Study of the pygmy-dipole resonances of ^{132}Sn and ^{128}Sn in inelastic α-scattering

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Pygmy-dipole resonance is commonly considered as a dipole mode of the nucleus related to a vibration of excess neutrons against a core. As such, it should be related to the neutron richness of the nucleus as well as its neutron-skin thickness. So far, the experimental information on this low-lying dipole mode is astonishingly scarce, even for stable nuclei[1)]. One interesting open question is the isospin character of the low-lying dipole strength. In an experiment with the stable ^{124}Sn isotope[2)], it has been concluded that a large fraction of the pygmy strength is of isoscalar character, however significant differences in the strength distribution compared with photoexcitation have been observed.

In November 2014, the isoscalar mode of the pygmy-dipole resonances in ^{128}Sn and ^{132}Sn isotopes were measured in inelastic α-scattering at RIKEN. The isotopes of interest were produced with a high-intensity primary ^{238}U beam of 345 MeV/u impinging on a beryllium target. The resulting secondary beam with an energy of approximately 200 MeV/u was directed towards the liquid helium target with a thickness of approximately 300 mg/cm^2. The γ-rays, which are ejected at the target position, have been measured by 8 large-volume 3.5"×8"LaBr$_3$:Ce crystals from Hector INFN Milano[3)] and 95 large-volume NaI(Ti) DALI2[4)] crystals. These crystals surrounded the target chamber to achieve a high geometric acceptance.

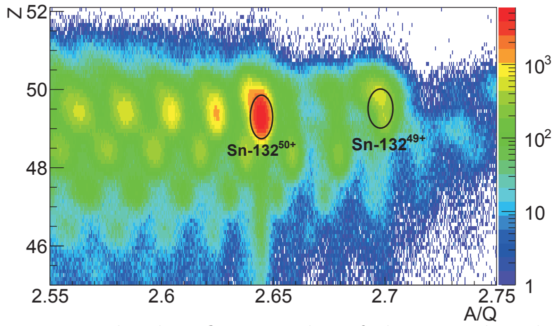

Fig. 1. Particle identification plot of the secondary beam after the liquid Helium target, gated on incoming ^{132}Sn ions determined using the ZeroDegree spectrometer.

As a first step of the analysis, the preliminary particle identification (PID) plot of Z versus A/Q can be determined by a combination of the measured energy loss, magnetic rigidity, and the time-of-flight using the BigRIPS and the ZeroDegree spectrometer[5)]. As a result, beam purity was dertermined to be 18% for ^{128}Sn and 26% for ^{132}Sn. As an example, the resulting PID for the outgoing particles for the ^{132}Sn experiment is shown in Fig. 1. In the plot, different charge states for ^{132}Sn can be observed. However, the ^{129}Sn^{49+}-state has to be considered, because it has a similar A/Q-value as the fully stripped ^{132}Sn ion ($A/Q(^{129}\mathrm{Sn}^{49+})$=2.633 and $A/Q(^{132}\mathrm{Sn}^{50+})$=2.640). The pygmy-dipole resonances can be identified by the correlation of the identified particles to the corresponding γ-rays. Finally, the strength of the isoscalar pygmy-dipole resonances can be determined. In addition, experiments already performed at GSI Darmstadt with the R^{3}B setup will profit, because with the result of this experiment, the isovector part of the resonance can be separated from the isoscalar part.

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