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SEARCH FOR THE NEUTRAL DECAYS $\omega^0 \to \eta\gamma$ AND $\omega^0 \to \pi^0\pi^0\gamma$

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The best determination of the fraction of neutral decay modes of ω^0 particles, defined as the ratio $\frac{\omega^0 \to \text{neutrals}}{\omega^0 \to \text{all modes}}$, cluster around 10% with an error of a few percent. This paper is designed for search for the neutral modes of the ω^0 particles: $\omega^0 \to \pi^0 \gamma$, $\omega^0 \to \eta \gamma$, $\omega^0 \to \pi^0 \pi^0 \gamma$ investigated not enough up to now.

1. Experimantal Procedure

The scanning of stereophotographs of 26-litre JINR xenon bubble chamber irradiated to a 2.34 GeV/c π^+ beam was done for one-prong events. The selected events may be interpreted as the interactions of the π^+-mesons with quasi-free neutrons of xenon nuclei[1]:

$$\pi^+ + n \to X + p \qquad (1)$$
$$\hookrightarrow 3\gamma, 5\gamma$$

The detailed analysis and description of the method of investigation was done in our work concerning the study of neutral bosons decaying into π^0-mesons and γ-quanta[2]. The efficiency

of detection of γ -quantum, by condition that its energy is measurable with an accuracy no less than 35%, is, in average, 85%. In each event the angles of γ -quanta emission, with an accuracy $\Delta\Theta_\gamma = (0.5 - 2)^\circ$, and the energies of γ -quanta, E_γ, with an accuracy $\Delta E_\gamma / E_\gamma \leq 35\%$ were estimated. The precision of the effective mass estimation is the function of the number of γ -quanta, and in average makes up $\Delta M_{3\gamma} / M_{3\gamma} \approx 12\%$ and $\Delta M_{5\gamma} / M_{5\gamma} \approx 9\%$, by given $\Delta\Theta_\gamma$ and $\Delta E_\gamma / E_\gamma$. In each event the effective mass $M_{2\gamma}$ which represents the mass of π^0 -meson or η -meson is well resolved. The mass value interval accepted for π^0 -meson was (90 -180) MeV, and that for η -meson (400 -700) MeV. Then, it was possible to distinguish the events like the $\omega^0 \to \pi^0 \gamma$, $\omega^0 \to \eta\gamma$, and $\omega^0 \to \pi^0 \pi^0 \gamma$ decays.

2. Experimental Data

Out of over 500 000 stereophotographs of the chamber 250 events of the type (1) with three γ -quanta and 44 events with five γ -quanta were selected. In addition, 33 three γ -events and 15 five γ -events were unmeasurable.

Only the distributions of $M^{3\gamma}_{3\gamma}(\pi^0\gamma, \eta\gamma)$ and $M^{5\gamma}_{5\gamma}(\pi^0\pi^0\gamma)$ will be here under consideration. The correlations of two γ -quanta give the effective mass showing presentation of one π^0 -meson or one η -meson in almost all three γ -events and two π^0 -mesons in all five γ -events.

In Fig.1 the distribution of the effective mass $M^{3\gamma}_{3\gamma}$ is shown in sample of 179 three γ -events in which the E_γ sum of three γ -quanta is no less than 700 MeV and the angle of cone formed by directions of three γ -quanta emission satisfying the

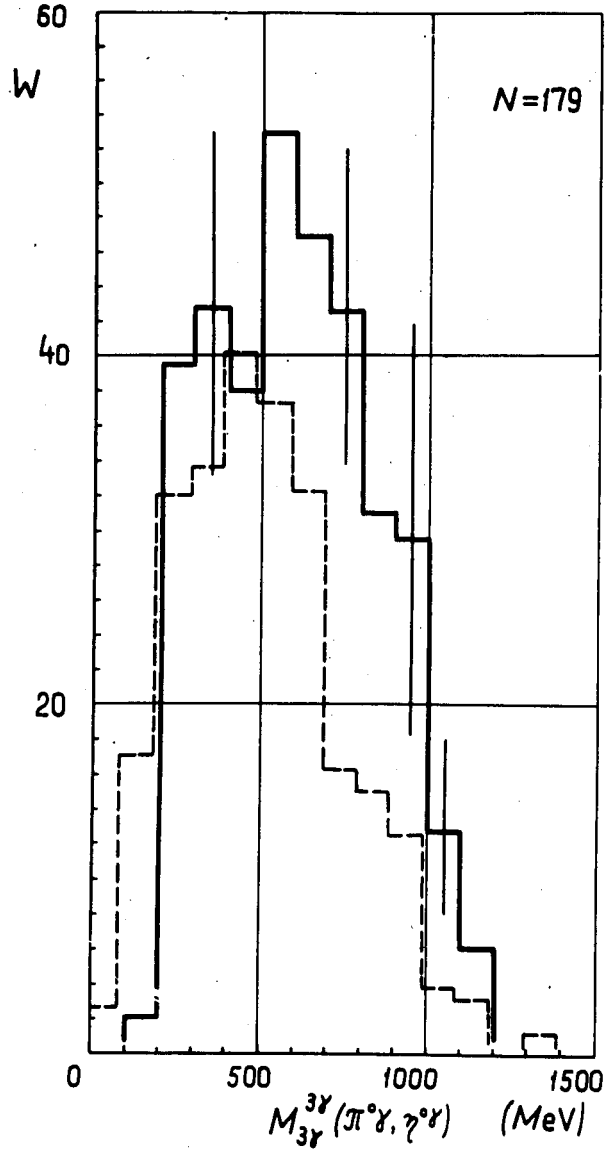

Fig.1. Distribution of $M_{3\gamma}^{3\gamma}(\pi^0\gamma,\eta\gamma)$ in three γ-events of type (1). $\Sigma E_\gamma \geq 700$ MeV, $\sin\beta/2 \geq 0.32$. Dotted line presents the background from four γ-events normalized to $M_{3\gamma}^{3\gamma} < 500$ MeV.

relation $\sin\beta/2 \geq 0.32$. The dotted line represents the distribution of $M^{3\gamma}_{4\gamma}(\pi^0\gamma,\eta\gamma)$ evaluated from four γ-events and normalized to the mass value interval $M^{3\gamma}_{3\gamma}(\pi^0\gamma,\eta\gamma) \leq 500$ MeV. Similar distributions of $M^{3\gamma}_{3\gamma}$, but by more restricted conditions for the sum of the γ-quanta energies: $\Sigma E_\gamma \geq 1100$ MeV, $\Sigma E_\gamma \geq 1300$ MeV are presented in Fig. 2.

The histogram presenting the $M^{5\gamma}_{5\gamma}(\pi^0\pi^0\gamma)$ distribution is shown in Fig.3. By the dotted line the background from six γ-events normalized to the mass value $M^{5\gamma}_{5\gamma}(\pi^0\pi^0\gamma) \leq 500$ MeV is drawn.

3. Results and Discussion

From the shapes of the distributions of $M^{3\gamma}_{5\gamma}$, $M^{3\gamma}_{6\gamma}$ follows that the contamination of $M^{3\gamma}_{5\gamma}$ and $M^{3\gamma}_{6\gamma}$ in the background in $M^{3\gamma}_{3\gamma}$ distribution is not significant in the region of ω mass value. The analysis of the angular and energy spectra of γ-quanta in 3γ-, 4γ-, 5γ- and 6γ-events indicates that the loss of three γ-events and five γ-events cannot be essentially different. Then, the ratio of the number of events with 5γ to the number of events with 3γ are very near the reality.

From the distribution presented in Fig.1. follows the existence of some number of events lying above the background level, and which may be explained as the $\omega^0 \to \pi^0\gamma$ and $\omega^0 \to \eta\gamma$. The average effective mass value $\bar{M}(\pi^0\gamma,\eta\gamma) = 790 \pm 12$ MeV. 19 ± 6 events like $\omega^0 \to \eta\gamma$ and 86 ± 12 events like $\omega^0 \to \pi\gamma$ are within the mass interval 650 MeV $\leq M^{3\gamma}_{3\gamma} \leq$ 900 MeV.

In the sample of five γ-events we have find 22 ± 10 lying above the background level. The average effective mass for events at the peak region $\bar{M}(\pi^0\pi^0\gamma) = 789\pm14$ MeV.

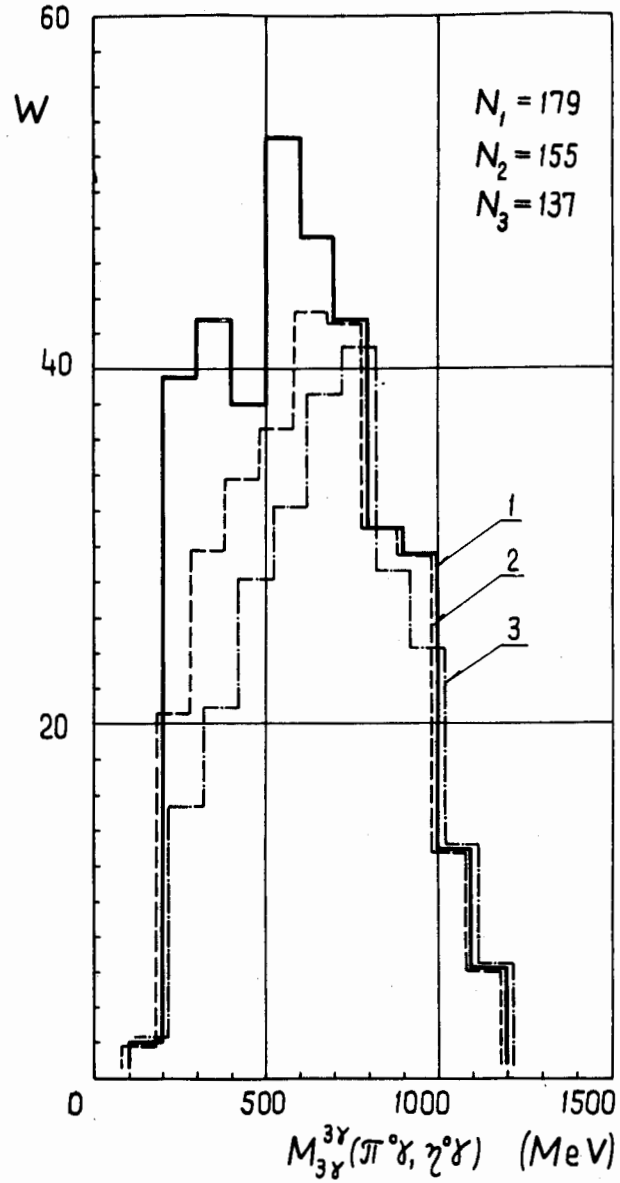

Fig.2. Distribution of $M_{3\gamma}^{3\gamma}(\pi^0\gamma, \eta\gamma)$ for three γ-events.
1. $\Sigma E_\gamma \geq 700$ MeV. 2. $\Sigma E_\gamma \geq 1100$ MeV. 3. $\Sigma E_\gamma \geq 1300$ MeV.

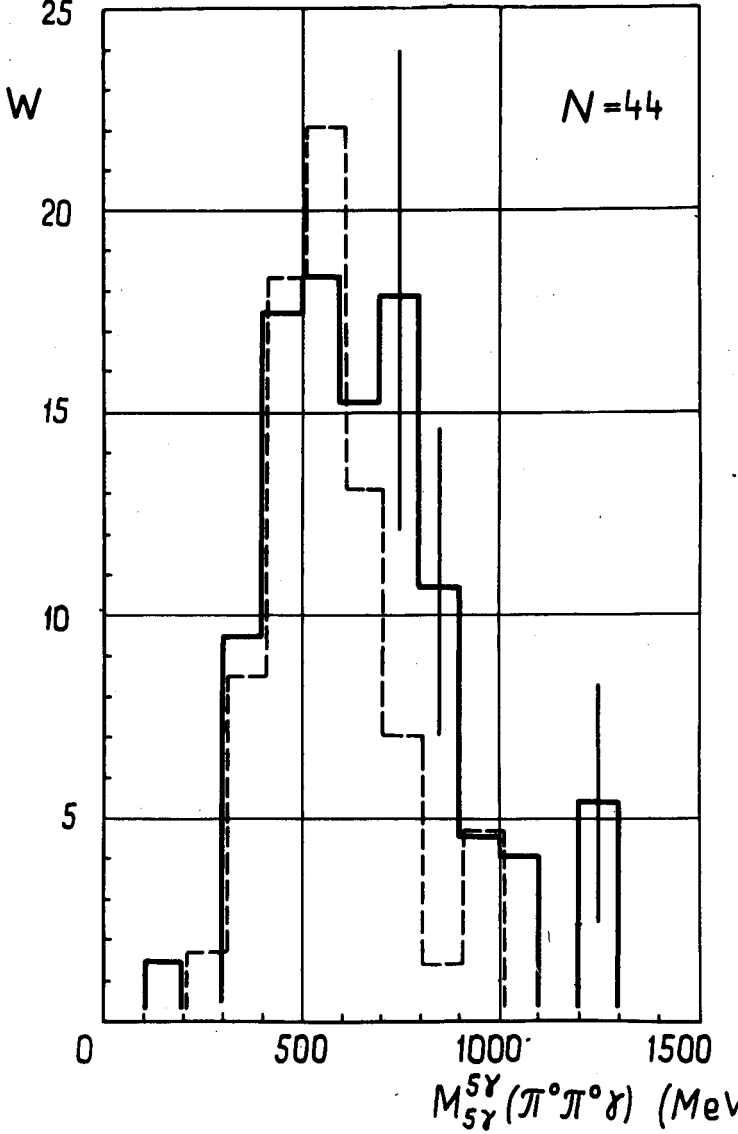

Fig.3. Distribution of $M_{5\gamma}^{5\gamma}(\pi^0\pi^0\gamma)$ in the sample of five γ-events. Dotted line presents the background from six γ events normalized to the $M_{5\gamma}^{5\gamma} \leq 500$ MeV.

The analysis of the experimental data leads to the following ratios:

$$R_1 = \frac{N(\omega^0 \to \eta\gamma \to \gamma\gamma\gamma)}{N(\omega^0 \to \pi^0\gamma)} = 0.22 \pm 0.11, \quad (2)$$

$$R_2 = \frac{N(\omega^0 \to \pi^0\pi^0\gamma)}{N(\omega^0 \to \pi^0\gamma)} = 0.45 \pm 0.33. \quad (3)$$

References

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