First KLOE results on scalar mesons

The KLOE Collaboration[a]
presented by A. Farilla
INFN - Rome III (Italy)

During its first year of data taking in 1999 the KLOE experiment[a,1], which is presently running at Daϕne in Frascati, has collected 2.4 pb^{-1} of integrated luminosity corresponding to ~8 Millions ϕ decays. This data sample has been used to study the radiative decays $\phi \to f_0\gamma$,$\phi \to a_0\gamma$. The preliminary results are reported in this paper and in Ref.2.

[a]The full author list can be found in ref.[2]

1 Introduction

The light scalar mesons $f_0(980)$ and $a_0(980)$ have defied classification for nearly half a century: they do not conform to the standard $q\overline{q}$ quark model expectations both in the total width (predicted Γ ~500 MeV, observed Γ ~50 MeV) and in the $\gamma\gamma$ coupling (predicted ~4.5 keV for f_0, ~1.5 keV for a_0, observed $\leq$0.6 keV for f_0, ~0.2 keV for a_0). In the last decades many models have been worked out in order to accomodate their properties as can be seen by other contributions to this working group [3]. Since the branching ratios of $\phi \to f_0\gamma$,$\phi \to a_0\gamma$ can range from 10^{-4} to 10^{-6}, depending on the nature of f_0,a_0, their accurate measurement at a ϕ factory can help in solving the puzzle. Moreover a precise determination of the shape of the $\pi\pi$ mass spectrum in f_0 decays and of the $\eta\pi$ mass spectrum in a_0 decays can help in establishing a realistic model for these particles.

2 $\phi \to f_0\gamma \to \pi^0\pi^0\gamma$

The signature for this decay are 5 prompt photons in the detector and no charged tracks. The main background comes from the non-resonant process $e^+e^- \to \omega\pi^0$. Other background processes are $\phi \to \rho\pi^0, \phi \to a_0\gamma, \phi \to \eta\gamma$ with only photons in the final state. A constrained kinematic fit and suitable topological cuts are applied to reduce the background. The final detection efficiency is $\sim$ 40%. In a data sample of 1.8 pb^{-1} 307 ± 18 $\pi^0\pi^0\gamma$ events have been selected, with a background of 112 ± 11 (estimated from MonteCarlo), corresponding to a Br($\phi \to f_0\gamma \to \pi^0\pi^0\gamma$)= $(0.81\pm0.09_{stat}\pm0.06_{syst})\cdot10^{-4}$. Different topological cuts have been applied to the same data sample to select $\omega\pi^0$ events (detection efficiency $\sim$ 35%) resulting in 529$\pm$23 events with a background of 93±10 events (estimated from MonteCarlo). This correspond to a cross section $\sigma(e^+e^- \to \omega\pi^0)$=0.67±0.04$_{stat}$±0.05$_{syst}$ nb.

3 $\phi \to f_0\gamma \to \pi^+\pi^-\gamma$

The signature for this decay are two charged tracks from the origin and a prompt photon. There is high background both from Initial State Radiation (I.S.R.) and from Final State Radiation (F.S.R.). The latter process gives rise to interference (whose sign is still unknown) with the signal.
$\pi^+\pi^-\gamma$ events have been selected in a sample of 1.8 pb^{-1} with an overall efficiency of $\sim$ 50%. Fitting the $M^2_{\pi\pi}$ spectrum in the background region ($M^2_{\pi\pi} < 0.84 GeV^2$) and extrapolating in the signal region ($M^2_{\pi\pi} > 0.84 GeV^2$) we obtain the upper limit: Br($\phi \to f_0\gamma \to \pi^+\pi^-\gamma$)$< 1.6 \cdot 10^{-4}$ at 90% C.L.

4 $\phi \to a_0\gamma \to \eta\pi^0\gamma$, with $\eta \to \gamma\gamma$

The signature for this decay is similar to the $\phi \to f_0\gamma \to \pi^0\pi^0\gamma$ decay, namely 5 prompt photons in the detector and no charged tracks. The main background processes are $e^+e^- \to \omega\pi^0$ and $\phi \to f_0\gamma, \phi \to \rho\pi^0, \phi \to \eta\gamma$ with only photons in the final state. A constrained kinematic fit and suitable topological cuts are applied to reduce the background. The final detection efficiency is $\sim$ 23%. In a data sample of 2.4 pb^{-1} 74 ± 9 $\eta\pi^0\gamma$ events have been selected, with a background of 21±6 (estimated from MonteCarlo), corresponding to a Br($\phi \to \eta\pi^0\gamma$)= (0.77±0.15$_{stat}$±0.10$_{syst}$)$\cdot 10^{-4}$ which results in Br($\phi \to a_0\gamma \to \eta\pi^0\gamma$)= (0.69±0.15$_{stat}$±0.10$_{syst}$)$\cdot 10^{-4}$ in the a_0 region.

In conclusion our preliminary measurements seem to favour B.R. O(10^{-4}) for $\phi \to f_0\gamma, \phi \to a_0\gamma$ and are in agreement with the latest results of the SND [4] and the CMD-2 [5] experiments at VEPP-2M.

References

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