The Eta-Photoproduction in the Relativistic Approach

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The (γ,η) reaction on nuclear targets is an ideal tool to study in-medium properties of baryons because the η is produced primiriry through excitation of $S_{11}(1535)$ resonance which shows a prominent resonant behaviour with little background. Recently Yorita et al. [1] measured the $(\gamma,\ \eta)$ cross section of Carbon and found an evidence of such in-medium effects, namely, their experimental results prefer 212 MeV as the width of the S_{11} resonance, while recent data for the elementary $H(\gamma,\eta)H$ reaction is explained with a width of 154 ± 20 MeV [2].

We investigate in this work the in-medium effects of the S_{11} resonance within the RMF approach by varing the Dirac fields of the nucleon and the S_{11} resonance separately. The parameter-sets of nuclear self-energies is given with PM1 [3]. On the contrary, we do not have any information on the S_{11}-resonance mean-fields. Then we fix the ratio of scalar and vector self-energies for nucleon (N) and the S_{11}-resonance (R):

$$u_r = \frac{U_s(R)}{U_s(N)} = \frac{U_0(R)}{U_0(N)}, \tag{1}$$

and examine effects of the S_{11}-resonance mean-fields by varing the ratio u_r.

In Fig. 1 we compare the results of photoproduction of η with the experimental data with ^{12}C target. The solid line, long-dashed line and dashed lines show the results for $u_r = 0$, $u_r = 0.5$ and $u_r = 1$, respectively. We can see that the calculation result well agrees with experimental data in the case that $u_r = 0$. This result can be explained with the following mechanism. The small Dirac-fields of S_{11}-resonance shift the peak to higher energy due to the binding effects, and the small effective mass of nucleon enlarges the width. The large resonance Dirac-fields also enlarge the width, but suppress the peak-shift, and it cannot explain the experimental data. Namely, in-medium modification of nucleon, such as small effective mass, plays more significant role than that of the resonance.

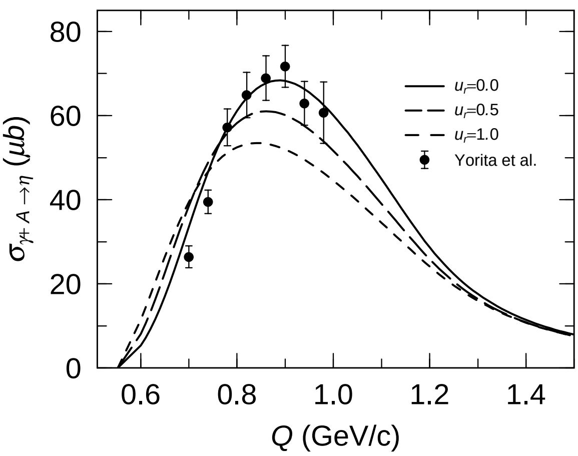

Fig. 1: Cross-section for eta photoproduction on ^{12}C targets. The solid, long dashed and dashed lines indicate the results with $u_r = 0.0, 0.5, 1.0$, respectively. Full circles show the experimental data [1].

In this work we investigate in-medium effects for the eta photoproduction. We use the RMF approach and calculate the η-production cross-section varing the Dirac-fields of S_{11}-resonance. As a result small Dirac-fields of S_{11}-resonance gives the best results though the nucleon fields are not small.

References

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