In-beam γ-ray spectroscopy of ^{80}Zn

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In-beam γ-ray spectroscopy of nuclei in the vicinity of the doubly-magic nucleus ^{78}Ni was performed. In recent studies, a drastic change of the shell structure was elucidated for the neutron magic number $N = 8$, 20, and 28 in the regions far from stability The energy of the first $I^{\pi} = 2^{+}$ state $E(2_1^{+})$, and the energy ratio of the 4_1^{+} state to the 2_1^{+} state $E(4_1^{+})/E(2_1^{+})$ in even-even nuclei are of particular interest, since they are sensitive to the evolution of the shell structure and nuclear deformation. In this study, the systematic energy trend of the low-lying states was investigated for the chain of Zn isotopes ^{74,76,78,80,}Zn which covers the magic number $N = 50$.

In order to produce RI beams around ^{80}Zn, a ^{238}U primary beam with energy of 345A MeV was made to impinge on a 925-mg/cm^2-thick beryllium target. The fragments produced were separated and identified with the BigRIPS[1)] by the $B\rho$-ΔE-ToF method on an event-by-event basis. Then, the RI beams impinged on a 1889-mg/cm^2-thick beryllium target to induce secondary reactions. The de-excitation γ-rays emitted from reaction residues were observed by the NaI(Tl) detector array DALI2[2)], which surrounded the secondary target. The reaction residues were identified using the ZeroDegree spectrometer. Figure 1 shows the particle identification plots for the incoming particles obtained with the BigRIPS (left) and for the outgoing particles obtained with the ZeroDegree spectrometer (right).

Figure 2 shows the Doppler-shift corrected γ-ray energy spectrum obtained for the reaction channel ^{9}Be(^{81}Ga,^{80}Zn) with a restriction of a γ-ray multiplicity M_γ, being equal to 1. In the spectrum, five peaks were observed. The peak at 1492(1) keV[3)] is for the known γ-ray transition corresponding to the $2_1^{+} \rightarrow 0_{\mathrm{g.s.}}^{+}$ decay, while the other four transitions are candidates for new levels and are still under analysis for confirmation. Further analysis is on-going to reconstruct the level scheme by γ-γ coincidence, and to identify the spins and parities of the states by the analysis of momentum distribution of the outgoing reaction residues.

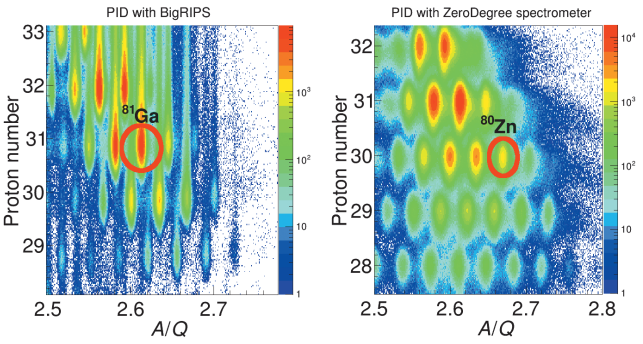

Fig. 1. Particle identification by the BigRIPS (left) and the ZeroDegree spectrometer (right). Plotted is the proton number against the ratio of mass to charge A/Q.

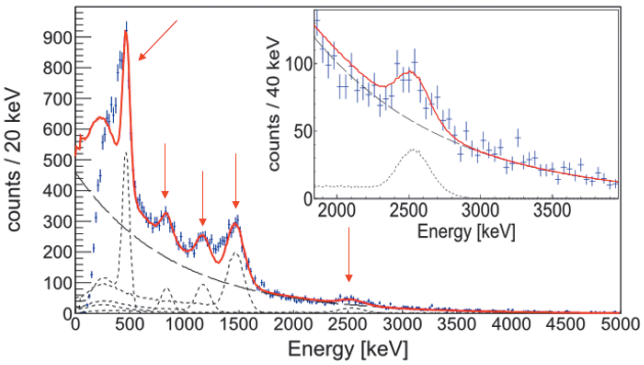

Fig. 2. Doppler-corrected γ-ray energy spectrum for ^{9}Be(^{81}Ga,^{80}Zn) reaction with M_γ=1 condition. The dotted curves are the response function with GEANT4 simulation. The solid curve corresponds to the fitting of five response functions with exponential background taken into account. The spectrum, expanded to around 2500 keV, is also shown in the upper inlet.

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References

1) T. Kubo et al.: Prog. Theor. Exp. Phys. 03C003 (2012).
2) S. Takeuchi et al.: RIKEN Accel. Prog. Rep. **41**, 149 (2008).
3) J. Van. de Walle et al.: Phys. Rev. Lett. **99**, 142501 (2007).