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Proton-neutron pairing and quartet condensation in nuclei

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The common treatment of proton-neutron pairing in N ≅ Z nuclei relies on Cooper pairs and BCS-type models. However, the nuclear interaction can induce, through the isospin conservation, quartet correlations of alpha type which might compete with the Cooper pairs. In fact, for any isovector pairing interactions the ground state of N=Z systems is accurately described not by Cooper pairs but in terms of collective quartets [1]. Cooper pairs and quartets can however coexist in systems with N>Z. In this case the ground state of the isovector pairing Hamiltonian can be described with high precision as a condensate of alpha-like quartets to which it is appended a condensate of neutron pairs [2,3]. Quartets appear to be the relevant degrees of freedom for treating not only the isovector pairing but also the competition between the isoscalar and the isovector proton-neutron pairing in N=Z nuclei [4,5]. These facts indicate that the many-body pairing problem in N ≅ Z nuclei can be more efficiently treated in calculation schemes based on alpha-type quartets rather than on Cooper pairs and BCS-type models.

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