High spin states in ^{216}Fr

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Introduction

Nuclei in the vicinity of doubly-magic nucleus ^{208}Pb with several valence nucleons provide an opportunity to study the interplay between single particle and collective states. Beyond the $N = 126$ shell closure, nuclear shape changes from spheroidal to mainly quadrupole and octupole deformed shapes. It has been observed that octupole collectivity enhances in comparison to quadrupole collectivity in the nuclei around $N = 130$. In the region around A $\sim$ 220, octupole collectivity is well established [1, 2].

A large amount of information is available for the nuclei with $Z < 82$ and $N < 126$, relative to the nuclei with $Z > 82$ and $N > 126$. It has been observed in earlier studies that, nuclei with $Z \geq 87$ and $N \geq 129$ have reflection asymmetric shapes while nuclei near the shell closure are of nearly spherical shapes. The phenomenon of reflection asymmetry has been mainly studied in even-even and odd-mass nuclei. For the doubly-odd nuclei, the reflection-asymmetric shapes were first observed in ^{218}Ac [3]. In the trans-Pb region, ^{216}Fr nucleus is the lightest nucleus where the effects of octupole deformation are seen to be visible [4]. Evidence of reflection asymmetry with eight particles outside the doubly closed shell closure is quite an interesting feature which requires further study. In the present work, preliminary results in the context of ^{216}Fr have been reported.

Experimental Procedure

High-spin states in ^{216}Fr were populated via ^{208}Pb (^{11}B, 3n) reaction. Self-supporting ^{208}Pb ($\sim$ 99% enriched) target of $\sim$ 6 mg/cm^2 thickness was bombarded with ^{11}B beam in the 54−62 MeV energy range. The beam was provided by 15-UD Pelletron accelerator at IUAC, New Delhi. γ rays from residual nuclei populated in the fusion-evaporation reaction were then detected by an array of 14 Compton suppressed clover detectors. The detectors were positioned at 90°, 123° and 148° with respect to the beam direction. The γ-γ coincidence data were acquired using CANDLE [5].

Results and Discussion

Earlier studies have reported the onset of reflection asymmetry in ^{216}Fr. Until now, levels up to (18^+) state have been established in ^{216}Fr by Debray *et al.* [4] using 5 Compton suppressed Ge detectors in conjunction with a BGO multiplicity filter. The ground state of ^{216}Fr has been assigned tentative spin-parity, $I^\pi = 1^-$, on the basis of alpha-decay systematics in the neighboring region [6]. In their work, Debray *et al.* have reported octupole structure built on a bandhead which has been assigned tentative spin-parity, $I^\pi = 9^-$. In ad-

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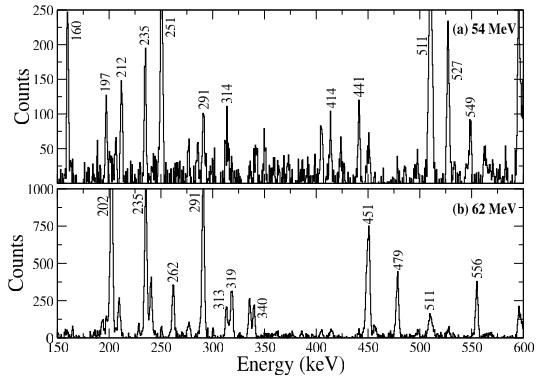

FIG. 1: Spectra showing transitions observed with beam energy (a) 54 MeV and (b) 62 MeV.

dition, the excitation energy of the bandhead state has been measured to be 219 keV with respect to the ground state [7].

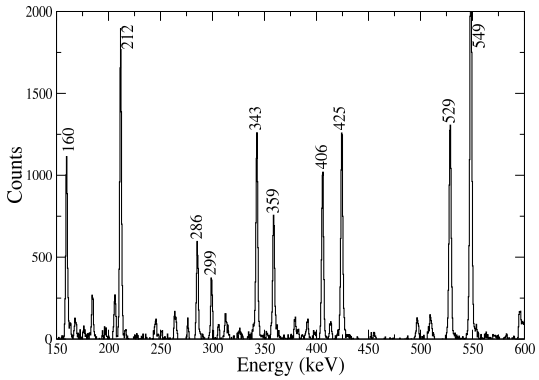

FIG. 2: Spectra showing ^{216}Fr γ rays obtained with gate on 251 keV transition.

Preliminary analysis shows evidence of several new transitions in ^{216}Fr. Figure 1(a) displays the γ rays at an incident beam energy of 54 MeV. At this energy, the 3n−evaporation channel leading to ^{216}Fr is dominant, and several transitions assigned to this nucleus are visible. With the beam energy at 62 MeV, the 4n−evaporation channel populating ^{215}Fr has the highest cross-section and transitions from this isotope are clearly seen in Figure 1(b). Comparisons of the spectra in Figures 1(a) and (b) along with the previously established transitions in ^{215}Fr and ^{216}Fr [4, 8] indicate that the 251 keV and 549 keV γ transitions are newly observed and can most likely be assigned to ^{216}Fr based on excitation function.

Figure 2 illustrates several new γ transitions observed in coincidence with the 251 keV γ transition. The transitions observed in Figure 2 have not been reported in the previous work [4] and could possibly be members of the simplex partner band in ^{216}Fr.

Acknowledgments

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