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CROSS-COINCIDENCES IN THE ^{136}Xe+^{208}Pb DEEP-INELASTIC REACTION*

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A deep-inelastic reaction experiment with a ^{136}Xe beam impinging on a ^{208}Pb target was performed. Gamma rays were detected with the AGATA Demonstrator. The beam-like fragments were identified with the PRISMA spectrometer on event-by-event basis. Doppler corrected γ-ray spectra were obtained for both the identified beam-like nuclei and for the target-like binary partners. This cross-coincidence method can be used to study heavy target-like nuclei which cannot be unambiguously identified in the spectrometer due to their large masses and low velocities.

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1. Experiment

A deep-inelastic experiment with the aim of obtaining information on the shell-model states in nuclei along the $N = 126$ line, as well as nuclei with $N > 126$, $Z < 82$ [1] was performed. A 940 MeV ^{136}Xe beam provided by the Legnaro PIAVE+ALPI accelerator system impinged onto a 1 mg/cm^2 thick ^{208}Pb target placed at 45° to the beam line. The measurement was performed in May 2010 and it was the first AGATA Demonstrator coupled with PRISMA and DANTE experiment. The gamma rays were detected by the AGATA Demonstrator [2], in this experiment consisting of three AGATA Triple Clusters. It was mounted at 18.8 cm from the target at $\approx 90°$ to the beam line. AGATA [3] is the Germanium tracking array being built within a European collaboration. It achieves superior performance when compared to the traditional Ge array by applying pulse shape analysis on the segmented crystals to provide resolution of a few mm for the interaction position [4]. Then tracking algorithms are applied in order to reconstruct the path of the photons.

The PRISMA [5] spectrometer was used to identify the-beam like fragments on an event-by-event basis. It was placed at the calculated grazing angle of 42° relative to the beam axis. Information on the target-like partner of interest can be obtained by considering the two-body reaction kinematics and appropriate Doppler correction. This method was successfully employed earlier with PRISMA+CLARA, whereby the excited states of ^{168,170}Dy studied [6] in the reaction ^{82}Se+^{170}Er.

The DANTE [7] heavy ion detector array was also used, with the aim of increasing the overall statistics of the reaction. It provides high statistics due to its large solid angle, but without particle identification.

2. Results

The identification of the beam-like ions with PRISMA is shown in Fig. 1. The element identification is done using the ionisation chamber placed at the end of the spectrometer. The charge state identification is based on the trajectory reconstruction and velocity determination through the PRISMA spectrometer. From the A/q measurement and the charge state identification the mass is determined.

The γ-ray energy spectra associated with, and Doppler corrected for the xenon isotopes are shown in figure 2. The spectra Doppler corrected for the lead binary partners of the identified Xe isotopes, assuming no neutron emission are also shown. For example, the strongest peaks in ^{134}Xe spectrum correspond to the $2^+ \rightarrow 0^+$ 847 keV and the $4^+ \rightarrow 2^+$ 884 keV transitions. The binary partner of ^{134}Xe is ^{210}Pb, with two more neutrons than the target. In the spectrum of the ^{210}Pb nucleus the $2^+ \rightarrow 0^+$ 799 keV and the

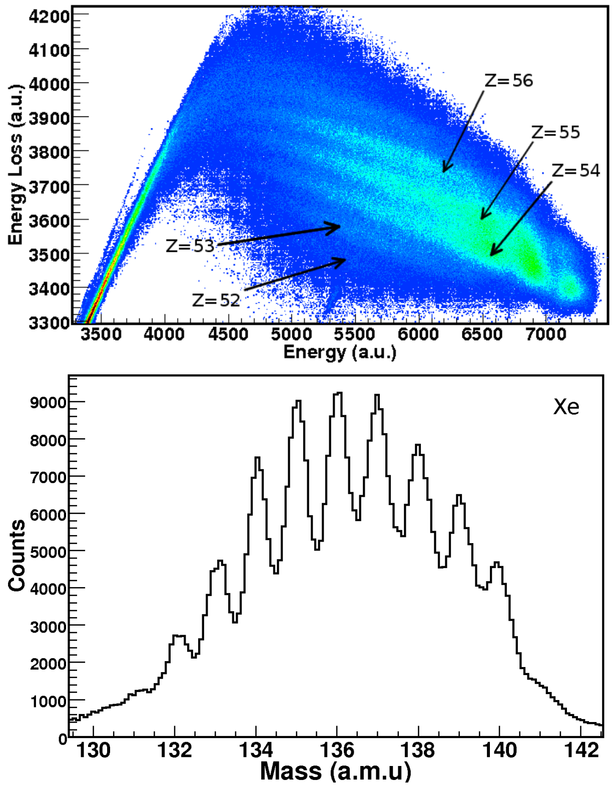

Fig. 1. Top: Z identification based on the ΔE–E method using the PRISMA ionisation chamber. Bottom: Mass spectrum of the Xe isotopes ($Z = 54$).

$4^+ \to 2^+$ 298 keV peaks are clearly visible. The situation is similar for the other Xe–Pb partners. The strongest lines are: $15/2^- \to 9/2^+$ 1423 keV line in ^{209}Pb; $3^- \to 0^+$ 2615 keV and $5^- \to 3^-$ 583 keV in ^{208}Pb; $5/2^- \to 1/2^-$ 570 keV line in ^{207}Pb. Therefore, the strong yrast transitions in the lead partners are always identifiable.

3. Conclusion

The ^{136}Xe+^{208}Pb deep-inelastic reaction was employed with the aim to study the heavy target-like products around ^{208}Pb. Gamma-rays were detected by the AGATA Demonstrator, and the target-like reaction products were detected by the PRISMA magnetic spectrometer. Assuming that there was no neutron evaporation, Doppler corrected gamma-ray spectra were created for the target-like partners. The strongest peaks in these spectra

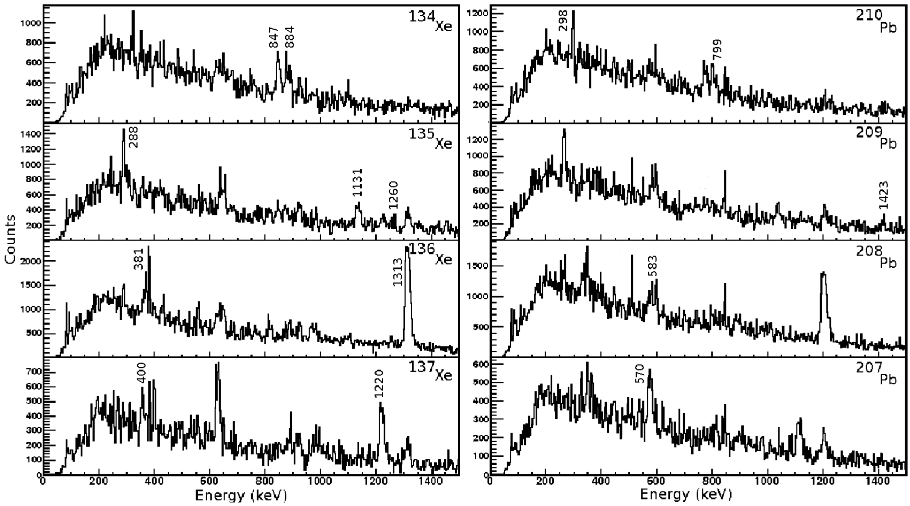

Fig. 2. Left: γ-ray spectra Doppler corrected for the beam-like Xenon isotopes identified with the PRISMA spectrometer. Right: The Doppler corrected spectra for the lead binary partners. The strongest transitions belonging to the nuclei of interest are labelled.

can be clearly identified as belonging to the yrast structure of the nuclei of interest. This cross-coincidence method is essential in the study of nuclei in which there is no information on the yrast structure is available. For example, it will be used to identify states built on the $\pi h^{-1}_{11/2}$ isomeric state in the one proton-hole nucleus ^{207}Tl.

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