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Shell-model study of 28Si: shape coexistence and superdeformation

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We study the shape coexistence in the nucleus ^{28}Si with the nuclear shell model using numerical diagonalizations complemented with variational calculations based on the projected generator-coordinate method. Although the ground-state oblate rotational band is well described in the sd shell by the USDB interaction, the second excited 0_3^+ state and higher-energy levels lack the features of a prolate rotational band, in contrast to experiment. Thus, guided by the quasi-SU(3) model, we slightly lower the energy of the $d_{3/2}$ orbital, which leads to a good description of the prolate band. Alternatively, we extend the configuration space to also include the pf shell, finding that the prolate band appears naturally using the SDPF-NR interaction. Finally, we address the possibility of superdeformation in ^{28}Si within the $sdpf$ space. Our results disfavour the appearance of superdeformed states with excitation energy below 20 MeV.

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