Evidence of a New State at $\sim 1660$ MeV/$c^2$ Observed in $\bar{n}p$ Annihilations (*)

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Summary. — A study of \( \bar{p}p \) in-flight annihilations is presented. The 4\( \pi \) invariant mass spectrum resulting from the analysis of the five-prong exclusive events, following the annihilation of \( \sim (100-297) \text{MeV}/c \), reveals, besides a large structure centred at \( \sim 1500 \text{MeV}/c^2 \), some evidences for a new state around 1660 MeV/c^2.

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1. – Introduction.

During the last two decades, the nucleon-antinucleon system (\( N\bar{N} \)) at low energies has been the subject of intense experimental investigations, since it represents an ideal entrance channel for the production of new types of meson resonances in addition to the usual quark-antiquark (q\( \bar{q} \)) configuration[1].

In particular, the energy region below 2 GeV/c^2 has been systematically explored at the CERN Low-Energy Antiproton Ring (LEAR), looking for these exotic objects like, for instance, quasi-nuclear bound states of the \( N\bar{N} \) potential, multiquark (q\(^2\bar{q}\)) structures, hybrids, i.e. q\( \bar{q} \)g mesons containing a dynamical gluon g, and glueballs.

The data and the experience accumulated so far show that the discovery of such new states can be favoured by the capability of selecting the initial quantum numbers of the interaction whose conservation restricts the possible final-state configurations. In other words, in order to minimize the quasi-two-body modes[2] and other backgrounds, one can choose the initial \( N\bar{N} \) state and the particular final pion charge states in an optimum way.

To this purpose, several new techniques have been proposed and developed in the last years: fewer \( N\bar{N} \) partial waves can be selected, for instance, if one exploits annihilations at rest, in gaseous or liquid targets, at NTP or at very low pressure[3, 4].

One option, never extensively used before because of its intrinsic technical difficulties[5], is the study of \( \bar{p}p \) annihilations. Although pn (isolated from pd reactions) and \( \bar{p}p \) studies, being charge symmetrical, are equivalent, the latter have better energy and momentum resolution, whereas in the pn annihilation there is an uncertainty in the neutron momentum due to Fermi motion in the deuteron. Thus \( \bar{p}p \) annihilation provides a cleaner way for studying pure isospin \( T = 1 \) state in \( N\bar{N} \) interactions.

These expectations have been confirmed by our collaboration: in fact we have