The Role of Structural Symmetries in nuclei

Two perspectives on Nuclear Theory

Microscopic in terms of nucleons and their interactions aiming to understand why nuclei do what they do

Macroscopic that describes what the nucleus as a many-body whole is doing. Focus on structural symmetries, often analytic and parameter-free (except for scale).

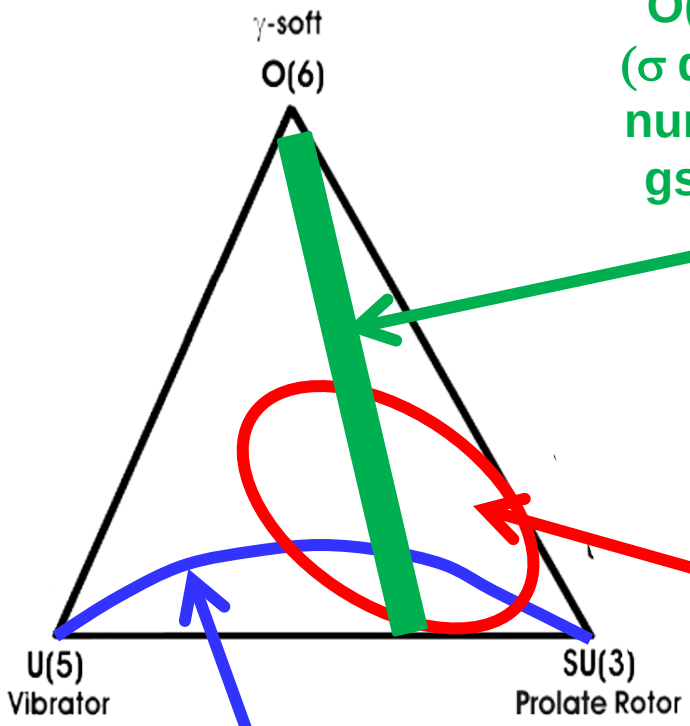
Unfortunately, very few physical systems, especially in atomic nuclei, manifest an idealized structural symmetry very well.

Situation is radically changing with a profusion of new "partial" and "quasi" dynamical symmetries (PDS, QDS) - empirically validated - in which important symmetry remnants (e.g., pure symmetry for some states, degeneracies, etc) persist in systems with otherwise severely broken parent symmetries.

Potential expansion of role of symmetry descriptions for nuclei

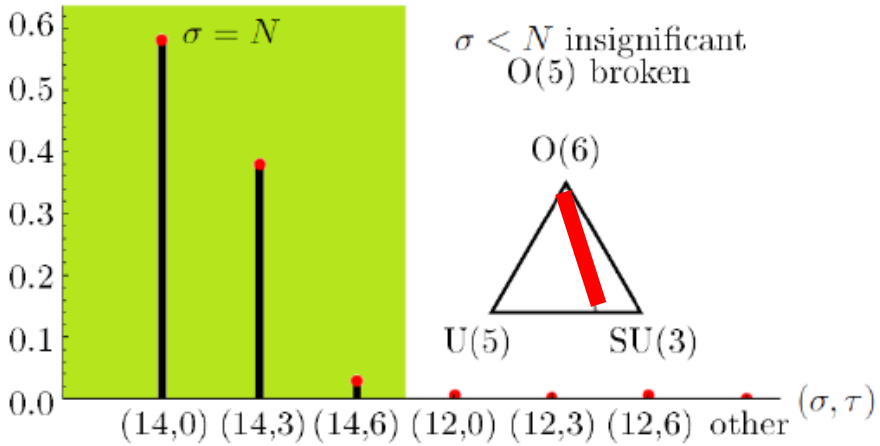
Proliferation of partial, quasi dynamical symmetries in the triangle

(Color coded guide)

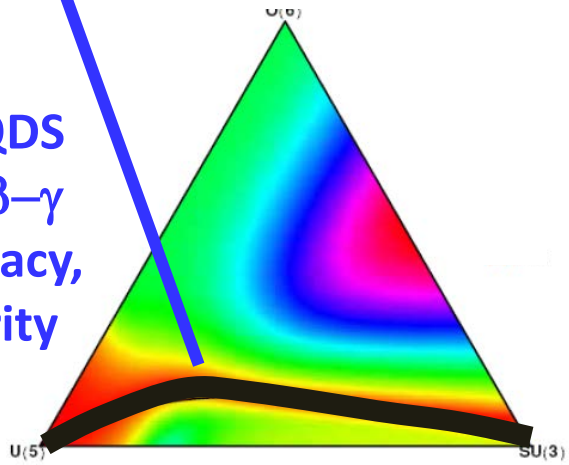


O(6) PDS (σ quantum number for gsb only)

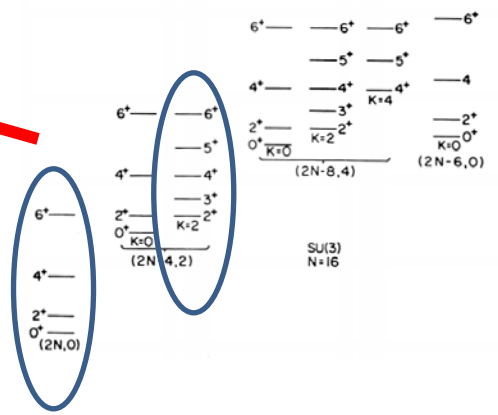
Expansion in O(6) basis (σ,τ)



SU(3)PDS



SU(3) QDS Arc of β–γ degeneracy, regularity



SU(3) PDS: γ, ground states are pure SU(3). All others highly mixed.

Perspectives for the future

- Understanding the relation of these partial symmetries to numerical calculations – how such seemingly diverse descriptions can be simultaneously successful.
- Role of finite valence space (deviations of PDS predictions from parent symmetries are valence nucleon-number dependent).
- Identifying the empirical signatures of partial symmetries.
- Uncovering which partial symmetries are relevant to actual nuclei.
- Interpreting the partial symmetries in terms of (basis-dependent) entropy.
- Linking these descriptions to microscopic calculations.