Search of E1 strength around threshold in ^{70}Ni†

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The structure and nature of the E1 strength distribution around the separation energy depends mainly on the neutron excess. Some information in stable nuclei has been obtained in the past but only very few data are available for exotic neutron rich nuclei using mainly Coulomb excitation techniques[1) and references therein].

There is an ongoing discussion on the possibility of extracting information on the neutron skin from the pygmy resonance strength[2)]. This quantity can be related to the isospin-dependent part of the nuclear equation of state (EOS) which in turn has relevant implications for the description of neutron stars. Furthermore, the presence of a strength with E1 character close to the particle threshold has important astrophysical implications in explosive nucleosynthesis scenarios.

In order to understand better the characteristics of this pygmy dipole 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 studied[1,2,3)], a new high intensity and high resolution experiment was performed on ^{70}Ni at RIKEN Radioactive Isotope Beam Factory (RIBF) in November 2014.

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 and purify 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 target. Reaction residues from the secondary target were identified using the ZeroDegree Spectrometer. Scattering angles were determined using parallel plate avalanche counters.

To detect gamma rays from the decay of different nuclear levels the reaction target was surrounded by a combination of the DALI2 array[5)] (consisting of 96 NaI(TI) crystals) and 8 large volume 3.5'' x 8'' $LaBr_3$:Ce detectors[6)] mounted at 30° in the forward direction. These latter detectors have a high efficiency, excellent energy resolution for high energy gamma rays and very good time resolution.

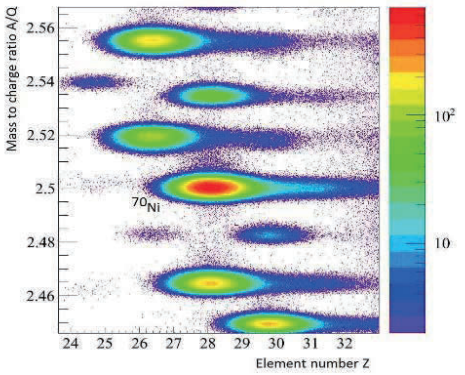

Fig. 1. Particle identification plot (Bρ-ΔE- B TOF) of the secondary beam in front of the Au reaction target. The ^{70}Ni isotopes are labeled.

Fig. 1 shows the particle identification plot taken during the experiment can be seen. The data are under analysis. The first preliminary outcome will be the 2+ state strength of ^{70}Ni. This known $2^+ \rightarrow 0^+_{gs}$ E2 transition strength will be taken as a benchmark for the determination of the unknown E1 transitions strengths below and above the threshold. Presently high energy gamma ray events in the $LaBr_3$:Ce detectors and add back spectra in DALI2 are being analyzed. The determination of the E1 strength distribution of the measured ^{70}Ni and the subsequent analysis of the relation between strength and neutron skin together with the data of the measured ^{68}Ni will give a better and important contribution to the understanding of the features of the pygmy dipole strength.

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References

1) O. Wieland et al. PRL **102,** 092502 (2009).
2) A. Carbone et al. Phys. Rev. C **81** 041301(R) (2010).
3) D. Rossi et al. PRL **111**, 242503 (2013).
4) T. Kubo et al. Prog. Theor. Exp. Phys. 03C003 (2012).
5) S. Takeuchi et al. NIM A**763**, 596 (2014).
6) A. Giaz et al. NIM A**729,** 910 (2013).