SEARCH FOR JACOBI SHAPE TRANSITION IN HOT ROTATING ^{88}Mo NUCLEI THROUGH GIANT DIPOLE RESONANCE DECAY*

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We report on preliminary results from the experiment performed at Legnaro National Laboratories aiming at the investigation of the shape evolution of the ^{88}Mo nucleus. The GDR spectra obtained for two data sets measured at ^{48}Ti beam energy of 300 and 450 MeV corresponding to 3 and 3.8 MeV temperatures, respectively, are presented. The low energy component in GDR strength functions, similar to the theoretical predictions of LSD model, possibly indicates the presence of Jacobi shape transition.

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1. Introduction

Studying the properties of the Giant Dipole Resonance (GDR) at high temperatures and angular momenta is one of the central topics in nuclear structure physics as it provides insight into the behavior of nuclei under extreme conditions. Of special interest are shape transitions induced by temperature and angular momentum, particularly the predicted Jacobi shape transition, seen so far up to mass $A = 50$ [1, 2, 3, 4, 5], but predicted to take place also in heavier nuclei. This phenomenon consists in an abrupt change from an oblate to an elongated triaxial shape occurring close to the critical value of spin above which the nucleus undergoes scission.

Most of the available experimental data on GDR measurements cover the temperature range up to 2.5 MeV, obtained mainly from the GDR gamma-decay following fusion-evaporation reactions. These data provide the evidence of structural effects such as damping of the collective mode and shape changes in function of spin [6, 7, 8, 9, 10, 11, 12, 13].

An experiment focusing on the ^{88}Mo nucleus was performed in LNL Legnaro using ^{48}Ti beam at 300, 450 and 600 MeV and 0.5 mg/cm^2 ^{40}Ca target, producing compound nuclei at temperatures of 3, 3.8 and 4.5 MeV, respectively, with angular momentum distributions centered around mean values of 41, 44 and 46 $\hbar$, correspondingly. The experimental setup included the GARFIELD array [14], the HECTOR array [15] and 32 phoswitch detectors from FIASCO experiment [16]. The GARFIELD $dE - E$ gaseous micro-strip and CsI(Tl) scintillation detectors, which covered range of angles: $\Theta = 30°$–$85°$ and $\phi = 0°$–$360°$, were used to measure light charged particles. High energy γ-rays from GDR-decay were measured by the 8 large volume BaF_2 crystals of HECTOR, which were placed at backward angles. The evaporation residues and fission fragments were detected by phoswich detectors covering the forward angles in the range of $\Theta = 5°$–$12°$ [17].

2. Analysis and results

The high-energy γ-ray spectra were measured by HECTOR array in coincidence with evaporation residues measured by phoswitch detectors. The proper gate employed on the dE *versus* time of flight measured with respect to RF (see Fig. 1 (a)) enabled to choose events corresponding only to fusion-evaporation reactions. The other gate (see Fig. 1 (b)) was set on time of flight spectra measured by BaF_2 detectors to remove the influence of neutron contributions to the γ-ray spectra.

The spectra obtained in that way from the γ-decay of the GDR, after careful background and bremsstrahlung subtraction, were analysed applying the statistical Monte Carlo CASCADE code [18] with the Reisdorf parametrization of the level density [19]. To obtain information on the GDR

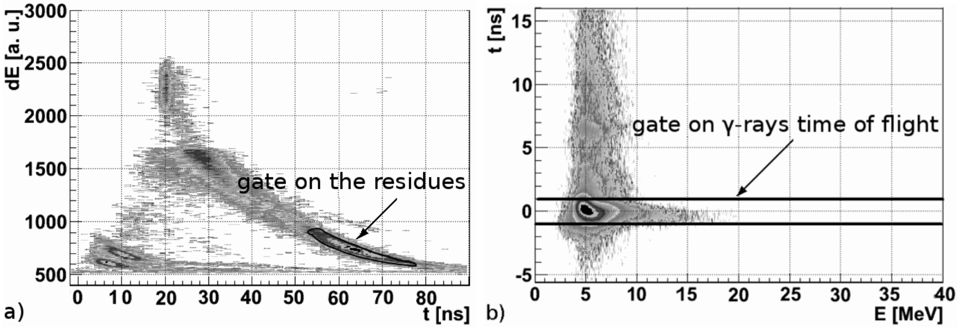

Fig. 1. (a) Energy loss (dE) in the first layer of the phoswitch detector [16] *versus* time of flight. The marked region corresponds to the detection of residues. This gate is used to produce the clean high-energy γ-spectra. (b) The time of flight *versus* energy measured with the HECTOR detector. The gate indicated selects γ-rays without influence of neutrons energy deposits.

line-shapes, a fit of GDR spectra was performed. Subsequently, the GDR strength functions in a linearized [6] form were produced. The measured spectra are shown with points in the upper panel of the Fig. 2 for both 300 and 450 MeV beam energies. The results of the fit are presented with the lines in the same figure. The middle panel presents the GDR strength functions obtained for both data sets. The results of theoretical predictions based on the liquid drop LSD model [20] for ^{88}Mo nucleus at average angular momentum $\langle I \rangle = 41\ \hbar$, temperature $T = 3$ and $\langle I \rangle = 44\ \hbar$, $T = 4$ MeV [21] are shown in the lower panel of Fig. 2.

One can see that the GDR line-shapes have a structure exhibiting low and high energy components. The intensity of the low energy part seems to be higher at the 450 MeV beam energy. This result is very similar to the theoretical predictions showing an increase of low energy component as a function of the temperature of the compound nucleus. This suggests that the Jacobi shape transition in ^{88}Mo might occur. A detailed analysis of the GDR strength function and GDR width dependence on temperature is in progress.

3. Conclusions

High-energy γ-ray spectra were measured for three beam energies (300, 450 and 600 MeV) in coincidence with evaporation residues. Preliminary analysis of the spectra at the 300 and 450 MeV beam energy has been performed. The obtained results, showing increase of low energy component of GDR strength function with temperature may indicate the existence of the Jacobi shape transition.

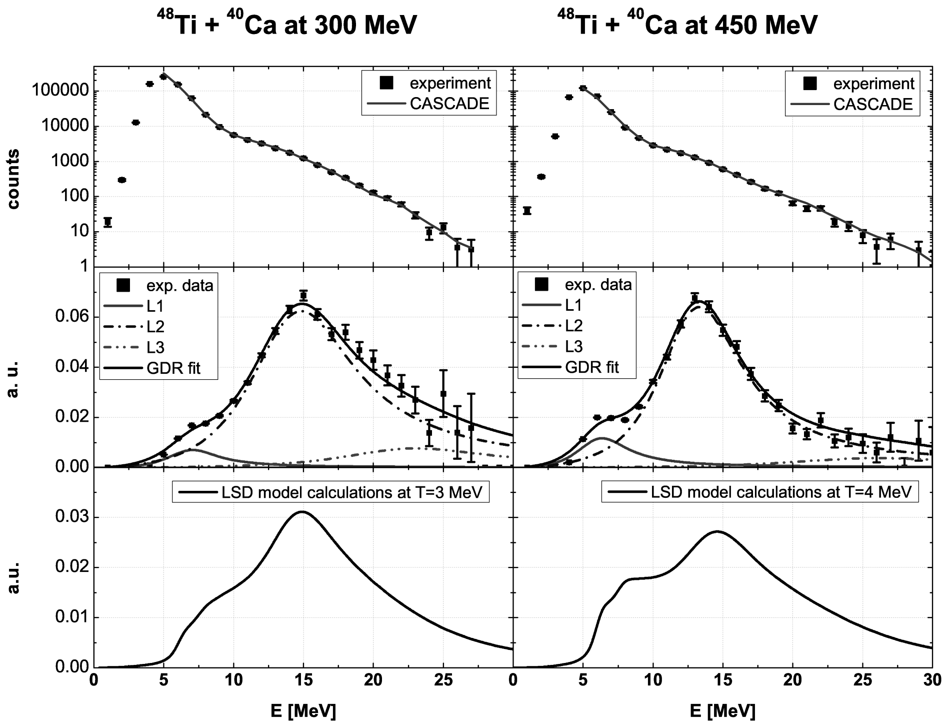

Fig. 2. Upper panel: The GDR spectra measured for ^{88}Mo at 300 MeV and 450 MeV ^{48}Ti beam energies compared to the calculations performed using Monte Carlo version of CASCADE code. Middle panel: The GDR line-shapes obtained from preliminary fits for 300 MeV and 450 MeV beam energies. The strength functions are composed of three components (also indicated in figure) showing the increase of low energy part for higher beam energy. Bottom panel: The GDR strength functions calculated using LSD model for ^{88}Mo at temperatures of $T = 3$ and 4 MeV for spin distributions with the average values of $\langle I \rangle = 41$ and 44 $\hbar$, respectively.

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