Nuclear magnetic and antimagnetic rotation in covariant density functional theory

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In the past decades, the experimental discovery of the rotational-like sequences in near-spherical nuclei, which are known as magnetic rotation or antimagnetic rotation bands, has opened a new era in high-spin physics. The intriguing feature here is that the orientation of the rotor is not specified by the deformation of the overall density distribution but rather by the current distribution induced by specific nucleons moving in high-j orbitals [1].

The cranking mean field approaches are widely used to understand the structure of the rotational bands in nuclei. A description of the magnetic rotation band requires a model going beyond the principal axis cranking, i.e., the rotational axis does not coincide with any principal axis of the density distribution. This leads to the development of the tilted axis cranking approach within the framework of the pairing plus quadrupole model or the Strutinsky shell correction method [1].

The covariant density functional theory with a small number of parameters allows a very successful description of ground-state properties of nuclei all over the nuclear chart. Recently, the self-consistent tilted axis cranking covariant density functional theory has been established in Ref. [2] based on a newly developed point-coupling interaction PC-PK1 [3]. So far, this model has been applied successfully to investigate magnetic rotation in both light nuclei such as ^{60}Ni [2] and heavy nuclei such as ^{198,199}Pb [4]. Moreover, it provides a fully self-consistent and microscopic investigation for the observed antimagnetic rotation band in ^{105}Cd [5,6].

In Ref. [2], the observed four magnetic rotation bands in ^{60}Ni are investigated systematically. The tilted angles, deformation parameters, energy spectra, and reduced $M1$ and $E2$ transition probabilities have been studied in a fully microscopic and self-consistent way for various configurations. It is found that there is a transition from magnetic rotation to electric rotation with the increasing angular momentum.

In Refs. [5,6], the observed antimagnetic rotation band in ^{105}Cd is investigated. The experimental spectrum as well as the $B(E2)$ values are reproduced very well. This microscopic investigation gives a strong hint that antimagnetic rotation with its two "shears-like" mechanisms is realized in specific bands in nuclei.

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