Isotopic effect in ϕ photoproduction at a few GeV

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Traditionally, the $\gamma p \to \phi p$ reaction is considered as a tool to study the Pomeron exchange dynamics, implying that (i) the vector meson dominance model is valid, and (ii) other hadronic mechanisms are suppressed by OZI rule. But our detailed analysis of the ϕ photoproduction amplitude [1, 2] shows that at $E_\gamma = 2-3$ GeV it is sensitive to the hadronic mechanisms as well and may be used for its study. Thus, the pseudoscalar exchange amplitude is the interference of the π and η exchanges. This interference is different for the proton and neutron target: it is constructive/distractive for $\gamma p/\gamma n$ reactions, respectively, and as consequence, the contribution of the unnatural parity exchange amplitude at forward direction for γp and γn reactions is different which may be seen in some of polarization observables. The difference depends on the value of ηNN coupling constant which status is not so clear. The value of $g^2_{\eta NN}/4\pi$ reported in the literatures varies from 0 to about 7. The largest value comes from fits to NN scattering data, using one boson exchange potential models [4]. But many other studies [5] favor a smaller value, $g^2_{\eta NN}/4\pi \sim 0.3 - 1.0$. In our calculation we accept the SU(3) symmetry prediction based on the most recent value of $F/D = 0.575$.

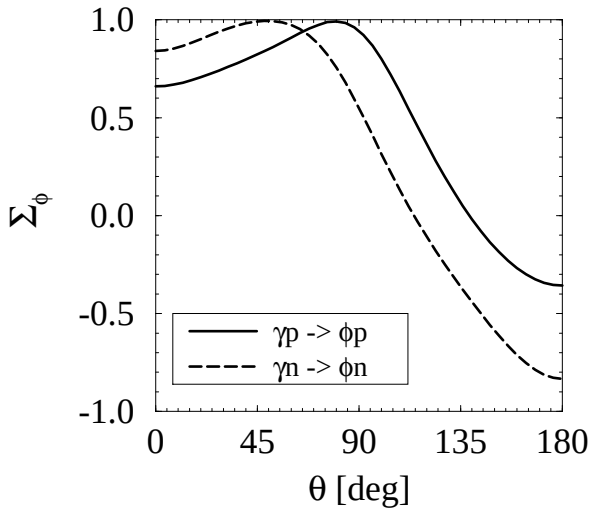

Figure 1: The ϕ decay asymmetry Σ_ϕ as function of θ at E_γ=2 GeV.

As an example, we show in Fig.1 our prediction of the ϕ decay asymmetry [3]

$$\Sigma_\phi = \frac{\sigma_{||} - \sigma_\perp}{\sigma_{||} + \sigma_\perp}, \tag{1}$$

where $\sigma_{||}(\sigma_\perp)$ are the cross sections induced by photons polarized in the direction parallel (perpendicular) to the $\gamma - \phi$ plane. These two cross sections refer to measurements of the

symmetrical K^+K^- pairs produced in the ϕ decay. Our prediction of Σ_ϕ at $E_\gamma = 2$ GeV is shown in Fig.1.

We find that the predicted isotopic effect at forward angles is largely due to the $\pi - \eta$ interference. Consequently, the predicted energy-dependence at $\theta = 0$ shown in the left panel of Fig.2 can be used to explore the relatively undetermined ηNN coupling constant. To facilitate such a study, we show the dependence of $\Sigma_\phi(\theta = 0)$ on $g_{\eta NN}$ in the right panel of Fig.2. At large angles, the cross sections are dominated by the direct $\phi-$radiation amplitude, which is also different for the γp, γn reactions. Hence a measurement of Σ_ϕ at large angles can be used to study the ϕNN coupling.

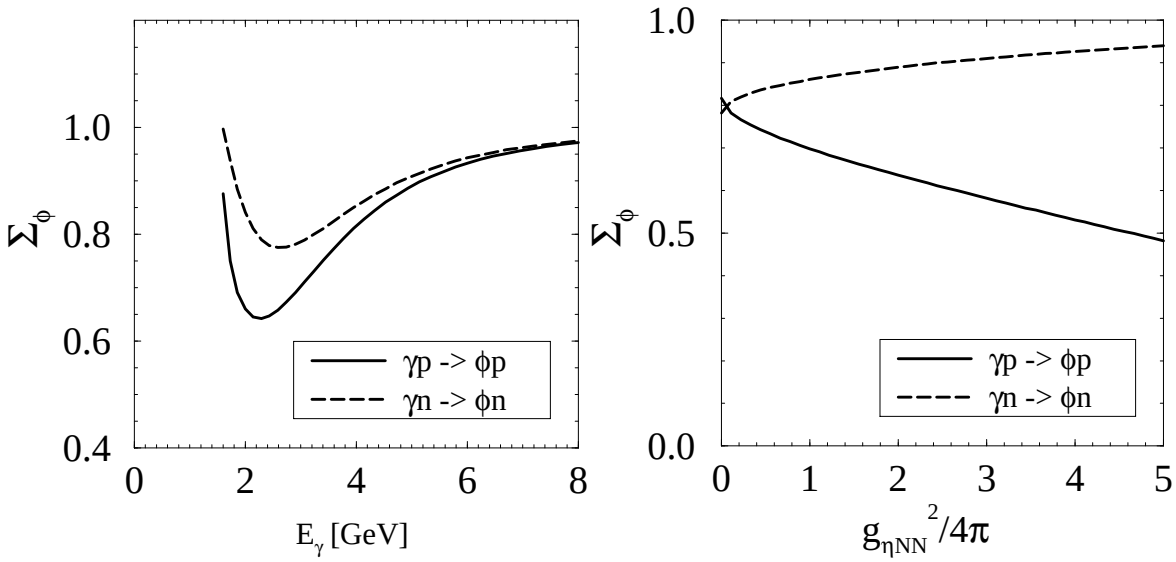

Figure 2: The ϕ decay asymmetry Σ_ϕ at $\theta = 0$ as a function of the photon energy (left panel) and as a function of the ηNN coupling constant (right panel).

References

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