Observation of rare shape-phase transition in hot and rotating ^{192}Pt nucleus

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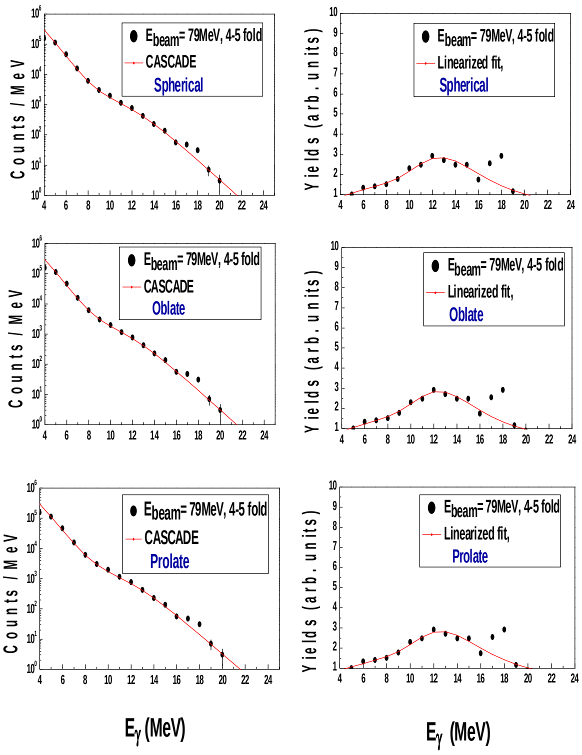
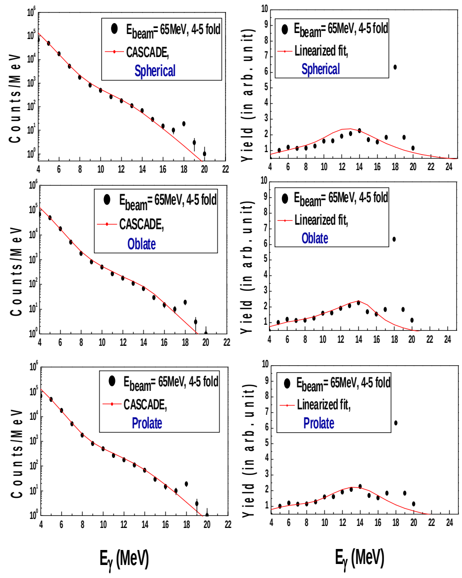
Introduction

We report about the first observation of a clear signature of a rare shape-phase transition in hot and rotating ^{192}Pt nucleus. The atomic nucleus can undergo a variety of shape phase transitions with increasing temperature and angular momentum. Exclusive measurements of high energy GDR (giant dipole resonance) γ-rays from different narrow windows of phase-space are required to determine such shape-phase transitions. We have been making concerted efforts to search for a rare shape transition, namely, from non-collective prolate to non-collective oblate rotation in a variety of heavy A ~ 190 nuclei. Here we report about our findings in ^{192}Pt. The ^{192}Pt nucleus was populated by bombarding a 1 mg/cm^2 ^{180}Hf nucleus with ^{12}C beam from the TIFR-BARC Pelletron at two different beam energies, namely, 65 and 79 MeV. The high energy GDR γ-rays were measured at two different angles with respect to the beam direction. The GDR γ-ray spectra were measured in a large, compact array of seven hexagonal NaI(Tl) detectors surrounded by an annular plastic anti-cosmic shield. The detector array was placed at around 75 cm from the target position for both the angles in order to separate neutrons from γ-rays by TOF method. Pile up rejection was carried out by standard zero-crossover method. Cosmic ray background was rejected by the plastic anti-cosmic shield. The dynamic range of the detector system was kept at 35 MeV. In order to measure spin-gated GDR γ-rays the TIFR 4π sum-spin spectrometer was used in conjunction with the high energy γ-rays setup. The TIFR spin-spectrometer is an array of 32 conical NaI(Tl) detectors with pentagonal and hexagonal cross sections. This setup has been used for several experiments since its commissioning and has been described in detail in references [1-3]. After initial data reduction the corrected γ-ray spectra have been generated for different spin windows for both the beam energies. Detailed statistical model calculations have been carried out using a heavily modified version of the code CASCADE to generate the spin-gated γ-ray spectra. The response of the 4π spin-spectrometer for different γ-ray multiplicities has been calculated using GEANT4 [4] simulation package. The measured fold distributions for both the beam energies have been converted to multiplicity distributions and finally to spin distributions. The calculated spin-distributions have been used in our statistical model calculations to reproduce the experimental spectra. The response of the high energy γ-ray spectrometer has been calculated from 1 to 30 MeV using GEANT4 package and the spectra generated from statistical model calculations have been convoluted with the response matrix. We have arrived at the best possible fits to the different spin gated spectra after chi-square minimization and visual inspections. The best fit GDR parameters, namely, GDR centroid energies and widths have been extracted and their variations with temperature and angular momentum have been determined. The most important finding of this work has been the dramatic reversal of the angular distribution of the GDR γ-ray spectra from 65 MeV to 79 MeV beam energy. We have calculated the angular distribution of the GDR γ-rays in the lab-frame assuming different shapes of the nucleus. We ascertain a definite signature of shape-phase transition from non-collective prolate to non-collective oblate as the nucleus moves from lower temperature to higher temperature in the phase-space. The finding is in conformity with predictions of Finite Temperature Hartree-Fock-Bogoliubov Cranked (FTHFBC) calculation of Alan Goodman [5] and our previous experimental finding in ^{194}Au which have prompted us to carry out these investigations with greater accuracy for last several years [6]. We have also carried out finite temperature microscopic-macroscopic calculations with proper treatment of thermal shape fluctuations to analyze our data. All the results will be presented in detail in this meeting. Figures 1. And 2 present two representative sets of a particular spin-window gated spectra along with the statistical model fits assuming different shapes for E_{beam} = 79 and 65 MeV. In each of these figures the right hand panels show the same data in more accurate linearised scales.





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