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Collective rotation of the nuclei near and beyond drip lines: new physical features

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Over the years it was established that collective rotation of the nuclei can act as a tool to access new physical features or increase the stability of specific nucleonic configurations. The most well known case is superdeformed (SD) rotational bands: they cannot be formed at low spin in most of the regions of nuclear chart but collective rotation of the nuclei leads to the formation of SD shell gaps at high spin and brings SD rotational bands to the yrast line making their experimental observation feasible.
Cranked relativistic mean field theory without pairing can describe successfully the properties of different types of rotational bands at high spin across the nuclear chart (see Refs. [1, 2]). Using this framework a detailed and systematic investigation of rotational properties of the nuclei near and beyond the proton and neutron drip lines and the impact of collective rotation on their stability has been carried out [3, 4, 5]. It is shown that rotational bands which are particle quasi-bound at zero or low spins can be transformed into particle bound ones at high spin by collective rotation of nuclear systems. This is due to strong Coriolis interaction which acts on intruder high-j orbitals and drives the highest in energy occupied single-particle states of nucleonic configurations into negative energy domain. Particle emission from such particle bound rotational states is suppressed by the disappearance of static pairing correlations at high spins of interest. In addition, a new phenomenon of the formation of giant proton halos in rotating proton-rich nuclei emerges: it is triggered by the occupation of strongly mixed intruder orbitals. These physical mechanisms lead to a substantial extension of the nuclear landscape beyond the spin zero proton and neutron drip lines. The comparison with the results for ground state rotational bands in very neutron-rich 11Be and 39Mg nuclei obtained in Refs. [6] within the particle-plus-core model based on a nonadiabatic coupled-channel formalism and the Berggren single-particle ensemble will also be presented.
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