Photon energy dependence of photo-neutron production from the ^{197}Au(γ,xn) reaction

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Double differential cross sections of the ^{197}Au(γ,xn) reaction for 14 MeV, 17 MeV and 20 MeV linearly polarized photon were measured at BL-01, NewSUBARU. The neutron energy distribution as a function of incident photon energy was discussed for the experimental data.

Keywords: photo-nuclear reaction, photon energy dependence, polarized photon, double differential cross section.

Introduction: The experimental data on double differential cross section (DDX) of photoneutron emission are important to evaluate photonuclear reaction models and parameters. In our previous studies, the energy spectra of photoneutron emitted from (γ,xn) reaction were obtained for medium-heavy targets with 16.6 MeV polarized photon [1,2]. The result indicates different angular dependences of low and high energy components of neutrons for all targets, and, the amount of high energy component increases with mass number of target. The energy distributions of the high energy components were not consistent with theoretical calculation [3]. Thus, the model implemented in the calculation should be improved to reproduce the experimental data. For the improvement, we measured additional experimental data on DDXs of the ^{197}Au(γ,xn) with different energies of the incident photons.

Data taking and analysis: To study the energy dependence of ^{197}Au(γ,xn) DDX, we used the same experimental setup mentioned in [2], but change the energy of incident photons. The mono-energetic, horizontal polarized photons were prepared through laser-Compton backscattering (LCS) that was collisions of the laser photons (λ=1.064 μm) and the high-energy electron beams at the NewSUBARU, BL-01. The photon energy is amplified by $4\gamma_L^2$ times at 180^0 back-scattering, where γ_L is the Lorentz factor of high-energy electrons. The electron's energies were adjusted to 892.6 MeV, 982.4 MeV, and 1068.8 MeV to select different LCS photon's maximum energies of 14 MeV, 17 MeV and 20 MeV, respectively. LCS photons were collimated to a gold target. Photoneutrons generated in the target were detected by a NE213 scintillator (12.7 cm$^{\phi}$×12.7 cm^{L}) placed at 90° horizontally and 60 cm away from the target. Because NE213 scintillators can detect neutron and gamma from target, pulse shape discrimination technique was applied to separate neutron-gamma. The neutron energy was determined using time of flight method. The number of the incident photons were counted by plastic scintillator with a 5 mm thickness. The same data analysis mentioned in previous study [2] was applied. The DDX was obtained by the spectrum normalized with solid angle, number of incident photons, photon attenuation and neutron attenuation factors.

Results: Figure 1 shows DDXs of the ^{197}Au(γ,xn) reaction for three photon energies at horizontal 90 degrees with respect to the incident photon direction. The black, red, and blue points are the DDX for 14 MeV, 17 MeV, and 20 MeV photon energies. The spectra indicate two energy components for all the incident photon energies. The low energy component shows evaporation shape and high energy doesn't. The 14 MeV result shows the highest neutron yield among three energies, that corresponds to energy dependence of the ^{197}Au(γ,xn) reaction cross section. The maximum energy of neutrons increases and the slopes of energy distribution of evaporation shaped component becomes gentle with the photon energy. The specific discussion on the photon energy dependence will be presented at the meeting.

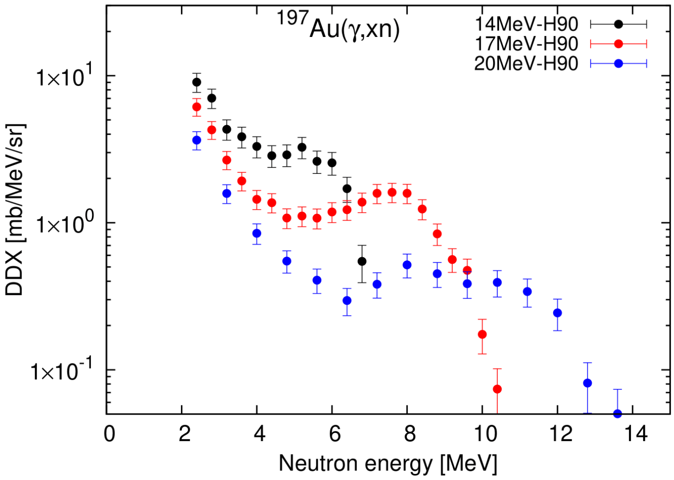

Fig. 1. DDX of ^{197}Au(γ,xn) measured with different γ energies.

References

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