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RESONANT $K^*(892)$ PRODUCTION IN MULTIHADRON e^+e^- ANNIHILATION.

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ABSTRACT. -

A preliminary analysis of multihadron events in the center of mass energy region W = 2.10 - 2.15 GeV shows an enhancement in the invariant mass spectrum of two prongs with total charge zero at the mass of the $K^*(892)$ which is not observed outside this energy region. This enhancement is accompanied by an increase in the observed charged multiplicity.

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We present here preliminary results obtained at Adone by the MEA experiment on some interesting features observed in multihadron production at a total energy $W \cong 2.1$ GeV. This is part of a large program to study the reaction

$$e^+e^- \longrightarrow \text{multihadrons} \qquad (1)$$

in the energy range $W = 1.6 - 3.1$ GeV.

The experimental apparatus is described in detail in ref. (1). We recall here that candidate events from reaction (1) must fulfill one of the following conditions:

a) more than two charged particles detected;
b) two charged particles observed with an acoplanarity angle $\Delta\phi \geq 10^\circ$.

Trigger conditions require that at least two of the detected particles have a minimum kinetic energy of ~ 130 MeV if pions or ~ 210 MeV if kaons.

Our attention was first directed to this energy region during a search for J/ψ - like resonances in the multihadronic cross section. No evidence for such resonances was found in the energy interval $W = 1.9 - 3.1$ GeV(2, 3), but some anomalies in the behaviour of the yield of detected events was observed in the energy interval $W = 2.100 - 2.150$ GeV. Subsequently this region was more carefully studied by collecting new data in a larger interval $W = 2.070 - 2.200$ GeV, up to a total effective luminosity $\mathscr{L} \simeq 50\ \text{nb}^{-1}$. Furthermore we have restricted our analysis to events with at least three charged particles detected, where background contamination was found to be negligible. Figure 1(a) shows the behaviour of the detected yield of multihadron events, $n_{\geq 3T}/\mathscr{L}$, as a function of the center of mass energy. In Fig. 1(b) the yield of events with at least four charged particles detected, $n_{\geq 4T}/\mathscr{L}$, is plotted. Here three consecutive points appear to be above the average level by more than one standard deviation.

To isolate this possible anomaly we have divided our data into two samples:

I) events produced in the energy interval W = 2.100-2.150 GeV (56 events collected with an effective luminosity $\mathscr{L} = 27\ nb^{-1}$);

II) events produced outside this interval, i.e. W = 2.070-2.100 GeV or W = 2.150-2.200 GeV (31 events collected with an effective luminosity $\mathscr{L} = 20\ nb^{-1}$.

In Figs. 2(a), 2(b) the inclusive momentum distribution of the detected particles for the two samples are shown. One observes a significant difference between samples II and I. The latter beeing richer in the momentum region 400 MeV/c $\leqslant$ p $\leqslant$ 600 MeV/c. The momentum resolution of our apparatus has been tested using two-body events, i.e. $e^+e^- \longrightarrow \mu^+\mu^-$, and was found to be $\Delta p \simeq \pm 10\%$ at p = 1.0 GeV/c.

In order to study possible dynamical correlations between the outgoing particles we have examined the invariant mass spectra of two particles neutral systems, assuming that each pair was either $(\pi^{\pm}\pi^{\mp})$, $(\pi^{\pm}K^{\mp})$ or $(K^{\pm}K^{\mp})$. Since our apparatus does not allow us, at present, to distinguish pions from kaons, the invariant mass spectra were obtained just by assuming that each particle was first a pion and then a kaon. In this way each pair of particles contributes two values to the $(\pi^{\pm}K^{\mp})$ spectrum. In Fig. 3 the invariant mass spectra for samples I and II are shown. The dashed curves of Fig. 3(a) are hand-drawn fits to the data of sample II. These curves, normalized to the same effective luminosity of sample I are also presented in Fig. 3(b).

The $(\pi^{\pm}\pi^{\mp})$ mass spectra do not show any significant structure nor is there any significant difference in the behavior of the two samples. On the contrary the $(K^{\pm}K^{\mp})$ and $(\pi^{\pm}K^{\mp})$ spectra for sample I show structures which are not present in sample II. The two effects, in the $(K^{\pm}K^{\mp})$ and in the $(\pi^{\pm}K^{\mp})$ system, are not independent, as they are due to the same particle pairs.

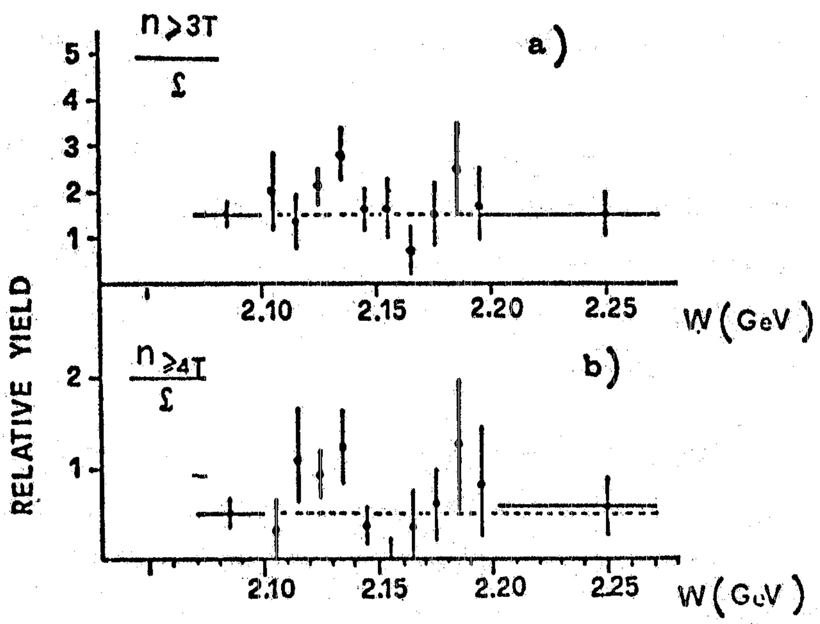

FIG. 1 - a) Yield of multihadron events with at least 3 charged particles detected vs. total energy. b) Yield of multihadron events with at least 4 charged particles detected vs. total energy.

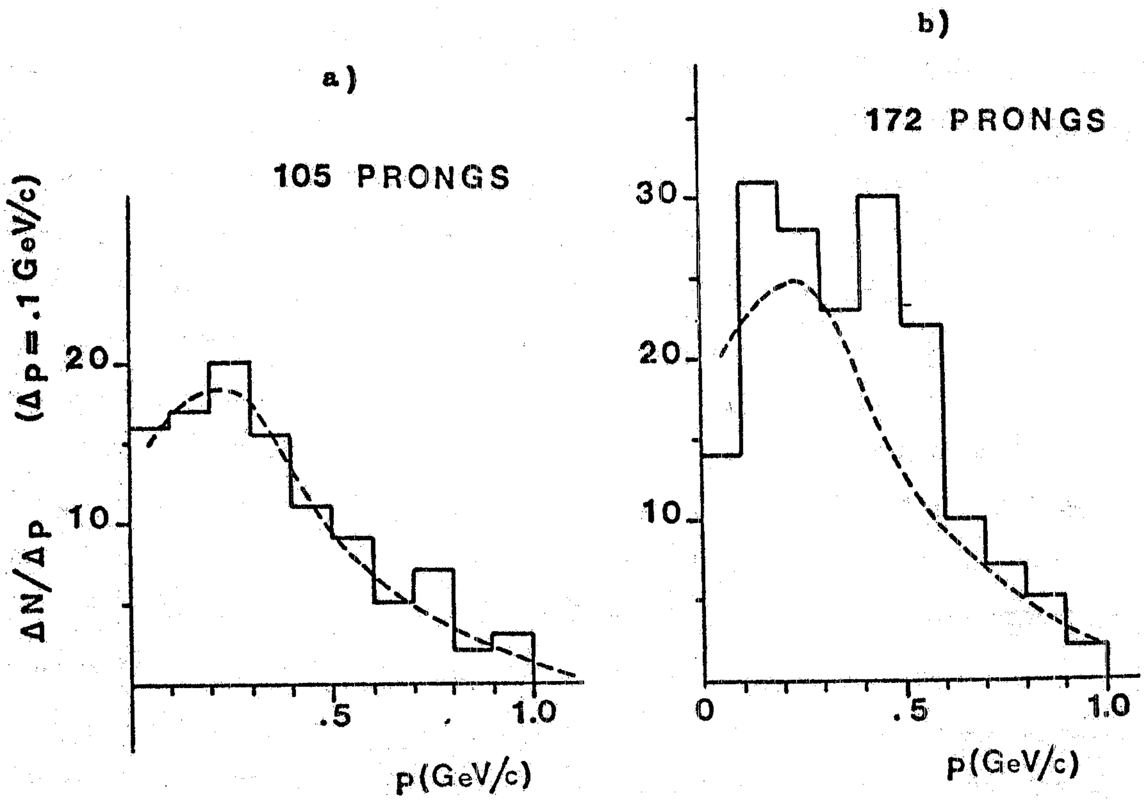

FIG. 2 - Inclusive momentum distributions of detected particles; a) for sample II, and b) for sample I. Dashed curve in a) is a hand-drawn fit to the histogram. The same curve normalized to the same luminosity is shown in b).

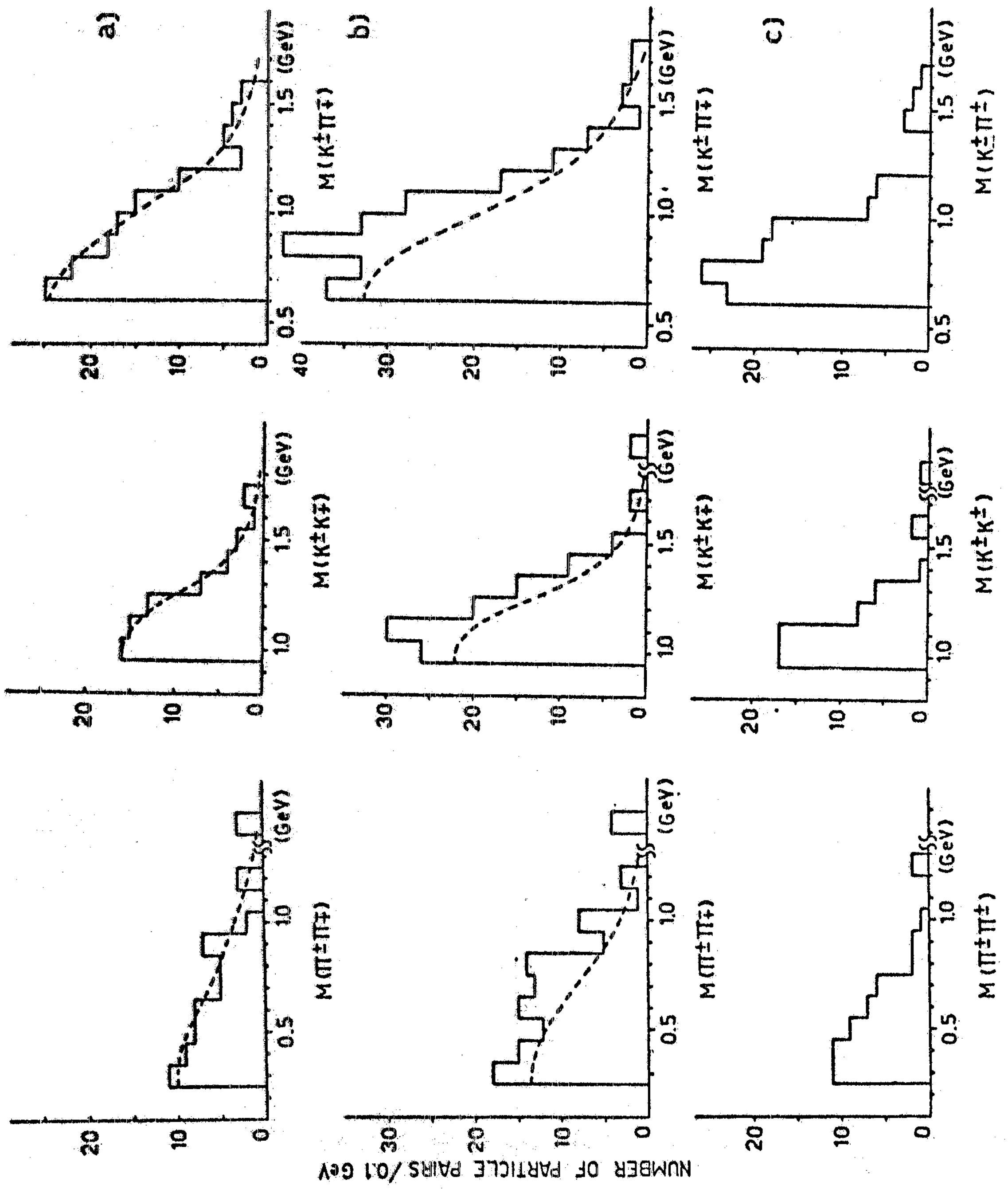

FIG. 3 - Invariant mass distributions for two particle systems; a) for neutral combinations ($\pi^{\pm}\pi^{\mp}$), ($K^{\pm}K^{\mp}$), ($K^{\pm}\pi^{\mp}$) at W = = 2.07-2.10 GeV and W = 2.15-2.20 GeV (sample II), b) for neutral combinations ($\pi^{\pm}\pi^{\mp}$), ($K^{\pm}K^{\mp}$), ($K^{\pm}\pi^{\mp}$) at W = 2.10-2.15 GeV (sample I), and c) for doubly charged combinations ($\pi^{\pm}\pi^{\pm}$), ($K^{\pm}K^{\pm}$), ($K^{\pm}\pi^{\pm}$) at W = 2.10-2.15 GeV (sample I). Dashed curve in a) are hand-drawn fits to the histograms. The same curves, normalized to the same luminosity, are shown in b).

To verify that we are not dealing with instrumental effects we have calculated invariant masses for pairs of tracks having the same charge. The resulting spectra for sample I are shown in Fig. 3(c): no anomalous behaviour either in the $(K^{\pm}\pi^{\pm})$ or in the $(K^{\pm}K^{\pm})$ system is seen thus indicating that no experimental bias is present in either sample.

To further investigate the significance of the observed effect we have calculated the $(K^{\pm}\pi^{\mp})$ and $(K^{\pm}K^{\mp})$ mass spectra attributing a weight to each pair of tracks such that, independent on the observed multiplicity, each event contribute a total weight of one. These mass spectra are shown in Fig. 4. The dashed curves appearing in Fig. 4(b) represent the spectra of Fig. 4(a) normalized to the same integrated luminosity. In this comparison the magnitude of the effect is more easily evaluated.

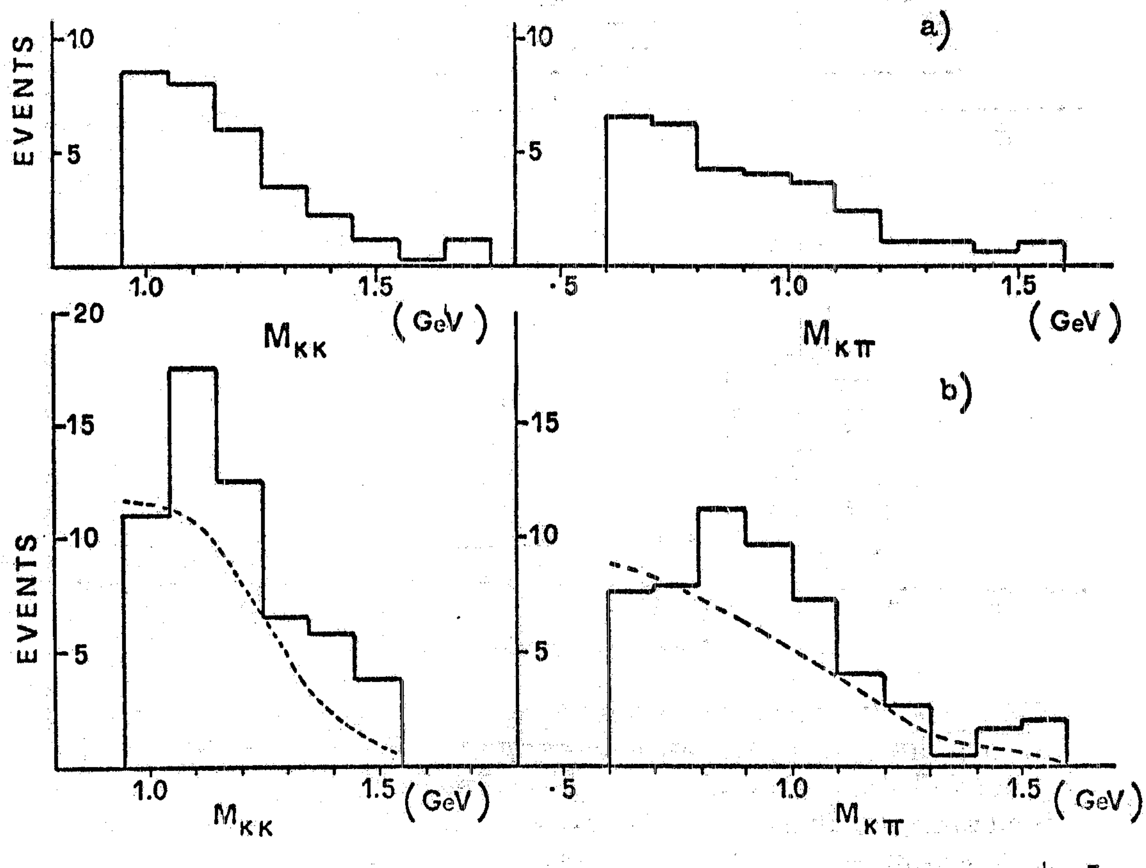

FIG. 4 - Weighted invariant mass distribution for $(K^{\pm}\pi^{\mp})$ and $(K^{\pm}K^{\mp})$ systems. a) sample II ; b) sample I. Dashed curves in b) are hand-drawn fits to the distributions of sample II normalized to the same effective luminosity.

Whether the physical effect is in the $(K^{\pm}\pi^{\mp})$ or in the $(K^{\pm}K^{\mp})$ mass cannot be definitely stated from the above analysis. However, since the enhancement in the $(K^{\pm}\pi^{\mp})$ system is centered around the $K^{*}(892)$ mass, the simplest interpretation is to assume that K^{*}'s are produced in multihadronic events in the energy interval W = 2.100-2.150 GeV.

Present data do not allow us to definitely determine the actual final state produced. However, once one assumes that K^{*}'s are actually produced, the large values of the observed multiplicity, strangeness conservation and consideration of the total available energy, lead us to consider the channel

$$e^+e^- \longrightarrow K^{*}K\pi^+\pi^-$$

as a reasonable hypothesis to explain the data. Also the occurence of K^o_s decays into two pions could account for the high rate of five prong events observed in the energy range W = 2.10-2.15 GeV.

We note that the mass region where strange particles seem to be produced coincides with theoretical expectations[4] for the third recurrence of the ϕ-meson.

Further work is in progress on an enlarged data sample and a more definite statement on the dynamics of the final state will be reported in the near future.

We would like to express our appreciation to the staff of Adone for their efficient collaboration and to the scanning staff of the Laboratori Nazionali di Frascati and of the Universities of Napoli and Padova for their careful work. Our special thanks are also due Dr. V. Valente and Prof. M. Greco for many helpful and stimulating discussions regarding the analysis of the data.

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