Search for PYGMY states in ^{70}Ni†

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The search for E1 strength in neutron-rich ^{68}Ni, located around the one particle separation energy was the object of a large effort[1,2] (and references therein). Concentration of the E1 strength were measured in a variety of nuclei along the entire valley of stability, but very few data for exotic nuclei are available. Commonly they are called pygmy dipole resonance (PDR) as they lie at energies below the giant dipole resonance (GDR) and have lesser strength. As their strength is related to the excess of neutrons the strength may be connected to the neutron skin thickness[3], the symmetry energy term of the nuclear equation of state. They influence significantly the scenario within explosive nucleosynthesis.

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 an experiment with high intensity beam and high efficiency and resolution on ^{70}Ni at RIKEN Radioactive Isotope Beam Factory (RIBF) was performed and analyzed. A primary beam of ^{238}U was accelerated up to 345 *A*MeV and made to impinge on a 1 g/cm^2 thick Be production target. In BigRIPS[4] the Bρ-ΔE-Bρ method was applied in order 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 thick gold secondary reaction target. Reaction products from this target were identified using the ZeroDegree Spectrometer in the large acceptance mode, while the scattering angles were determined using parallel plate avalanche counters. In this way pure relativistic coulomb excitation[1] events could be selected. The reaction target was surrounded by a combination of eight large-volume 3.5” x 8” LaBr3:Ce detectors[5] mounted at 30° in the forward direction and of the DALI2 array[6] (consisting of 96 NaI(TI) crystals) at different angles in a way to detect the emitted γ rays from the reaction.

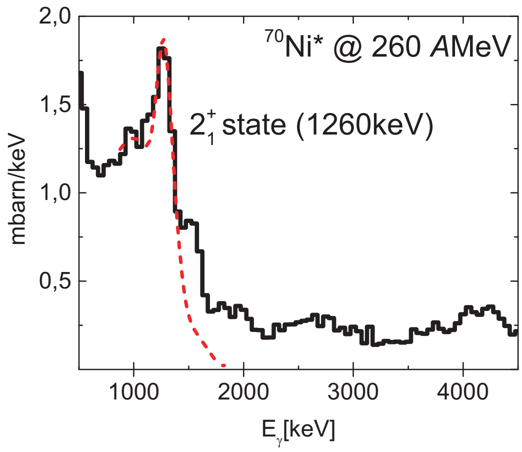

Fig. 1. Gamma-ray spectrum for the strength of the $2^+ \rightarrow 0^+_{gs}$ E2 transition cross section in ^{70}Ni together with Geant Monte Carlo simulation of the transition.

In order to determine the B(E1) values distribution in ^{70}Ni an absolute efficiency measurement of the detectors at NewSUBARU was done in 2016. Together with the measured gamma ray spectrum we determined the B(E2) strength as can be seen in Figure 1. The spectrum shows the target contribution subtracted $2^+ \rightarrow 0^+_{gs}$ transition corrected for detector response and virtual photon flux[1]. In order to extrapolate the target contribution to the spectra a statistical model simulation for the target was compared with a measurement with ^{24}O beam (no bound states are present) and the original gold-target under the same experimental conditions. This reaction gives practically only gamma emission from the target deexcitation. A good agreement has been obtained which will help for future analysis of the B(E2) strength. The future analysis of the E1 strength in the experiment will give a relation between the strength and the neutron skin in ^{70}Ni. Together with the data of the measured ^{68}Ni this will provide an important contribution to the understanding of the features of E1 strength around the particle separation energy.

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