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Variations on Nuclear Shapes

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The concept of nuclear shape, most often of quadrupole type, is ubiquitous in nuclear physics. We speak of spherical, prolate, oblate or triaxial nuclei; of the evolution of the shapes along isotopic or isotonic chains, and of the coexistence of different shapes in the spectrum of a given nucleus. The last two phenomena, are closely related and prominent at the very neutron rich edge of the nuclear chart, in particular at the Islands of Inversion which occur around the neutron magic numbers N=20, 28, 40 and 50. In these cases, the latter acts as the portal to the IoI's where the shape evolution takes place. However, the very notion of shape is intimately linked to our semiclassical view of the nucleus or, in other words, it only makes sense when a description in the intrinsic reference frame is valid. Thus, how can we characterize the nuclear shape in the laboratory? The only invariant quantities at hand are the scalars made from the quadrupole operator $\hat{Q}_2$ usually known as Kumar invariants. Only recently the higher order invariants (up to $(\hat{Q}_2)^6$) needed to obtain not only the values of β and γ but also its variances, have been calculated. I will present a panoply of results which question some of our long time cherished semantics, because in many cases nuclei exhibit a non negligible degree of β softness, and in most cases they are fully γ soft. We submit that when the variances of β and γ are large the notion of shape makes no sense. In particular, there is not such a thing as a spherical nucleus.

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