Nuclear level density variation with angular momentum induced shape transition

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Introduction

Variation of Nuclear level density (NLD) with the excitation energy and angular momentum in particular has been a topic of interest in the recent past and there have been continous efforts [1–4] in this direction on the theoretical and experimental fronts but a conclusive trend in the variation of nuclear level density parameter with angular momentum has not been achieved so far. A comprehensive investigation of N=68 isotones around the compound nucleus ^{119}Sb from neutron rich ^{112}Ru (Z=44) to neutron deficient ^{127}Pr (Z= 59) nuclei is presented to understand the angular momentum induced variations in inverse level density parameter and the possible influence of deformation and structural transitions on the variations on NLd.

Brief description of work

Calculations are performed using [1] 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. The inverse level density parameter 'K' (=A/a) calculated using the expression a = S^2/4Ex at excitation energy around 31 MeV computed for T =1.3 MeV and angular momentum values M = 0$\hbar$ − 40$\hbar$.

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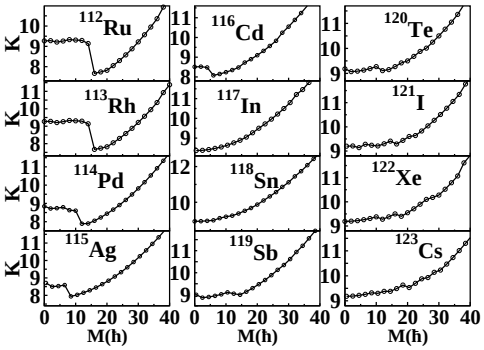

FIG. 1: Variation of K as a function of angular momentum for N=68 isotones of Z=44−55

Results and Discussion

Our calculated values of inverse level density parameter 'K' with angular momentum for N=68 isotones around ^{119}Sb from neutron rich ^{112}Ru (Z=44) to neutron deficient ^{123}CS (Z= 55) nuclei (plotted in Fig. 1) increase with increasing angular momentum for all the nuclei for all M except at certain values of M in ^{112}Ru, ^{113}Rh, ^{114}Pd, ^{115}Ag and ^{116}Cd where one observes a sharp decline in the value of 'K' with increasing angular momentum. Value of 'K' drops significantly by even upto ≈ 1.5 MeV from a value 9.14 MeV at M=14$\hbar$ to 7.67 MeV at M=16$\hbar$ in case of ^{112}Ru. At these values of M in ^{112}Ru, ^{113}Rh, ^{114}Pd, ^{115}Ag and ^{116}Cd, we report a shape transition (see Fig. 2) from oblate to a rare shape phase of prolate non-collective where we observe a sharp drop in the value of 'K'. For M >16$\hbar$ 'K' again increases gradually with increasing M. The drop in K value ceases to occur near shell closure and completely vanishes at Z=49−50. In the absence of any shape transition in nuclei with Z=51 to 55(^{119}Sb to

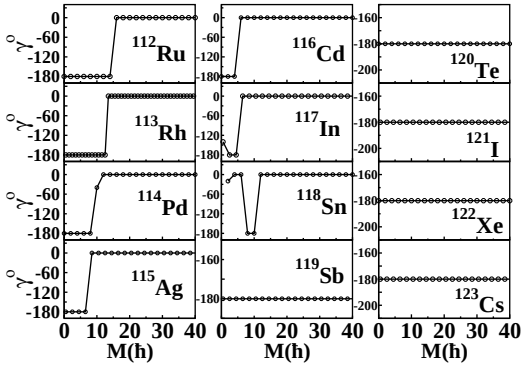

FIG. 2: Shape parameter γ vs angular momentum M($\hbar$).

^{123}Cs), K increases graually with M but fluctuates slightly with small fluctuations in deformation β with angular momentum. These small fluctuations due to β could explain small decline in experimental [3] 'K' values in the case of ^{119}Sb that lie close to our calculated values [5] although thier data sample is too small for comparison with our data. Few more experimental data points with a wider range of angular momentum would have been useful to give a conclusive viewpoint. Now it is evident that the structural transitions have profound influence on the level density and K increases with increasing angular momentum and shows a decreasing trend whenever there is a shape transition or deformation fluctuations.

Conclusion

Inverse level density parameter increases with increasing angular momentum for all N=68 isotones from ^{112}Ru to ^{123}CS but a steep decline in 'K' value is observed in few isotones when there is a shape transition from oblate to prolate non-collective which also influences neutron emission probability and level density significantly. Hence a strong correlation between the structural transitions and the level density variation with angular momentum is predicted.

Acknowledgments

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