

Comment on “Evidence for narrow resonant structures at $W \approx 1.68$ GeV and $W \approx 1.72$ GeV in real Compton scattering off the proton”

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(Received 8 July 2015; published 11 December 2015)

We comment on the statement by Kuznetsov *et al.* that the structure around $W = 1.72$ GeV seen in the beam asymmetry in Compton scattering off the proton is not observed in the total cross section of η photoproduction on the neutron.

DOI: 10.1103/PhysRevC.92.069801

PACS number(s): 14.20.Gk, 13.60.Rj, 13.60.Le

In a recent paper Kuznetsov *et al.* [1] presented the results of Compton scattering off the proton from the GRAAL experiment. The discussion focused on narrow peak structures in the beam asymmetry Σ for this reaction. They related these structures to earlier observations in photoproduction of η mesons, in particular off neutrons, from the GRAAL [2], ELSA [3,4], and MAMI [5–7] facilities.

We would like to comment on one important issue that has been incorrectly raised in their paper. The structures in Compton scattering have been observed at total center-of-mass (c.m.) energies of 1681 MeV and 1726 MeV. The peak at smaller W has a prominent counterpart in η photoproduction off the neutron (although the actual peak positions from different measurement deviate by up to 15 MeV and the width is different from the structure observed in Compton scattering off the proton). However, for the structure at 1726 MeV the authors note that it has not been observed in other reactions or observables, and state in their conclusions: “On the other hand it still remains unclear . . . why the structure at $W \approx 1.72$ GeV is seen in Compton scattering and is not seen in η photoproduction on the neutron.” This statement would be very important for the interpretation of the nature of the structure, but it is not correct. Actually, at this c.m. energy there is a narrow, small—but statistically significant—structure present in already published data [5–7] for η photoproduction off the neutron. The little peak in the total cross sections in [5–7] was not explicitly discussed in these references (and is better visible in a finer binned version of these data) so that it has obviously escaped attention of the authors of [1].

In order to demonstrate this, we show in Fig. 1 the excitation functions for photoproduction of η mesons off neutrons bound in the deuteron and in ${}^3\text{He}$ nuclei. The results published in [5] are shown in the small inset with the relevant energy range magnified. Both excitation functions for the neutron show a statistically significant, although small peak at exactly the same invariant mass as the structure observed in the beam asymmetry of Compton scattering off the proton. The agreement between the measurements with the deuterium and the ${}^3\text{He}$ targets (the signals agree in position and are of comparable size and width) suggest that this signal is robust. The main part of the figure shows the excitation functions for quasifree neutrons and protons bound in the deuteron with a finer energy binning. The neutron data were fitted

with the same parametrization as used in [7], adding an additional Breit-Wigner function to account for the structure near $W = 1720$ MeV. The position was determined to be $M = (1728 \pm 1)$ MeV and a width of $\Gamma = (15 \pm 4)$ MeV was extracted. The indicated uncertainties are only statistical.

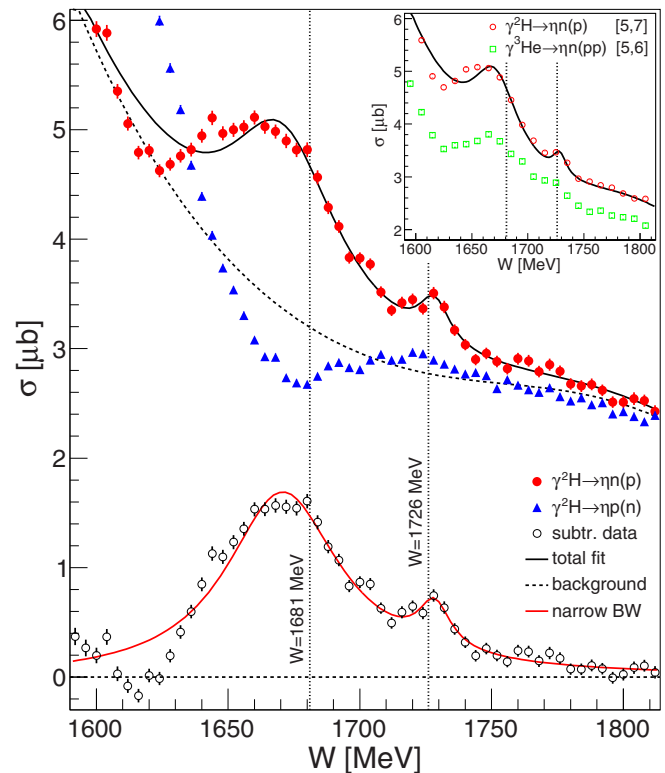


FIG. 1. (Color online) Excitation functions for quasifree photoproduction of η mesons. Inset: total cross sections for quasifree neutrons bound in the deuteron (red circles) and in ${}^3\text{He}$ nuclei (green squares). Data are as published in Fig. 1 of Ref. [5]. Fit curves include Breit-Wigner resonance for the structure at 1726 MeV. Main figure: finer binned data for the measurement with deuterium target. Red circles (blue triangles): quasifree neutron (proton) data. Curves: total fit (solid black curve), background contributions (dashed black curve), and sum of two narrow signal Breit-Wigner functions (red solid curve). Open black circles: background-subtracted neutron data. Vertical lines: markers at $W = 1681$ MeV and $W = 1726$ MeV.

The nature of these structures and the relation between the results from Compton scattering off the neutron [8] and the proton [1] and η photoproduction off the neutron [2–7] are not yet understood. For η production, the prominent structure at $W \approx 1670$ MeV has been recently interpreted in the framework of the Bonn-Gatchina (BnGa) partial wave analysis mainly as an interference pattern in the S_{11} partial wave [9]. The interference between the $N(1535)1/2^-$ and $N(1650)1/2^-$ states changes sign between protons and neutrons so that it is destructive for the proton and constructive for the neutron. The comparison of proton and neutron excitation functions in this energy range (see Fig. 1) is indeed suggestive for such an interference pattern. The structure observed in Compton scattering off the proton [1] is narrower and peaks at a larger invariant mass (position indicated in Fig. 1) which coincides with a little dip in the proton cross section for η photoproduction.

The peak observed around $W \approx 1720$ MeV in the beam asymmetry of the $\gamma p \rightarrow p\gamma'$ reaction coincides exactly with the clear, statistically significant structure observed in η photoproduction with coincident detection of recoil neutrons from deuterium and ^3He nuclei. The data with coincident recoil protons may show a tiny structure at this invariant mass,

but this is at the very edge of statistical significance. The position of this structure is suspiciously close to the production threshold of ω mesons off the free neutron, $W_{\text{thr}} \approx 1722$ MeV. As already noted in Ref. [1], a detailed combined analysis of η photoproduction and Compton scattering off protons and neutrons in this energy range seems to be highly desirable to clarify the nature of this rich spectral features.

In conclusion, contrary to the statements in the paper by Kuznetsov *et al.* [1], experimental data for quasifree photoproduction of η mesons off neutrons show a significant narrow structure at precisely the invariant mass at which the second narrow peak in the beam asymmetry Σ for Compton scattering off the proton has been reported. This signal in the $\gamma n \rightarrow n\eta$ reaction is much fainter than the prominent structure at $W \approx 1670$ MeV and has therefore only been observed in the high statistics measurements with deuterium and ^3He targets at MAMI [5–7], but not in the previous GRAAL [2] and ELSA [3,4] experiments. So far it has not been discussed in any detail in the literature.

This work was supported by Schweizerischer Nationalfonds (200020-156983, 132799, 121781, 117601, 113511 and 158822).

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