E1 strength around threshold in ^{70}Ni†

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The electric dipole response of atomic nuclei is presently attracting increasing attention from the nuclear physics research community. In particular, the E1 strength in neutron-rich nuclei, located at around one particle separation energy (6-12 MeV energy range) is the object of a large effort[1,2] (and references therein). In this energy region structures and accumulations of the E1 strength were measured in a variety of nuclei along along the entire valley of stability, but very scarce data for exotic nuclei are available. These structures are commonly called pygmy dipole resonance (PDR) as they lie at energies below the giant dipole resonance (GDR) and have lesser strength. They are at the center of the scientific debate as the strength is connected to the neutron skin thickness[3], the symmetry energy term of the nuclear equation of state and has important astrophysical implications in explosive nucleosynthesis scenarios.

In order to understand better the characteristics of this PDR strength it is important to study an isotopic chain of a nucleus with increasing neutron number. As the pygmy dipole strength distribution in ^{68}Ni around the threshold has recently been observed,[1,2,3] a high-intensity and high-resolution experiment was performed on ^{70}Ni at RIKEN Radioactive Isotope Beam Factory (RIBF).

A ^{238}U primary beam was accelerated up to an energy of 345 *A*MeV and made to impinge on a thick rotating Be production target. In BigRIPS[4] the Bρ-ΔE- Bρ method was applied to select a secondary beam of ^{70}Ni (30 kcps with 40% purity at a beam energy of 260 *A*MeV). The ^{70}Ni isotope was incident on a 2 g/cm^2 gold secondary target. Reaction products from the secondary target were identified using the ZeroDegree Spectrometer in the large acceptance mode, while the scattering angles were determined using parallel plate avalanche counters.

In order to detect gamma rays from the decay of different nuclear levels, the reaction target was surrounded by a combination of eight large-volume 3.5'' x 8'' LaBr3:Ce detectors (providing high efficiency and resolution[5]) mounted at 30° in the forward direction and of the DALI2 array[6] (consisting of 96 NaI(TI) crystals) at mid and backward angles.

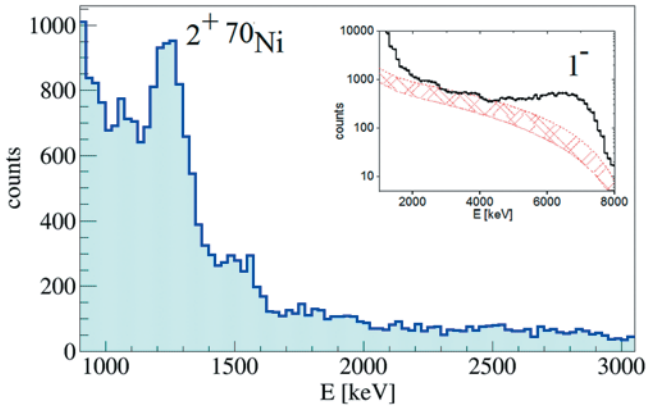

Fig. 1. $2^+ \rightarrow 0^+_{gs}$ E2 transition in ^{70}Ni. In the inset, high-energy γ ray spectra are shown till 8 MeV. The shaded area is the contribution from the thick gold target, deduced from the measured spectra at backward angles and the projectile GDR–tail calculated with a statistical model.

Figure 1 shows the first outcome of the experiment, which is the observation of the first 2+ state of ^{70}Ni. It is planned that the $2^+ \rightarrow 0^+_{gs}$ B(E2) transition strength will be determined. In the inset an important unresolved E1 contribution between 5 and 8 MeV is observed. The E1 character is deduced from angular distribution measurements. This issue will be under investigation in near future. In order to determine the E1 strength distribution in ^{70}Ni an absolute efficiency measurement of the detectors at NewSUBARU is planned in 2016. The analysis of the relation between the strength and the neutron skin in ^{70}Ni together with the data of the measured ^{68}Ni will make an important contribution to the understanding of the features of the pygmy strength.

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