It should be noted at the same time that the continuous emission spectrum background observed by us, which stretches into the long-wave region away from resonant emission lines (n = 5 and n = 6), is possibly a manifestation of this mechanism. This question, however, calls for a more detailed experimental and theoretical investigation.

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"LEADING" PARTICLE AND ASYMMETRY OF THE NEUTRAL ρ^0-MESON DECAY IN THE REACTION $\pi^- + A \to 2\pi^-\pi^+ + A^*$

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In our earlier study of the production of three pions ($2\pi^-\pi^+$) by π^- mesons with momentum ~3.9 GeV/c on light nuclei (C, F, Cl) [1], the interactions with the quasi-free nucleons of the nuclei were selected by fitting to the nucleon reaction. This revealed intense ρ^0-meson generation in the ($\pi^+\pi^-$) system. If no limitations are imposed on the 4-momentum transfer, then the relative amplitude of the ρ-meson signal is equal to the amplitude observed in reactions with free nucleons at the same primary energy.

The selection of events with effective masses of the ($\pi^+\pi^-$) combination in the ρ-meson band and with 4-momenta $\Delta^2 < 0.5$ (GeV/c)^2 transferred to the ($\pi^+\pi^-$) pair causes the cases of peripheral production of aligned ρ^0 mesons to be added to the selected events, as seen from Fig. 1. The asymmetry of the neutral ρ decay, which is universally known [2], is also clearly manifest in this case. The predominant forward emission of a pion having the same sign as the primary one is customarily attributed to interference between the fundamental P-wave (ρ meson) and the background S-wave. The presence of an S-wave ($\pi^+\pi^-$) resonance with a mass close to the ρ-meson mass (ε^0) is assumed.

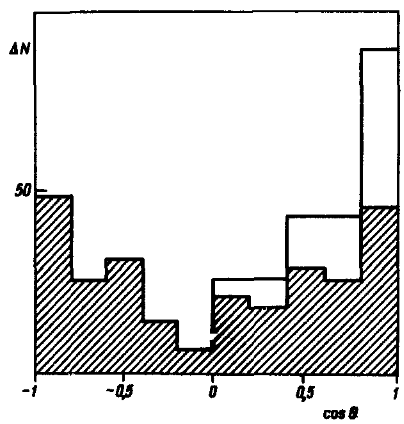

Fig. 1. Distribution with respect to the π^--meson emission angle in the ($\pi^+\pi^-$) c.m.s.; $\Delta^2 < 0.5$ (Gev/c)^2; 0.64 GeV < $M_{\pi^+\pi^-}$ < 0.88 GeV. The events outside the region 1.08 < $M_{N\pi}$ < 1.3 GeV are shown shaded.

Certain considerations can be advanced with respect to the mechanism that causes the asymmetry. It is based on the following facts.

The angular and momentum distributions for the reactions $N(A) \to 3\pi N(A^*)$ (A and A^* are the initial and final nuclei, respectively) reveal clearly a group of particles (leader) having the same sign as the primary particle, and retaining in general its direction and momentum.

In our case there is a leader both in the incoherent and the coherent [1] components of the reaction, the lower momentum limit of the group of leading particles was assumed to be $p_{\parallel} > 0.5$ GeV/c ($p_{\parallel}$ is the momentum component parallel to the momentum of the primary particle in the c.m.s. of the πN collision (Fig. 2). In the mass spectrum of the $(\pi^+\pi^-)$ combination, where one particle has $p_{\parallel} > 0.5$ GeV/c, one can see a clearly pronounced peak in the ρ^0-meson region over a rather extended background of nonresonant origin (Fig. 2). There are no singularities whatever in the mass spectrum of the "leader + π^-" combination, which is shown in the same figure. It is important, however, that this spectrum encompasses an extensive mass region, including the ρ-meson band. A comparison of this fact with the presence of a background in the $M_{\pi^+\pi^-}$ distribution shows that an imitation of the ρ mass is present as a result of the kinematic properties of reactions with a leader.

The hard momentum spectrum of the leader and the sharp forward directivity of its angular distribution cause the leader to be emitted in the c.m.s. of the $\pi^+\pi^-$ combination into the forward hemisphere relative to the beam. Taken together with the imitation of the ρ-meson mass, this becomes manifest in the form of the ρ-meson decay asymmetry.

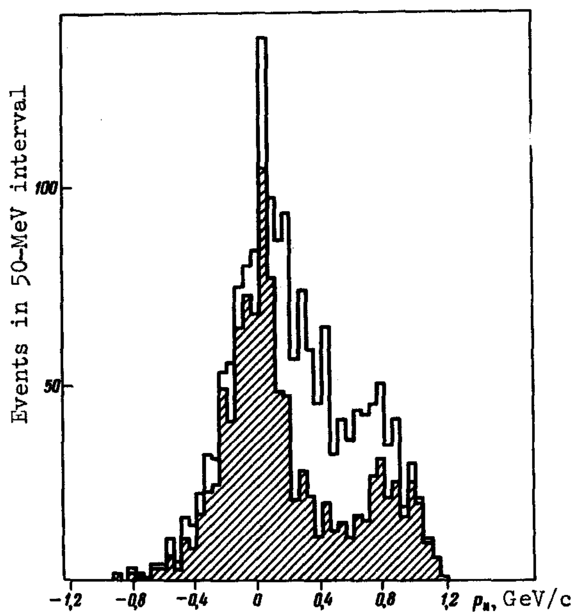

Fig. 2

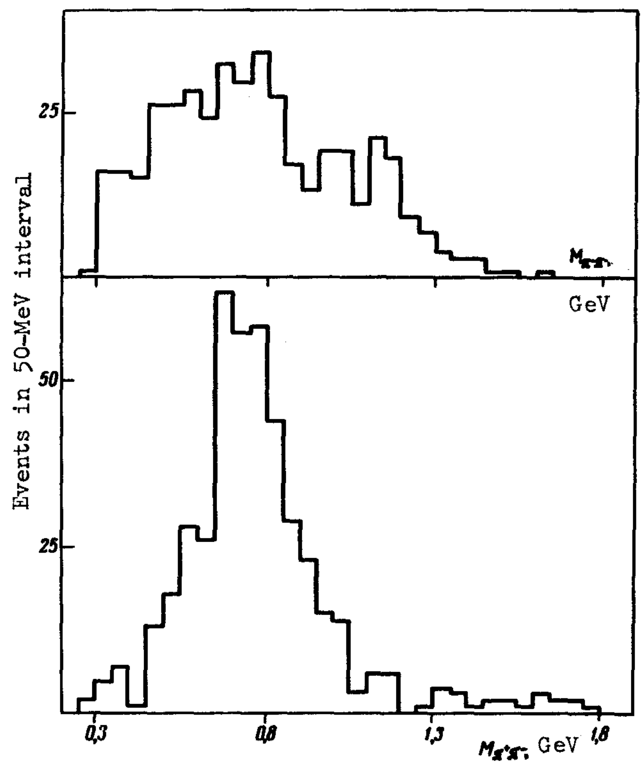

Fig. 3

Fig. 2. Distribution of the longitudinal components of the momentum of the secondary π^- mesons in the c.m.s. of the πN collision. The distribution for the events with 1.1 GeV < $M_{N\pi^-}$ < 1.38 GeV are shown shaded.

Fig. 3. Distribution of the effective masses of the $(\pi^{\pm}\pi^-)$ combination. The longitudinal component of the π^--meson momentum in the πN c.m.s. is $p_{\parallel} > 0.5$ GeV/c.

Since the indicated results do not depend on the energy-momentum transfer and are observed simultaneously in the coherent and the incoherent components, it can be concluded that they are a common property of the processes that cause leader formation, regardless of the concrete mechanism (for example, regardless of the particular Feynman diagram).

It is known that calculations for the reaction $\pi p \rightarrow 3\pi p$, performed in the OPE approximation with allowance for the S and P waves on the basis of a Feynman diagram with a $\pi^+\pi^-$ pair in one block, explain the asymmetry only qualitatively [2]. The addition of a diagram with a $\pi^-\pi^-$ pair in the meson blob improves the agreement with experiment [3]. This confirms the need for taking into account the processes in which the π^+ and π^- mesons with effective masses $M_{\pi^+\pi^-} \sim M_\rho$ are not genetically related.

The momentum spectrum of the pions accompanying the leader is soft. The effective masses of combinations of such mesons with a nucleon are therefore grouped near the left-hand boundary of the $M_{N\pi}$ spectrum. This accumulation is not necessarily due to a lower nucleonic isobar, since in our case there is no reliable signal from the isobars in the mass spectrum of the $(N\pi^+)$ combination, where the region near the threshold is determined entirely by the events with a leader. This circumstance allows us to take into account the influence of the leader and to reduce the background in the ρ-meson region. Thus, the asymmetry is noticeably decreased if we exclude events with values of $M_{N\pi^+}$ near the left-hand boundary (Fig. 1).

In conclusion, we can deduce the following. The facts listed above, including the ρ^0-decay asymmetry, are the consequence of the general kinematic properties of reactions that lead to the formation of the leader. In practical calculations of such processes it is necessary to take into account the possible leader-generating mechanism. Thus, besides the contribution of the process described by the diagram with one-pion exchange, the asymmetry of the ρ^0-meson decay occurring in the reactions $\pi^\mp p(A) \rightarrow 2\pi^\mp\pi^\pm p(A)$ receives also contributions from diagrams with a Pomeranchuk-pole exchange or with a ρ meson. The latter exchange is accompanied by diffraction disintegration of the exchange particle in the target. A contribution is made also by a diagram with exchange of two mesons that are diffracted independently.

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