Ground state bands in ^{113,111,109}I in the framework of particle rotor model

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I. INTRODUCTION

Iodine nuclei with Z=53 lies in the transitional region between primarily spherical Sn nuclei and fairly well deformed La and Ce nuclei and is observed to be soft against deformation.The low-lying nuclear structure of these odd-mass iodine isotopes show ΔJ=2 bands based on $5/2^+$ ground state and $7/2^+$ first excited state. These low-lying bands have oblate shape [1] for neutron rich odd mass iodine nuclei. The present work shows that these bands have prolate shape for neutron deffi cient odd-mass iodine nuclei close to proton dripline. The present work shows the change in the configuration of the ground state band as the odd mass iodine nuclei approaches the proton dripline.

II. RESULTS AND DISCUSSION

Particle rotor model calculations have been done to study the change in the configuration of the ground state band in ^{113,111,109}I. In this model ,the details of which have been discussed elsewhere [2],[3], [4] we have chosen the energies of the ground state band of $^{A-1}$Te core as an input parameter.The μ and κ have been chosen to be 0.48 and 0.07 respectively and the attenuation factor was fixed to 1 in all the cases. For the same value of the deformation parameter β_2=0.28 the fermi level was adjusted for all the nuclei to give best fit to the experimental data. The ground state band in ^{113}I is based on the 5/2[413] orbital of N=4 oscillator shell with admixture from the neighbouring 7/2[404] orbital . The ΔJ=2 band based on low-lying $7/2^+$ orbital however is relatively pure and is based on 1/2[411] orbital. In ^{111}I, the ground state band as well as the band built on the $7/2^+$ state is based on the 3/2[411] orbital with strong admixture from the neighbouring 5/2[413] orbital. The ^{109}I nucleus lying beyond the proton dripline however has both ΔJ=2 bands based on the 1/2[431] orbital. The present experimental data does not corroborate the occurrence of the $5/2^+$ ground state in ^{109}I. However, the experimental investigations on proton radioactivity from the ground state suggest decay from l=2($d_{5/2}$) to be more favoured than l=4($g_{7/2}$) orbital [5].The ground state has been found to be reasonably deformed in our calculation with β_2=0.28 in ^{109}I. A large quadrupole deformation has also been predicted [5] for ^{109}I because the nucleus approaches the N=50 shell closure. A ground state deformation of β_2=0.28 along with an adjustment in the fermi level gave reasonable fit to the band based on the $5/2^+$ state and $7/2^+$ state in ^{113}I and ^{111}I. The neutron deffi cient odd-mass iodine nuclei show a gradual change in configuration of the ground state as one proceeds towards the proton dripline. This is expected to provide information about the single particle energies and residual interaction. Theoretically the bands have been predicted upto the $21/2^+$ spin state in ^{111,109}I (^{109}I is shown in Fig.1) though experimentally it is reported upto $9/2^+$ in ^{111}I and $23/2^+$ in ^{109}I.In ^{113}I shown in Fig.2, the bands have been predicted upto $33/2^+$ state and it is experimentally reported upto $23/2^+$ state.

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III. CONCLUSION

The $\Delta J=2$ bands built on $5/2^+$ ground state and $7/2^+$ first excited state has been observed in neutron rich odd-mass iodine nuclei with oblate deformation [1]. The present study corroborates the presence of such bands in neutron defficient odd-mass iodine nuclei with prolate deformation. This is further confirmed from the Nilsson diagram which shows that the corresponding orbitals forming the band have lower excitation energy. Further experimental work is needed to confirm the results of the theoretical calculation.

IV. ACKNOWLEDGEMENT

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[1] Ranjana Goswami, B.Sethi, P.banerjee and R.K.Chattopadhyay Phys.Rev.C 47,1013 (1993).
[2] R.Goswami, B.Sethi, M.Saha Sarkar and S.Sen Z.Phys. A352,391(1995).
[3] Ritesh Kshetri, M.Saha Sarkar and S.Sarkar Phys.Rev.C 74,034314(2006).
[4] Ranjana Goswami and Subimal Sen, Phys.Scr.85(2012)0352012.
[5] M.Petri,E.S.Paul,E.Cederwall et.al, Phys.Rev.C 76,054301(2007).

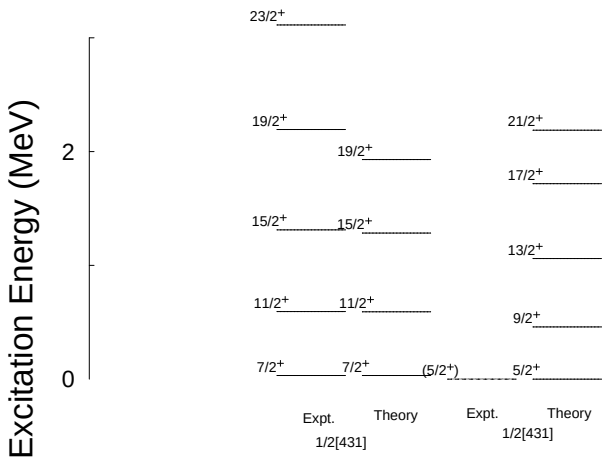

Fig.1 Partial level scheme of 109I

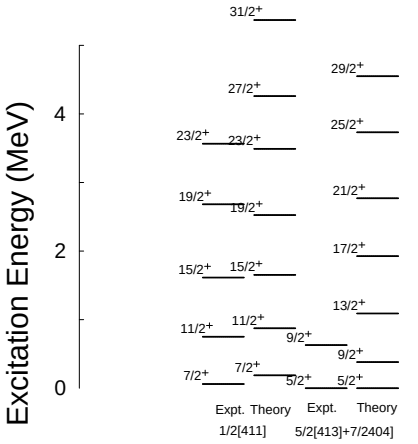

Fig.2 Partial level scheme of 113I