Towards the Electromagnetic Transition Form Factor of the η Meson with WASA-at-COSY

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We present a study of the Dalitz decay $\eta \to \gamma e^+e^-$. The aim is to determine the transition form factor of the η meson. The transition form factor describes the electromagnetic structure of the meson. The transition form factor is determined by comparing the experimental e^+e^- invariant mass distribution with the QED calculation. The analysis uses the proton-proton collision reaction at 1.4 GeV. The data has been collected with the WASA detector at COSY (Forschungszentrum Juelich, Germany). The preliminary results of the analysis will be shown.

KEYWORDS: Dalitz decay, Transition form factor, Conversion decay...

1. Introduction

The electromagnetic transition form factor is important as it describes the intrinsic structure of the hadrons. The electromagnetic transition form factor of the η meson can be deduced by studying its Dalitz decay ($\eta \to \gamma^*\gamma \to e^+e^-\gamma$). In this decay, a virtual photon decays into di-lepton pairs. Hence, the squared momentum transferred by the virtual photon is equivalent to the squared invariant mass of the lepton-antilepton pair. The decay rate for a point-like particle can be calculated within Quantum Electrodynamics (QED). However, the complex structure of the particle causes a deviation in the decay rate. Transition form factor can be measured by comparing the lepton-antilepton invariant mass distribution in the experiment with the QED calculation. The transition form factor of the η meson can be determined using the following equation 1 [1].

$$\frac{d\Gamma(\eta \to \gamma e^+e^-)}{dq^2 \cdot \Gamma(\eta \to \gamma\gamma)} = \frac{2\alpha}{3\pi}[1 - \frac{4m_e^2}{q^2}]^{1/2}[1 + \frac{2m_e^2}{q^2}]\frac{1}{q^2}[1 - \frac{q^2}{m_\eta^2}]^3 \mid F_\eta(q^2) \mid^2 \tag{1}$$

Where m_e stands for the lepton mass, m_η is the mass of the η meson and q^2 is the squared four-momentum transfer of the virtual photon. The transition form factor is usually parameterized using single pole approximation:

$$F_\eta(q^2) = \frac{1}{1 - \frac{q^2}{\Lambda^2}} \quad . \tag{2}$$

The slope of the form factor is related with the radius of the charge distribution. In a recent measurement, the value of the slope of the form factor $\Lambda^{-2} = (1.95 \pm 0.15_{stat} \pm 0.10_{syst})\ GeV^{-2}$ [2] has been reported by CB/TAPS at MAMI collaboration. Their result matches with the recent theoretical calculation and the Vector Meson Dominance (VMD) model. We expect to measure a more precise value for the transition form factor with our high statistics data.

The study of light mesons like π^0, η and η' has also been proved as a good testing ground for the model like VMD, where the photon-hadron interaction is mediated via a vector meson. The transition