Study of high spin states of very neutron-deficient La, Ba, Cs , Xe nuclei near proton-drip line

J. Ray[1], U. Datta Pramanik[1*], P. Banerjee[1], R.K. Bhowmik [2], S. Chakraborty[1], A. Chakraborty [3], R.Garg[4], S.Goyal[4], S.Ganguly[5], S.Kumar[4], S. Mandal[4], B.Mukherjee[3], S.Muralithar[2], D.Negi[2], M.Saxena[4], K. Selvakumar [6], A. Rahaman[1], I.Ray[1], Purnima Singh [5], A.K.Singh [5], R.P. Singh[2],

[1]*Saha Institute of Nuclear Physics, Kolkata -700064, INDIA*

[2] *Inter University Accelerator Centre (IUAC), New Delhi*

[3] *Viswa Bharati University, Santiniketan,*

[4] *University of New Delhi, New Delhi*

[5]*Chandannagar College, Chandannagar* [6] *Indian Institute of Technology, Kharagpur*

email: ushasi.dattapramanik@saha.ac

Introduction

The proton drip line defines nature's fundamental limits to the stability of atomic nucleus. For each element there are a minimum number of neutrons that can be supported if the nucleus is to remain stable to nucleonic emission. This limit defines the proton drip line. It has been already established that the shell structure change in the nuclei near the neutron drip line. The properties of nuclei near the neutron drip line and the proton drip line are expected to be different due to large Coulomb barrier for protons. It would be interesting to explore the shell structure for nuclei near proton-drip line. The nuclei around A~110-130 region show a wide range of interesting features in high spin states, which reflect different types of symmetry breaking mechanisms as well as maintaining symmetries. These are Chiral band, magnetic rotation band, anti magnetic rotation band, hyper deformed band, octupole band etc. It is of special interest to look into the high spin states of the very neutron deficient nuclei to explore the features related to nuclear shapes and comparison with those, which have been observed in the neutron deficient nuclei close to the β-stable line. Experimental informations on high spin states of very neutron deficient transitional nuclei near proton drip line are limited [1-3]. B. Cederwall et al., [1] reported two independent bands (positive and negative parity) of high spin states of loosely bound ^{121}La nuclei without any details of intensity information. In this article, we shall report our recent experimental studies on high spin states of very neutron deficient La (N=64) , Ba (N=64-66), Cs (N=65-66) isotopes.

Experimental details:

High spin states of very neutron-deficient nuclei ^{118}Xe (Sp=4.6 MeV), ^{120}Cs (Sp=2.5 MeV), ^{121}Ba (Sp=4.1 MeV), ^{121}La (Sp= 0.8 MeV) were populated through fusion evaporation reaction ^{92}Mo (^{32}S, xpyn). The ^{32}S beam at an energy of 150 MeV was obtained from 15UD Pelletron machine at IUAC, New Delhi and bombarded on self-supporting ^{92}Mo target with the thickness of 7.3 mg/cm^2. The de-excited gamma-rays of the populated nuclei were detected in coincidence mode (γ-γ-t) using INGA (Indian national Gamma detector Array), consisting 12 Compton suppressed Clover HpGe detectors which were placed at 148^0, 123^0, 90^0, 57^0, 32^0 with 4, 2, 2, 2, 2 detectors respectively. The data were collected in list mode using the CAMAC based MULTI-CRATE synchronization mode.

Results:

The coincidence events were sorted into conventional γ-γ symmetric as well asymmetric matrics. Fig. 1.b shows, projected gamma-ray spectra gated on gamma-ray transition with energy '251' KeV. Fig 1a shows the level

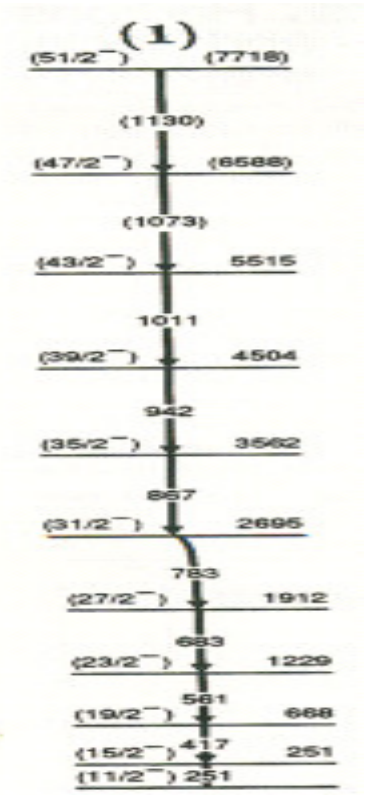
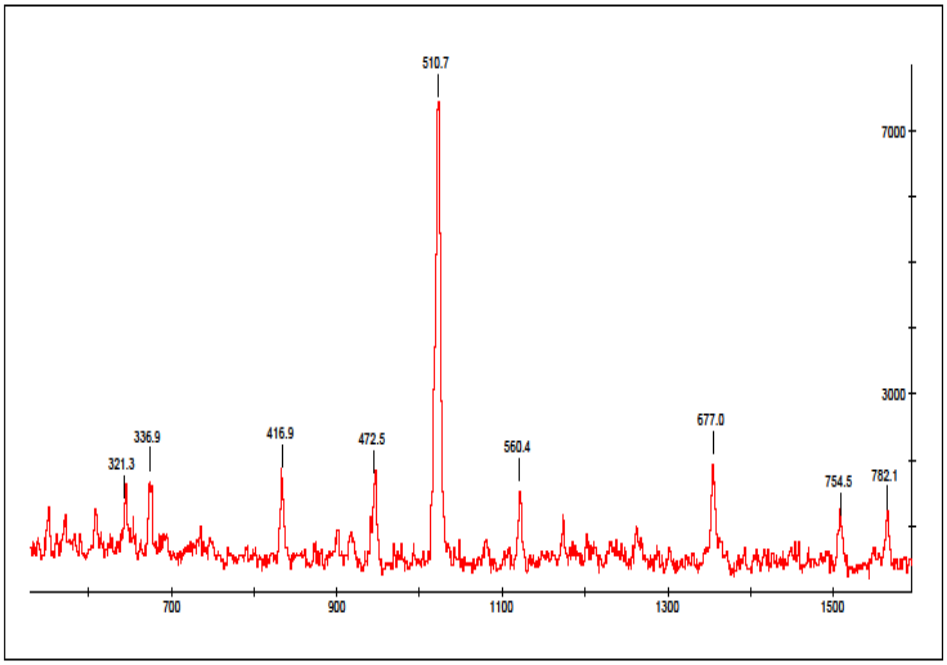


Fig. 1.a level scheme of ^{121}La [1]

Fig. 1.b projected γ-ray spectra obtained from present experiment with gate on '251' KeV γ-ray



scheme of ^{121}La nuclei, reported by Cederwall et al. [ref.1] where 15/2$^-$ states decays to 11/2$^-$ state by emitting gamma-rays with energy 251 KeV. Fig.1.b shows the γ-ray spectra obtained from the present experiment with gate on '251' KeV gamma-ray transition. Earlier reported gamma-ray transitions of energy 417 KeV, 561 KeV, 782 KeV have been observed in present experiment but 683 KeV gamma-ray transition has not been confirmed. In addition to that a number of gamma-ray transitions (336 KeV etc.) observed in this spectra, were reported in another positive parity band of ^{121}La [1]. This clearly indicate that those two bands are linked with transitions which was not mentioned in earlier report. More details of the analysis is going on to establish the connection between two bands and hence verify the spin and parity of those states.

Unlike, ^{121}La, ^{120}Cs and ^{122}Ba were studied earlier using different reactions, ^{107}Ag(^{16}O,3n) [3] and ^{107}Ag(^{19}F,4n) [4], respectively.. In the present experiment higher mass projectile has been used to populate much higher spin states in these nuclei. The details of this experimental results will be presented in this report. The experimental results will be compared with particle rotor model [5] calculation to understand detail configuration of those states.

References:

[1]B. Cederwall et al., Z. Phys. A 338 (1991)

[2] F.Liden et al., NPA524 (1991)140

C.-B. Moon et al., N.P **A 696** (2001)

[4] Jiang et al., Chinese Phys. Lett. 18 1027

[5] U.datta Pramanik et al, PRC52, 117, (1995)