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η' DECAYS WITH WASA-AT-COSY

Benedykt R. Jany[∞⋆1] and David Duniec[#2]
for the WASA-at-COSY Collaboration

[∞]Nuclear Physics Division, Jagiellonian University, 30059 Cracow, Poland
[⋆]IKP-2, Forschungszentrum-Jülich, 52428 Jülich, Germany
[#]Department of Nuclear and Particle Physics, Uppsala University, 75121 Uppsala, Sweden

Abstract

This article describes the physics of the $\eta' \to \eta\pi\pi$ decays. Predictions of the Chiral Unitary Approach for these decays are discussed. The first look into high energy data of a commissioning of WASA-at-COSY are presented.

1 Theory overview and predictions

The strong, isospin conserving decays of the η' into three mesons, $\eta' \to \pi\pi\eta$ are responsible for most (65.3% [1]) of the total decay width of the η'. There are some data available for these decays [2–5], with at most about ten thousand events. Another very interesting decay is $\eta' \to \pi^+\pi^-\pi^0$ which violates the Isospin Symmetry and was never measured. These decays allow to study fundamental symmetries of QCD, for example, by means of Chiral Unitary Approach framework [6]. One uses the low energy expansion of QCD – Chiral Perturbation Theory together with relativistic coupled channels, via Bethe-Salpeter Equation (BSE). Based on the framework and on the available data one can predict distributions of the decay products of hadronic η' decays. In Fig. 1, the expected shape of the Dalitz plot for $\eta' \to \pi\pi\eta$ is shown. The influence of $a_0(980)$ $(I = 1)$ Fig. 1a or $f_0(980)/\sigma$ $(I = 0)$ Fig. 1b in the final state can be observed by different populations in the Dalitz plot. The limited statistics of the existing experimental data does not allow to distinguish between the two possible scenarios since the difference is small (the total variation of the Dalitz plot densities is only 20%). The Branching Ratio(1.8%) and Dalitz plot for the yet unobserved $\eta' \to \pi^+\pi^-\pi^0$ decay is predicted in Fig. 2.

[1]E-mail address: b.jany@fz-juelich.de, jany@if.uj.edu.pl
[2]deceased

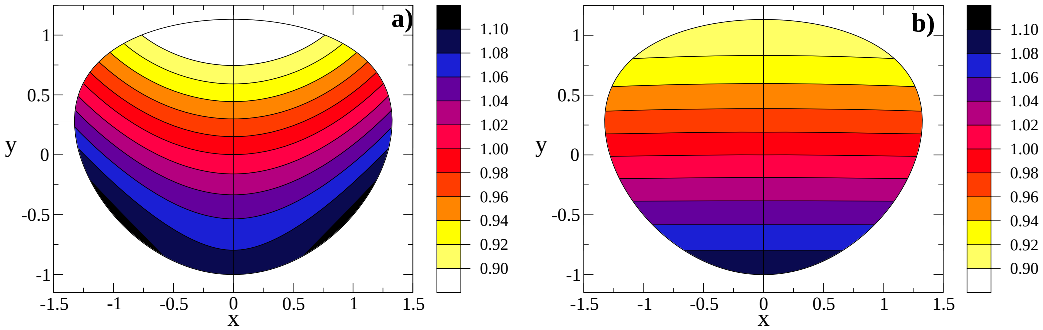

Figure 1: Predicted Dalitz Plot for the $\eta' \to \pi\pi\eta$ decay: a) with $a_0(980)$ dominance, b) with $f_0(980)/\sigma$ dominance [8].

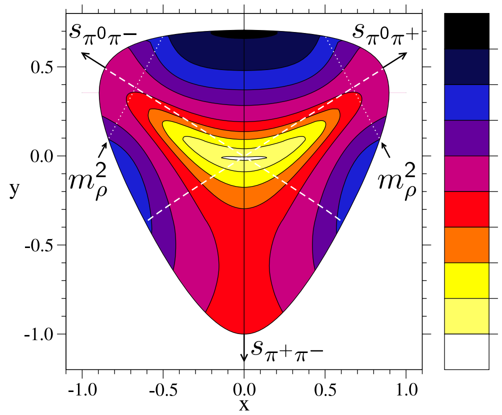

Figure 2: Predicted Dalitz Plot for the $\eta' \to \pi^+\pi^-\pi^0$, one sees $\rho^\pm(770)$ dominance [7].

2 Data First Look

The recently commissioned WASA-at-COSY detector [9] at the COSY accelerator in Jülich is well suited to study decays of the η' meson. It has a large acceptance with nearly 4π sr coverage and both charged and neutral decay products can be measured. During commissioning a total of about 45 hours of data was taken at the proposed η' production proton beam momentum 3.35GeV/c for the $pp \to ppX$ reaction. The analysis of this data has focused on the experimentally clean $\eta' \to \pi^0\pi^0\eta \to 5\pi^0 \to 10\gamma$ reaction channel. One finds events consistent with the η' signal in the plot of the invariant mass of the 10 reconstructed photons versus the missing mass of the two protons, as shown on Fig. 3a. If one looks at the projection onto the invariant mass and missing mass axis Fig. 3b, Fig. 3b, one observes about 20 η' candidates. This is consistent with luminosity estimates based on the monitoring reaction $pp \to pp(\eta \to \gamma\gamma)$ collected simultaneously.

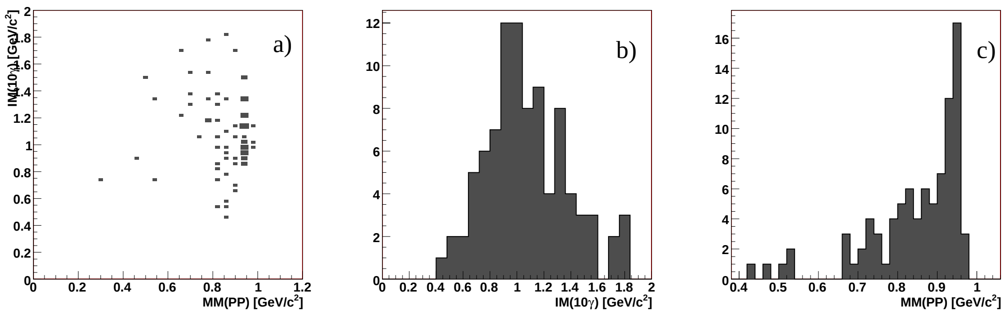

Figure 3: Results of a first Look onto Data: a) Invariant Mass of 10 reconstructed photons versus Missing Mass of 2 charged tracks, b) Projection to the Invariant Mass axis, c) Projection to the Missing Mass axis.

3 Summary

The hadronic decays of η' are well suited to study symmetries in nature and to provide experimental verifications of the Chiral Unitary Approach predictions. The first results gives confidence that the WASA-at-COSY detector can contribute with precise data.

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