Jacobi Shape Transition Investigation in Hot Rotating ^{88}Mo Nuclei

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INTRODUCTION

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 general properties of nuclei under extreme conditions. Of special interest are nuclear shape changes induced by temperature and angular momentum and particularly Jacobi shape transition predicted as an abrupt change from an oblate to a more and more elongated triaxial shape occurring close to the critical spin value for scission. Recently, the Jacobi shape transition, observed so far only in nuclei up to mass 50 [1-5], seems to be observed in more heavy ^{88}Mo nucleus [6].

The ^{88}Mo compound nuclei were produced in fusion-evaporation reactions at temperatures about 3, 3.8 and 4.5 MeV, using the ^{48}Ti beam at 300, 450 and 600 MeV bombarding a ^{40}Ca target. The experiment was performed at LNL Legnaro. The experimental setup consisted of the GARFIELD array [7] for light charged particle measurement, HECTOR [8] for high-energy gamma-rays and 32 phoswich detectors from the FIASCO experiment [9] for evaporation residues detection. The GARFIELD *ΔE-E* gaseous micro-strip and CsI(Tl) detectors were placed at angles $\theta = 30^o$ to $\theta = 85^o$ and $\varphi = 0^o - 360^o$. The 8 large volume BaF_2 crystals of HECTOR, were placed at backward angles. The evaporation residues and fission fragments were detected by phoswich detectors covering the forward angles in the range of $\theta = 5^o - 12^o$ [10].

ANALYSIS AND RESULTS

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

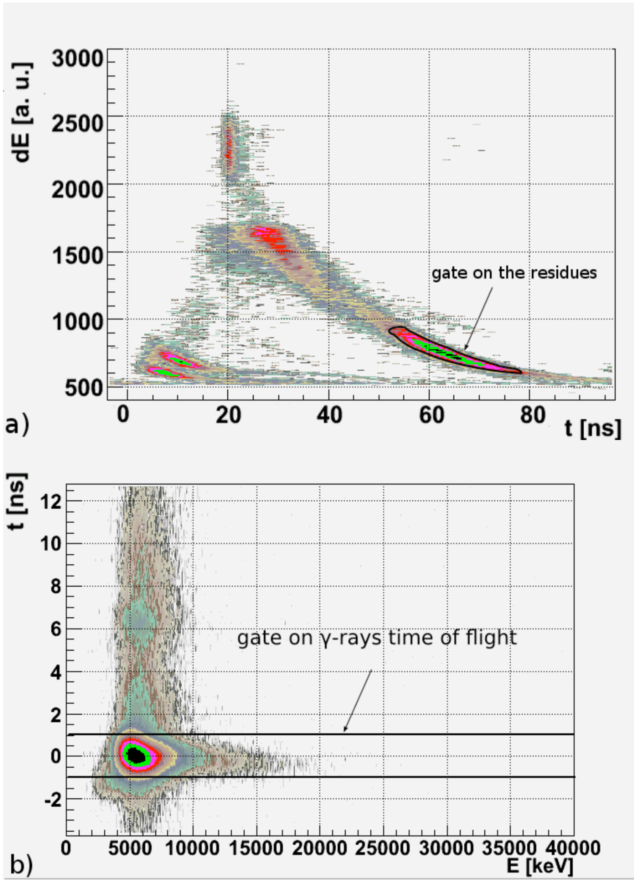

Fig. 1. *Upper panel*: Energy loss (*ΔE*) in the first layer of the phoswich detector versus time of flight. The marked region corresponds to the detection of residues. This gate is used to produce the clean high-energy γ-spectra.
Lower panel: The time of flight versus energy measured with the HECTOR detector. The gate indicated selects γ-rays without influence of neutrons energy deposits.

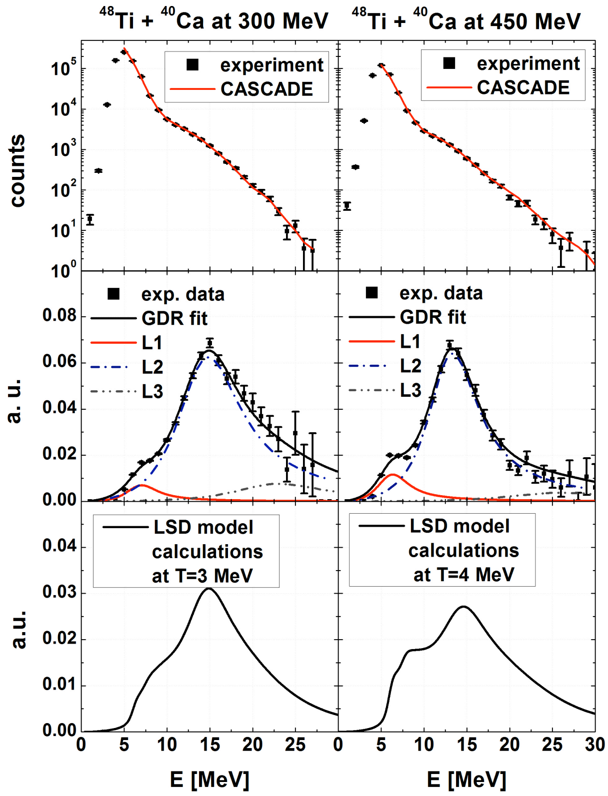

Fig. 2. *Top panel*: The GDR spectra measured for ^{88}Mo at 300 MeV and 450 MeV ^{48}Ti beam energies compared to the calculations performed using Monte Carlo version of CASCADE code. *Middle panel*: The GDR line-shapes obtained from preliminary fits for 300 MeV and 450 MeV beam energies. The three components of each function are also indicated in figure. *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 $< I > = 41$ and 44 $\hbar$, respectively.

As a start of the analysis, the data corresponding to beam energies of 300 and 450 MeV have been employed. The background subtracted high-energy γ-ray spectra obtained in the way described above have been analyzed using the statistical Monte Carlo CASCADE code [11] with the Reisdorf parameterization of the level density [12]. The GDR parameters (energies, widths and strengths) have been obtained from experimental spectra fits. Subsequently, the GDR strength functions [13] have been 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 preliminary fit with the GDR line-shapes, which consisted of three Lorentzian components, are presented with the lines in the same figure. The middle panel displays the GDR strength functions obtained for both data sets. The results of theoretical predictions based on the liquid drop LSD model [14] for ^{88}Mo nucleus at average angular momentum $< I > = 41\ \hbar$, temperature $T = 3$ and $< I > = 44\ \hbar$, $T = 4$ MeV [15] are shown in the lower panel of fig. 2.

The preliminary results demonstrate that the GDR line-shapes obtained for both sets of the experimental data 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. Similar result is presented by the strength functions calculated using LSD model. The GDR line-shapes, predicted by theory for Jacobi shape transition, show an increase of low energy component with the temperature of the compound nucleus. This observation suggests that the Jacobi shape transition in ^{88}Mo might occur [6]. A detailed analysis of the GDR strength function and GDR width dependence on temperature is in progress.

CONCLUSIONS

The high-energy γ-ray spectra measured for the beam energies of 300, 450 MeV in coincidence with evaporation residues were analyzed as the first step of the Jacobi shape transition study in ^{88}Mo nucleus. Preliminary results may indicate the existence of the Jacobi shape transition. To verify this finding the systematic, more careful analysis is needed. The results presented in this report will be published in Acta Physica Polonica [6]. Further analysis, also concerning spectra gated with light charged particles and the study of 600 MeV data is in progress.

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