# Search for Tidal Waves in Nuclear mass region~100

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## Introduction

The collective nature of Nuclei is conventionally classified in terms of "harmonic vibrators" and "Symmetric rotors": Rotors have a fixed shape that rotates around a defined axis. One of the major themes in nuclear structure research is shape evolution with nucleon number and/or angular momentum. The angular momentum ($I= \Im\omega$) is gained either by increasing the moment of inertia, $\Im$, or the rotational frequency, ω, and both. Vibrational and rotational modes differ by the way of producing angular momentum. A rotor generates angular momentum by increasing the angular frequency ω at nearly constant deformation (and, hence, the constant moment of inertia). In a transitional nucleus, the angular momentum is gained by increasing the moment of inertia, $\Im$ and the rotational frequency ω. From a vibrational perspective, the increase of ω reflects the anharmonicities of the motion, from the rotational perspective, the increase of $\Im$ reflects the softness of the rotor. The yrast states of vibrational and transitional nuclei can be understood as tidal waves [1], if most of the angular momentum is generated by the increase of the moment of inertia or deformation. Figure 1 shows the experimental relations between the angular momentum and the angular frequency, the moment of inertia, and spin.

In A∼100 region, a transition from the vibrational motion at low spin to rotational motion at high spin has been observed. The concept of the E-Gamma Over Spin (E-GOS) plots (Fig. 2) exhibits a decay sequence consistent with quasi-vibrational excitations at lower spins, which gives way to more statically (albeit weakly) deformed sequences above spins of (10-12) $\hbar$ [2].

## Theoretical Approach

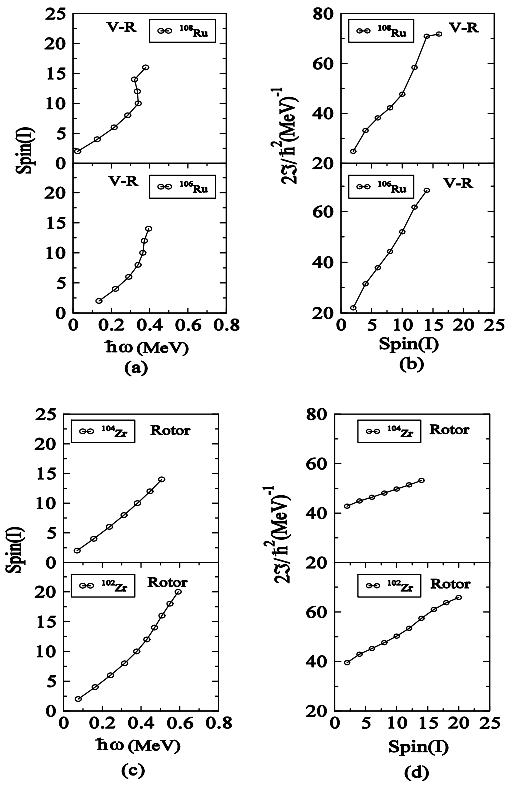


**Fig. 1** (a) Angular momentum (I) as a function of angular frequency ($\hbar\omega$) (b) Moment of inertia ($\Im$) with spin (I) for the yrast states of nuclei $^{106,108}$Ru for vibration to rotation. (c) Angular momentum (I) as a function of angular frequency ($\hbar\omega$) (d) Moment of inertia ($\Im$) with spin (I) for the yrast states of nuclei $^{102,104}$Zr for deformed nuclei.

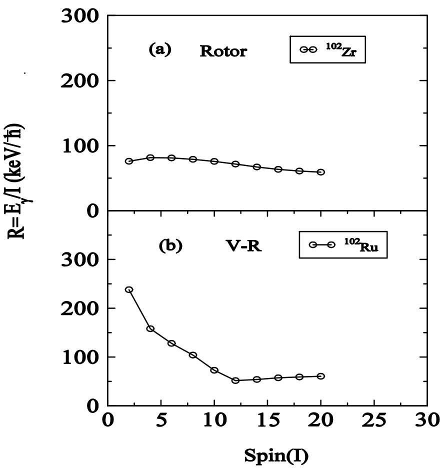


**Fig. 2** (a) E-GOS curves for an axially symmetric rotor with first $2^+$ excitations of 100 KeV for deformed nuclei. (b) E-GOS plot for the yrast sequence in $^{102}$Ru for vibration to rotation.

The rotor like scenario has been well studied, with the measured reduced transition probabilities, i.e., B(E2) values, confirming that the deformation remains rather constant. For the tidal wave like scenario; the measured B(E2) values increase linearly with *I*, such that the ratio B(E2)/$\Im$ is constant within the experimental uncertainties. The First evidence of tidal wave in $^{102}$Pd, was quoted in Ref. [3] by measuring the lifetime of yrast state in $^{102}$Pd which is in contradiction to the study [4], which is against the tidal wave nature, Fig. 3.

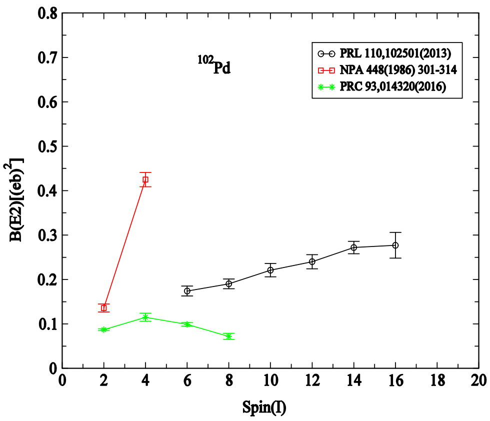


**Fig. 3** Electromagnetic transition probabilities for the yrast state of $^{102}$Pd as a function of spin (I).

The low-spin parts show the expected gradual transition from the vibration-like behavior of the nuclides near the closed shell (Z=48, N=56) to the rotation-like behavior of the nuclide farthest in the open shell (Z=44, N=66). For most transitional nuclei, the situation is intermediate: Both mechanisms of generating angular momentum are present, one favored over the other as the angular momentum increases.

## Conclusion

With the results and discussion as given, it can be concluded that the lack of B(E2) values in mass region ~100, weakens the experimental evidence of a tidal wave as expected from theoretical calculations. However the detailed work on the subject is underway and will be presented.

## References

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