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Energy dependence of $e^+e^- \to 6\pi$ and $e^+e^- \to N\bar{N}$ cross sections near the $N\bar{N}$ threshold

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Using recent BABAR, CMD-3 and SND data, the sum of $e^+e^- \to 3(\pi^+\pi^-)$, $2(\pi^+\pi^-\pi^0)$, $p\bar{p}, n\bar{n}$ cross sections is obtained. Unlike $e^+e^- \to 3(\pi^+\pi^-)$ and $e^+e^- \to 2(\pi^+\pi^-\pi^0)$ processes, no structures in total cross section are found near the $N\bar{N}$ threshold within the limits of measurement errors.

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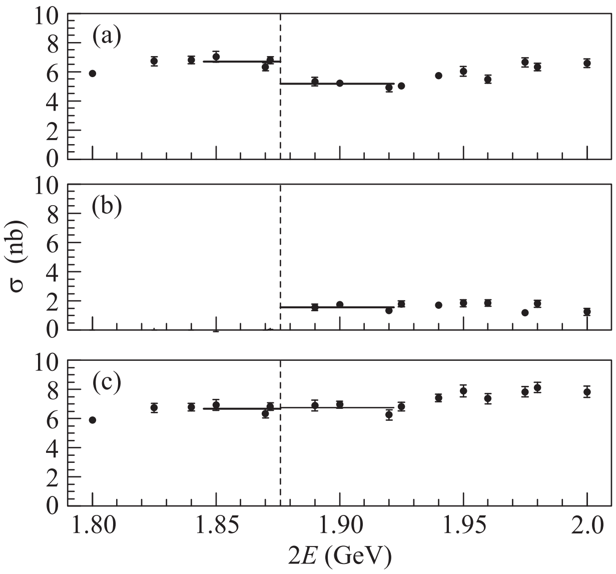
First observation of six-pion production in electron-positron annihilation was performed in $\mu\pi$ experiment at ADONE collider [1]. The dip in $e^+e^- \to 3(\pi^+\pi^-)$ cross section near the $N\bar{N}$ threshold was found in DM1 experiment at DCI [2]. Later, it was confirmed by more precise measurements in FOCUS [3] and BABAR [4] experiments. The similar structure also was observed in $e^+e^- \to 2(\pi^+\pi^-\pi^0)$ mode [4, 5]. One of the possible theoretical explanations of this dip suggests the existence of $p\bar{p}$ underthreshold bound state [6].

Recently, more precise BABAR and SND data on $e^+e^- \to p\bar{p}$ [7] and $e^+e^- \to n\bar{n}$ [8] cross sections were published together with the new CMD-3 data on $e^+e^- \to 3(\pi^+\pi^-)$ [9] and $e^+e^- \to 2(\pi^+\pi^-\pi^0)$ cross sections [10].

We suggest that the sum of $e^+e^- \to$ *hadrons* cross sections including $N\bar{N}$ final state should contain no structure near the $N\bar{N}$ threshold due to absence of quark-antiquark resonances in this energy range.

For the purposes of this work only $e^+e^- \to 3(\pi^+\pi^-)$, $e^+e^- \to 2(\pi^+\pi^-\pi^0)$, and $e^+e^- \to N\bar{N}$ processes can be considered, as far as the cross sections of $e^+e^- \to 2\pi, KK, 3\pi, KK\pi, 4\pi, KK\pi\pi, 5\pi, \ldots$ don't contain structures near the $N\bar{N}$ threshold [11]. We use CMD-3 data on $e^+e^- \to 6\pi$ processes, BABAR and SND data on $e^+e^- \to N\bar{N}$ processes. The sum of isovector $e^+e^- \to 3(\pi^+\pi^-)$ and $e^+e^- \to 2(\pi^+\pi^-\pi^0)$ cross sections with isoscalar $e^+e^- \to \eta\pi^+\pi^-\pi^0$ background subtraction [12] is shown in Fig. a. The sum of $e^+e^- \to p\bar{p}$ and $e^+e^- \to n\bar{n}$ cross sections is shown in Fig.b. These sums are fitted by constants in the energy ranges $2E = 1.85{-}1.876$ and 1.876–1.92 GeV. The cross section discontinuity values are: $\Delta\sigma = -1.5 \pm 0.2$ nb for the sum of $e^+e^- \to 6\pi$ processes, $\Delta\sigma = 1.6 \pm 0.25$ nb for the sum of $e^+e^- \to N\bar{N}$ processes. For the total sum of $e^+e^- \to 6\pi$ and $e^+e^- \to N\bar{N}$ processes $\Delta\sigma = 0.1 \pm 0.3$ nb (Fig. c). The quoted uncertainties include both statistical and systematic errors. The total cross section doesn't contain structures within measurement error limits.



The sum of $e^+e^- \to 3(\pi^+\pi^-)$ and $e^+e^- \to 2(\pi^+\pi^-\pi^0)$ cross sections with $e^+e^- \to \eta\pi^+\pi^-\pi^0$ background subtraction (a). The sum of $e^+e^- \to p\bar{p}$ and $e^+e^- \to n\bar{n}$ cross sections (b). The (a)+(b) sum (c). Only statistical errors are shown. The dashed line is the $N\bar{N}$ threshold

We suggest that negative discontinuity in the cross section of $e^+e^- \to 6\pi$ processes at the $N\bar{N}$ threshold can be quantitatively explained by the opening of new annihilation channel $e^+e^- \to N\bar{N}$. However, it is un-

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clear, why it is isovector $e^+e^- \to 6\pi$ final state that provide nearly full compensation in the total cross section $e^+e^- \to hadrons$.

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