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Ab initio view of emergent symplectic Sp(3,R) symmetry and its crutial role in nuclear dynamic

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Abstract

Exact symmetry and symmetry-breaking phenomena provide a better understanding of many-body systems, from quarks and nuclei, through molecules and galaxies. In atomic nuclei, exact and dominant symmetries such as rotational invariance, parity, and charge independence have been established early on. At the same time, the nature of nuclear dynamics appears to exhibit a high degree of complexity with no additional symmetries immediately evident from the underlying nuclear interactions. In this talk, I will discuss results of first-principles nuclear structure studies unveiling that the special nature of the strong nuclear force determines highly regular and ubiquitous patterns of dominant nuclear shapes and their vibrations and rotations [1, 2]. This emergent structure is tied to an approximate symplectic Sp(3,R)⊃U(3) symmetry group chain, and it determines dominant features of light to intermediate-mass nuclei, including their low-lying excited states and giant resonances, even in close-to-spherical nuclear states without any recognizable rotational properties. I will also discuss recent progress in the development of new and increasingly sophisticated computational tools [3, 4] based on SU(3) and Sp(3,R) symmetry groups, that are capable of utilizing dominant nuclear shapes and collective dynamics for ab initio large-scale nuclear structure and reactions modeling [5] with unprecedented reach and accuracy.

References

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