1.80 to 2.10 GeV/c^2. ($< Y_8^o >$:5 st. dev., $< Y_8^2 >$:6 st. dev.)

Neglecting contributions from higher partial waves, the moments can be expressed in terms of amplitudes :

$$< Y_{2L}^o > \sim C_1 |L_o|^2 - C_2 (|L_-|^2 + |L_+|^2)$$
$$< Y_{2L}^2 > \sim C_3 (|L_-|^2 - |L_+|^2)$$

L_o : spin L helicity 0 amplitude produced by unnatural parity exchange (UPE) in the t-channel.

$L_\pm$: spin L helicity 1 amplitude produced by NPE (+) and UPE (-).

C_1, C_2, C_3 : positive Clebsch-Gordan coefficients.

The negative sign of the moments indicate that the spin 4 state is mainly produced by natural parity exchange.

We have performed a χ^2 fit to a relativistic Breit-Wigner form for a spin 4 object (taking into account centrifugal barrier effects [4, 5]) to the $< Y_8^o >$ moment. The result is :

Mass	1963	±	46 MeV
Width	250	±	170 MeV
Confidence level 50 %			

This result is compatible with that found at 10 GeV/c :

Mass	1903	±	10 MeV
Width	166	±	43 MeV

In conclusion, our data at 50 GeV/c confirm the existence of a $I^G = 1^-$, $J^P = 4^+$ $K^0_S K^\pm$ meson resonance at $\sim$ 1950 MeV with a width of about 200 MeV.

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References

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{2} R. Baldi et al., Systematic study of Kπ production in the reaction $K^{\pm}p \rightarrow K^{o}_{s}\ \pi^{\pm}\ p$: technique and measurements at 10 GeV/c, Nucl. Phys. B 134 (1978) 365 - 391.

{3} W. Cleland et al., Study of the energy dependence of the reaction $K^{\pm}p \rightarrow K^{o}_{s}\pi^{\pm}\ p$.
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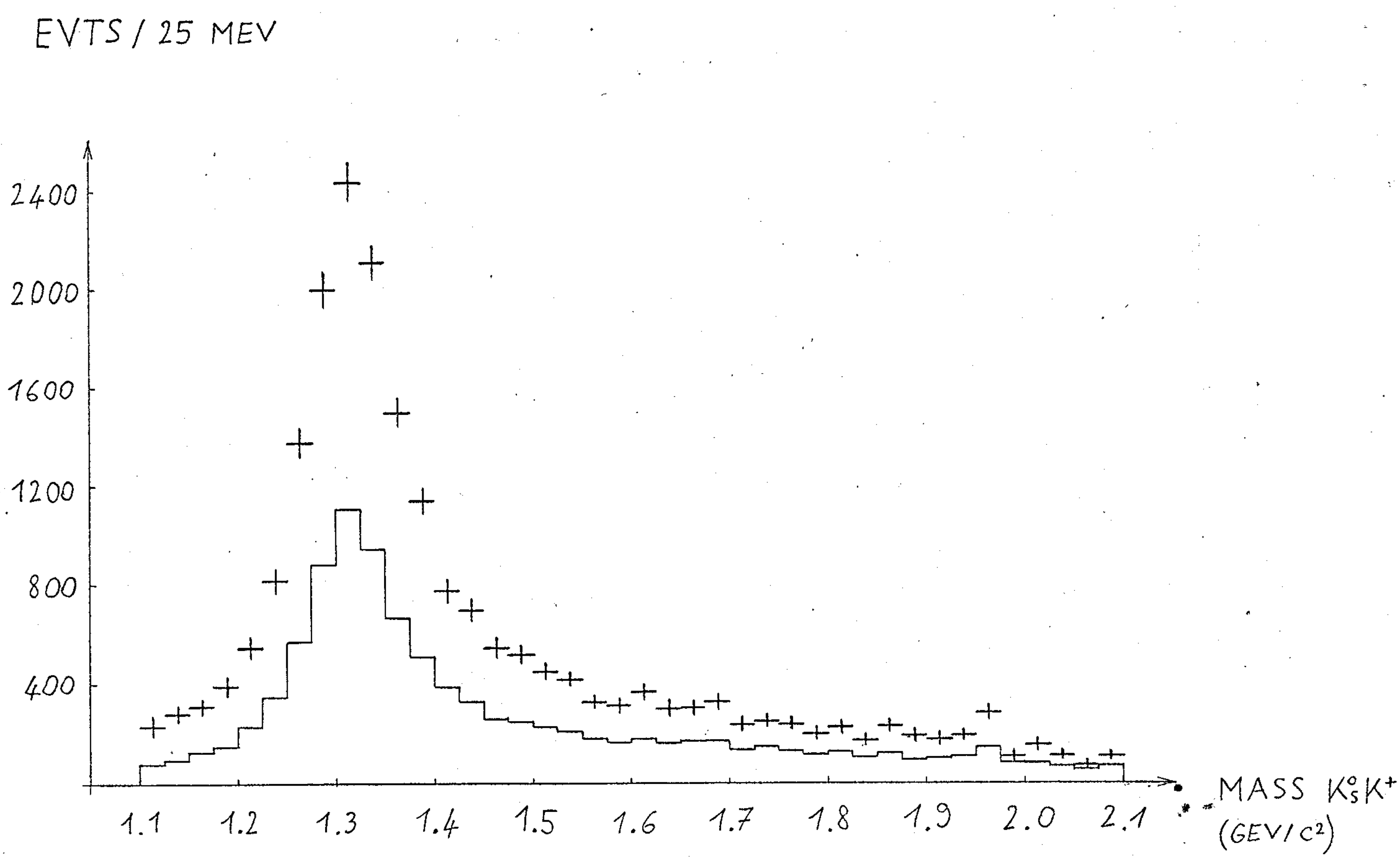
Figure captions

Fig. 1 : $K_s^oK^+$ effective mass spectrum, for $0.05 \leq |t| \leq 0.80$ $(GeV/c)^2$. The spectrum is shown before (histogram) and after (points with end bars) acceptance correction.

Fig. 2a and 2 b : The unnormalized acceptance-corrected moments $N < Y_L^M >$ of the angular distribution of the K^+ in the t-channel helicity frame, as a function of $M(K_s^oK^+)$. The data are in the t range $0.05 \leq |t| \leq 0.80$ $(GeV/c)^2$.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2000
1600
1200
800
400
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
MASS $K^0_sK^+$
(GEV/c^2)

Fig. 1

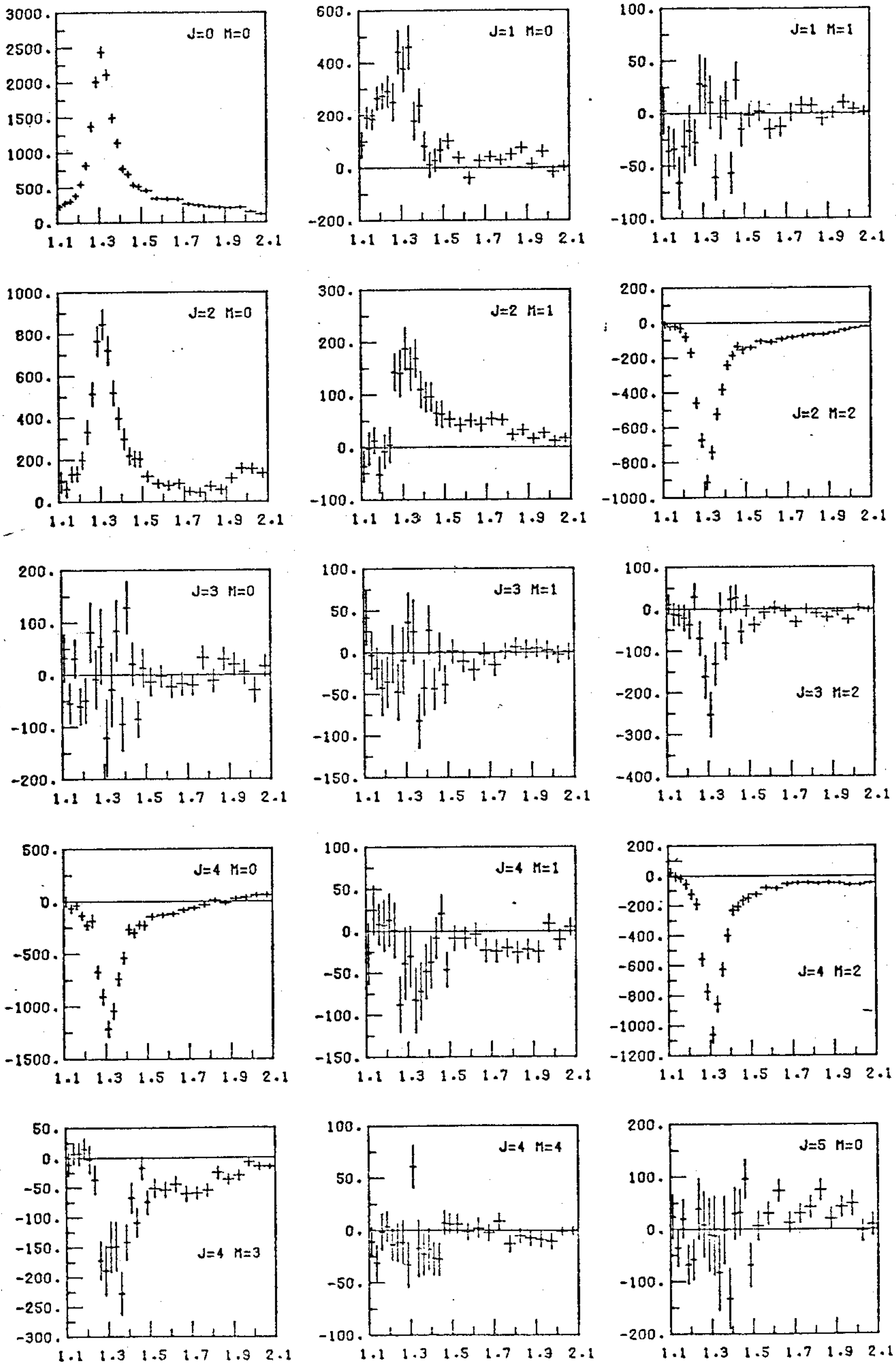
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Fig. 2a

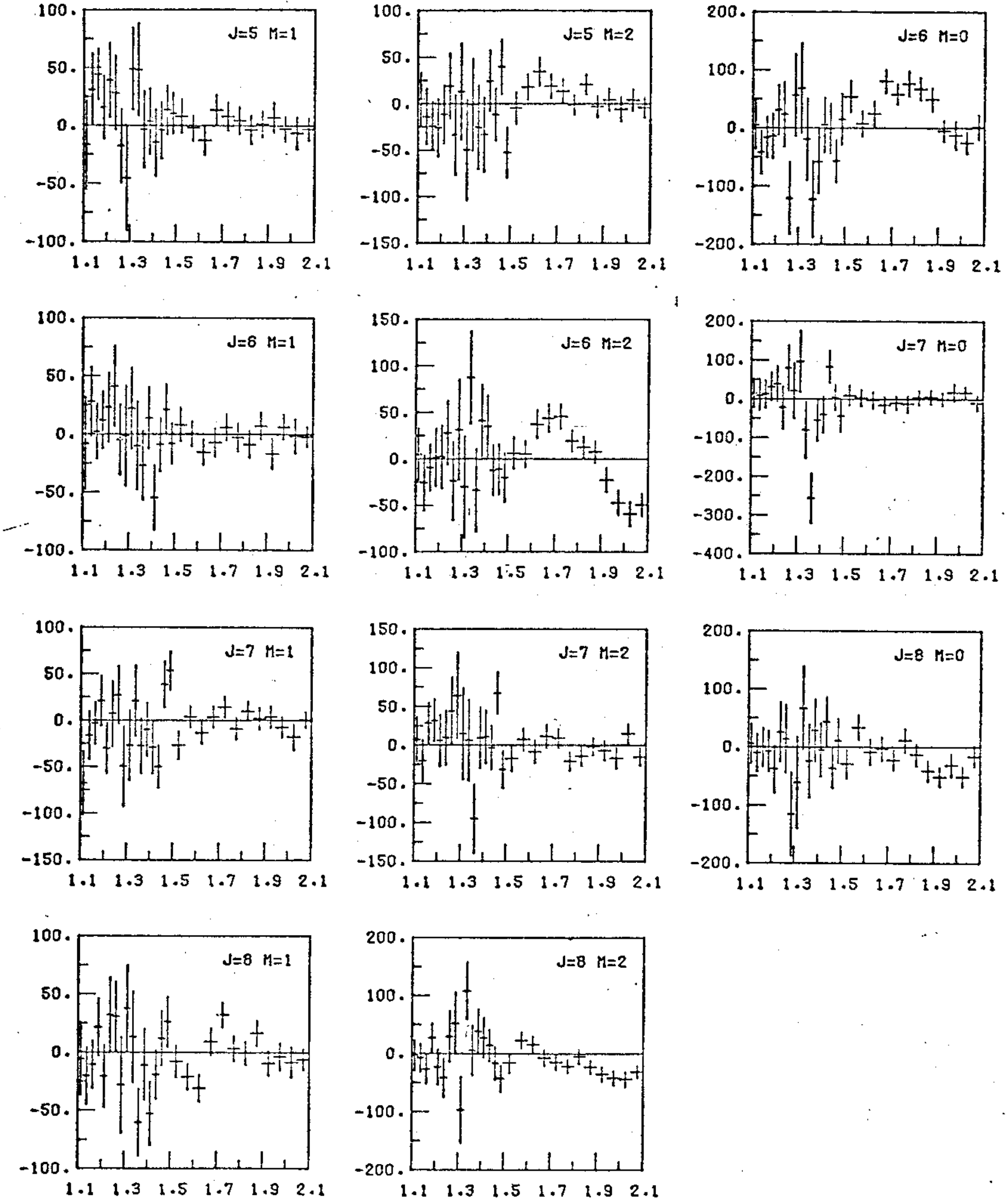

Fig. 2 b