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Pseudospin symmetry in nuclear single-particle spectra and its perturbative interpretation

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While a remarkable spin-orbit splitting is crucial for understanding the nuclear magic numbers, pairs of single-particle states with quantum numbers $(n-1, l+2, j = l+3/2)$ and $(n, l, j = l+1/2)$ are always found to be quasi-degenerate. The so-called pseudospin symmetry (PSS) was introduced by Arima et al. and Hecht et al. in 1969 to explain this phenomenon. Although it has been more than 40 years since then and comprehensive efforts have been made, the origin of PSS still remains a puzzle and whether or not its nature is perturbative is also under debate.

Recently, by using the perturbation theory, we showed that the PSS breaking in realistic nuclei can be indeed understood in a perturbative way [1]. As a step further, we consider it is promising to understand PSS and its breaking mechanism in a fully quantitative way by combining the similarity renormalization group technique, supersymmetric quantum mechanics, and perturbation theory. The key points of this idea were illustrated by taking a Schrodinger equation as an example [2].

[1] H. Liang, P. Zhao, Y. Zhang, J. Meng, and N. Van Giai, Phys. Rev. C 83, 041301(R) (2011);
[2] H. Liang, S. Shen, P. Zhao, and J. Meng, Phys. Rev. C 87, 014334 (2013).

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