Study of the Structure of the Pygmy Dipole Resonance States in ^{64}Ni via the $(p,p'\gamma)$ and $(\alpha,\ \alpha'\ \gamma)$ Reactions

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As part of the CAGRA+GR experimental campaign, the low-energy part of the $E1$ response, denoted as Pygmy Dipole Resonance (PDR) [1], was studied in the nucleus ^{64}Ni via inelastic proton and α scattering. The motivation for these experiments is manifold. One aim is to determine the full $E1$ strength distribution using the (p,p') reaction at 300 MeV to fill the gap between available results on ^{58,60}Ni [2, 3] and ^{68}Ni [4] to build up a systematic investigation of the PDR as a function of the neutron-to-proton ratio. As another aspect, the isospin character of the PDR states in ^{64}Ni is investigated. A detailed study of the 1^- states populated in the $(\alpha,\alpha'\gamma)$ reaction and the comparison to results from the $(p,p'\gamma)$ measurement will allow to proof, if the recently observed "splitting" of the low-lying $E1$ strength into groups of excited states with strong isoscalar and isovector components, respectively (see, e.g., Ref. [1, 5]) is also present in the Ni isotopes. Furthermore, the investigation of the γ-decay in ^{64}Ni will allow to constrain input parameters for nuclear astrophysical calculations in the vicinity of the branching point nucleus ^{63}Ni by the determination of the $E1$ photon strength function in ^{64}Ni.

The energy loss of the inelastically scattered protons and α particles was measured using the magnetic Grand Raiden spectrometer. In coincidence, γ-rays emitted from the target nuclei were detected by the γ-ray detector array CAGRA, which consisted of 12 Clover detectors and 4 $LaBr_3$ scintillators.

The $(p,p'\gamma)$ measurement was performed at scattering angle of 0° and with a beam energy of $E_p = 300$ MeV. For the $(\alpha,\alpha'\gamma)$ experiment, an α beam of $E_\alpha = 140$ MeV was used, while the GR spectrometer was set to 4.5° scattering angle. Each reaction was measured for about 50 hours to collect a sufficient amount of statistics, in particular for the particle-γ coincidences. Figure 1 shows very preliminary spectra of the $(\alpha,\alpha'\gamma)$ measurement. A coincidence matrix is given, showing the correlation between the measured γ-ray energy vs. the excitation energy of the target nuclei that is determined from the energy loss of the inelastically scattered α particles. Events that satisfy the condition $E_x = E_\gamma$ correspond to ground-state transitions of the associated excited states (region between the red dashed lines). The right part of Fig. 1 shows γ-ray spectra obtained after applying conditions on the excitation energy of $E_x = 6.4$ MeV and $E_x = 7.8$ MeV. Peaks originating from ground-state transitions in ^{64}Ni are observed as well as the corresponding detector response, such as single-escape and double-escape peaks. This project is subject to an ongoing analysis of the experimental data obtained for ^{64}Ni.

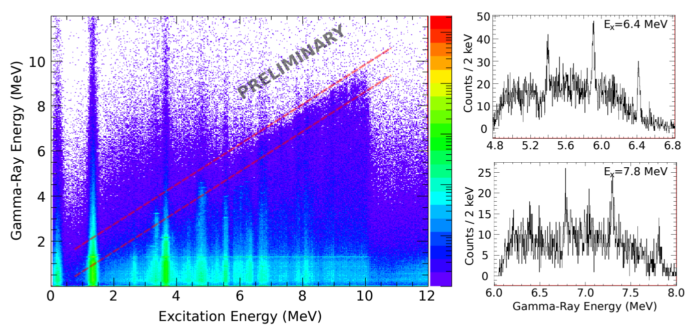

Figure 1: Left:Coincidence matrix in the $(\alpha,\alpha'\gamma)$ experiment. Right: γ-ray spectra after applying energy gates on the excitation energy of 6.4 MeV and 7.8 MeV, respectively.

References

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