Variation of level density parameter with angular momentum in ^{119}Sb

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Introduction

Nuclear level density (NLD), a basic ingredient of Statistical Model has been a subject of interest for various decades as it plays an imortant role in the understanding of a wide vaiety of Nuclear reactions. There have been various efforts towards the precise determination of NLD and study its dependence on excitation energy and angular momentum as it is crucial in the determination of cross-sections. Here we report our results of theoretical calculations in a microscopic framework to understand the experimental [1] results on inverse level density parameter (k) extracted for different angular momentum regions for ^{119}Sb corresponding to different γ-ray multiplicities by comparing the experimental neutron energy spectra with statistical model predictions where an increase in the level density with the increasing angular momentum is predicted [1]. NLD and neutron emission spectra dependence on temperature and spin has been studied in our earlier works [2–4] where the influence of structural transitions due to angular momentum and temperature on level density of states and neutron emission probability was shown.

Brief description of work

In the framework of a Staistical Model, an excited and rotating nucleus is treated with a mean-field approximation with excitation energy E and angular momentum J as the input parameters and the entropy is maximized to determine the equilibrium shape of the nucleus. However it is more convenient to replace these extensive variables E and J by their intensive partners temperature T and angular velocity of rotation and minimize the appropriate free energy. We use [5] statistical Model and a triaxially deformed Nilsson potential including shell correction where the entropy is computed and the free energy $F = E - TS$ is minimized. F minima are searched for Nilsson deformation parameters β and γ which give equillibrium deformation and shape of the excited nucleus. To compare our results with Ref. [1], excitation energy varying between 30 MeV to 45 MeV is computed for T = 1.1 − 1.6 MeV. The level density parameter is extracted for angular momentum values M = $12\hbar - 22\hbar$ using the expression a = $S^2/4Ex$.

Results and Discussion

Inverse level density parameter 'K' for ^{119}Sb and its neighbouring nuclei for N=68 for T = 1.2 − 1.4 MeV at a fixed angular momentum value is plotted in Fig. 1 where shell effects on the level density are evidently seen. At shell closures, level density parmeter 'a' should be minimum and 'K' (=A/a) a maximum as is seen in Fig. 1. After 'K' maxima at Z=50, there is a sudden drop in 'K' value for Sb(Z=51) which being next to shell closure sees a shape transition from spherical to oblate with small deformation. Variation of 'K' with angular momentum for ^{119}Sb is shown in Fig. 2 along with the experimental data where M ranges from $12\hbar$ to $21\hbar$. Value of 'K' lies within the limits of experimental data although the angular momentum values

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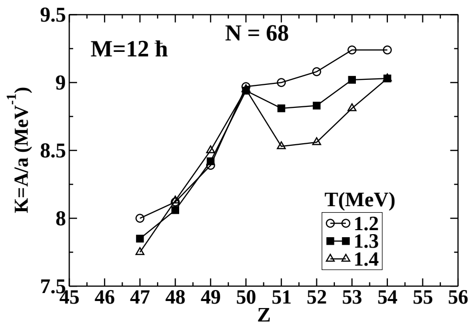

FIG. 1: Inverse level density parameter'K' vs. Z for N=68. K shows maxima at shell closure.

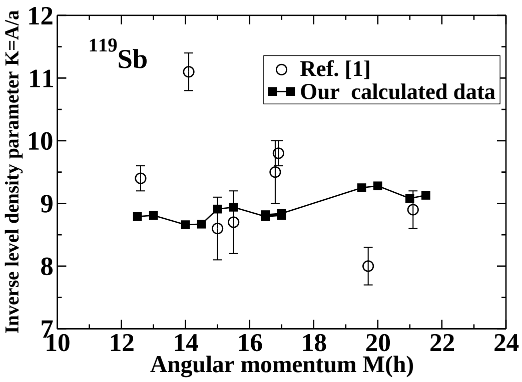

FIG. 2: Our calculated theoetical values of 'K' vs angular momentum values varying in a range from $12\hbar$-$21\hbar$ for ^{119}Sb. Excitation energies are calculated using T=1.2-1.6 MeV

of Ref.[1] have a very large spread. The agreement of 'K' values is reasonably good. Although the range of angular momentum and T values used for calculations are same as those used in Ref.[1] and a similar trend in the variation of 'K' values is predicted, however efforts for better accuracy and calculations to evaluate NLD and yield are in progress.

Conclusion

Preliminary results of theoretical calculations in a microscopic approach to study the experimentally derived level density parameter in ^{119}Sb in a recent work and its variation with angular momentum are presented. Inverse level density parameter 'K' is influenced by shell effects, shape and deformation. Sb being next to shell closure shows a sudden dip in 'K' value as it experiences deformation and shape transition from spherical to Oblate shape. Variation of 'K' values with angular momentum is in reasonable agreement with the experimental data.

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