PRODUCTION OF π^0, η, ω AND EXOTIC LOW MASS MESONS IN N–N SCATTERING *

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The differential cross sections of light meson production: $X = \pi^0, \eta$ and ω were measured in $\vec{p}p \to ppX$ reaction. A theoretical analysis based on s-channel contributions in 2^+ and 1^- intermediate states was performed. Narrow peaks were looked for between η and ω meson masses, and were extracted at 588, 608, 647, 681 and 700 MeV. The evidence for their existence is discussed in accordance with the corresponding number of standard deviations (SD).

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Light mesons: π^0, η, and ω were produced in $\vec{p}p \to ppX$ reactions at $T_p = 1.52, 1.805, 2.1\,\mathrm{GeV}$ (from 0° up to 17° lab.) at Saturne Spes3 beam line. The corresponding cross sections and analyzing powers were observed in the missing mass M_X. Both protons were observed in the same detection. Cross sections were obtained using a simulation code to allow corrections. They were normalized by $(\Delta p_{p1}\, \Delta p_{p2})$ which vary with M_X, acceptances, and incident flux. Their extraction was performed, using polynomials for background and gaussians for peaks. The detection and data processing were already described [1].

Data were compared to theoretical curves calculated with s-channel graphs, taking into account $J^P = 1^-$ and 2^+ intermediate states.

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Both experimental and calculated data were shared into two parts, depending on the two proton invariant mass: (a) small $M_{pp} - 2M_p$, ${}^1S_0$ state and (b) all M_{pp} events.

The complete results will be published elsewhere. We only illustrate here our results with a few examples. Fig. 1 (left) shows the cross section for $pp \to pp\eta$ production at 1520 MeV. Full (dashed) curve corresponds to events without cuts on the invariant mass of the two proton final state M_{pp} (with the following cuts: $M_{pp} \geq 2M_p + 5$ MeV). In case of ${}^1S_0(M_{pp})$ state ($2M_p \leq M_{pp} \leq 2M_p + 5$ MeV selection), it was not possible to extract any cross section, in agreement with our model. The angular dependance is described by the following equation:

$$\frac{d\sigma}{d\Omega_\eta} = A(1 + \cos^2\vartheta) + B\left(\cos^2\vartheta - \frac{1}{3}\right)^2 , \tag{1}$$

where B/A is the ratio of 2^+ over 1^- intermediate states, and is close to 2 ± 1 at $T_p = 1.52$ GeV, in agreement with the result of the study of $\vec{p}p \to \Delta^{++}\Delta^0$ reaction at the same energy [2]. Fig. 1 (right) shows the cross section for $pp \to pp\omega$ production at 2100 MeV. Dashed (full) curve corresponds to events without cuts on the invariant mass of the two proton final state M_{pp} (with the following cuts: $2M_p \leq M_{pp} \leq 2M_p + 5\,$MeV).

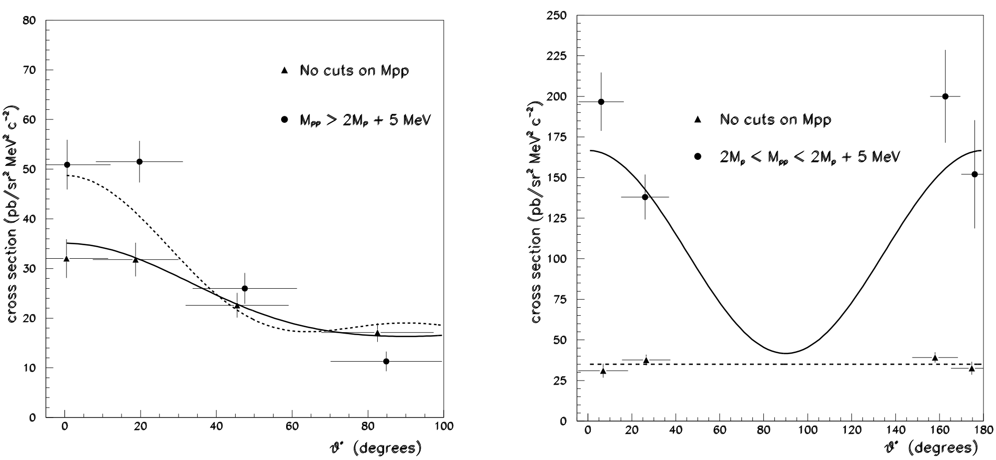

Fig. 1.

Several narrow structures were extracted in the mass range $560 \leq M_X \leq 750$ MeV. Indeed the data do show narrow structures at 588, 608, 647, 681 and 700 MeV which were not identified in previous works. Fig. 2 (left) shows a selection of some results. These data correspond to 9° lab., and in addition to η meson peak, they show several narrow structures, from top to bottom:

(a) T_p=1805 MeV, forward c.m. angles, and structures at M=588 MeV (SD= 4) and M=647 MeV (SD= 4.6), where SD is the number of standard deviations;

(b) T_p=2100 MeV, backward c.m. angles, and structures at M=588 and 608 MeV;

(c) T_p=2100 MeV, forward c.m. angles, ${}^1S_0$ cuts for M_{pp}, and structures at M=647 and 753 MeV.

These masses were compared with success, to values obtained using the following two parameter phenomenological mass formula [3] for two quark clusters:

$$M = M_0 + M_1[i_1(i_1+1) + i_2(i_2+1) + (\tfrac{1}{3})s_1(s_1+1) + (\tfrac{1}{3})s_2(s_2+1)]\,. \quad (2)$$

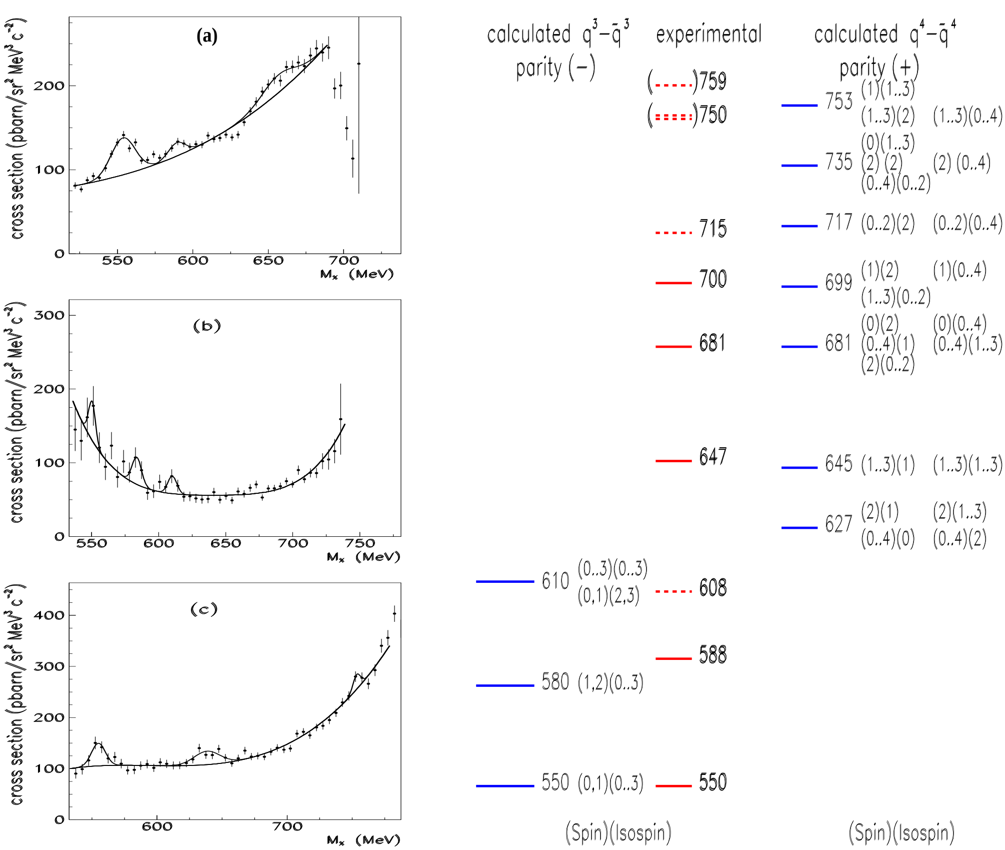

Fig. 2.

This comparison is shown in Fig. 2 (right) for the values: M_1=30 (27) MeV and M_0=310 (357) MeV for $q^3 - \bar{q}^3$ ($q^4 - \bar{q}^4$) clusters respectively. Due to large degenerascy involve by equation (2), another value for M_0 (M_0=519 MeV), allow to get the same level scheme between 627 and 753 MeV in case of ($q^4 - \bar{q}^4$) clusters. The formula allows to predict possible spins and isospins for these possible spin and isospin values will levels. For different M_0, the be different. An enhancement at $M_{\pi^+\pi^-}$=759 MeV was already observed [4] in the $np \to np\pi^+\pi^-$ reaction at Dubna. A state at $M = 749{\pm}30$ MeV ($\Gamma = 32{\pm}17$ MeV) was extracted from the triple pion effective mass of the $\pi^- A \to \pi^+\pi^-\pi^- A$ reaction [5]. A state called $\sigma(750)00^{++}$, $M = 744 \pm 5$ MeV, $\Gamma = 77 \pm 22$ MeV was extracted from the $\pi^- p \to \pi^-\pi^+ n$ reaction [6].

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