Parity-conserved self-consistent CHFB solution

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We developed a new program for solving the constrained Hartree-Fock-Bogoliubov (CHFB) equation without parity mixing. In this scheme (CHFB5), we require five constraints, one each on the total angular-momentum I, proton number Z_+ in the + parity shell (p^+), proton number Z_- in the − parity shell (p^-), neutron number N_+ in the + parity shell (n^+), and neutron number N_- in the − parity shell (n^-). As an example, we choose ^{134}Nd with the same parameter set as that adopted in Ref. 1). Here, we solved the full CHFB equation[2)] including all exchange terms (Fock terms), while Ref. 1). adopts only the Hartree terms. The values of (Z_+, Z_-, N_+, N_-) are selected in reference to the usual CHFB solutions with three constraints (CHFB3). The usual CHFB3 solutions show $(Z_+, Z_-, N_+, N_-) = (14.59, 17.41, 13.87, 10.13)$ at $I = 0$, while $(14.04, 17.96, 14.0, 10.0)$ at $I = 26$. Here, $(Z, N) = (32, 24)$ are numbers outside the closed core $(28, 50)$. Thus, we select $(14, 18, 14, 10)$ for the CHFB5 equation. The intrinsic difference between CHFB3 and CHFB5 solutions is in the quasi-particle (QP) energies. In Fig. 1, we compare the behavior of the lowest QP energies of Λ with its time-reversed energy $\tilde{\Lambda}$ vs. I. The equations for Λ and $\tilde{\Lambda}$ have been provided in Ref. 2). The degeneracy is lifted by the Coriolis anti-pairing effect with increasing I. Figure 1(A) shows the neutron shell, and (B) the proton shell. In both panels, ± specifies the ± shell; the filled symbols express $\tilde{\Lambda}$ and the open symbols Λ. Those in the abbreviation "with" denote CHFB5 solutions, while the others denote CHFB3 solutions. At low I, QP energies by CHFB3 and CHFB5 solutions coincide in the neutron shells (A); however, there is a considerable difference among the p^+ shell (B). The negative value of Λ in the n^+ shell is observed at $I =$ 10 in both CHFB3 and CHFB5 solutions; this indicates the first backbending is caused by the $i_{13/2}$ level in the n^+ shell. There occur negative values of Λ in the n^+ and n^- shells around $I = 20$ to 26, and they correspond to decreasing Δ_n, *i.e.*, 0.00021 (CHFB3) and 0.00035 (CHFB5).

References

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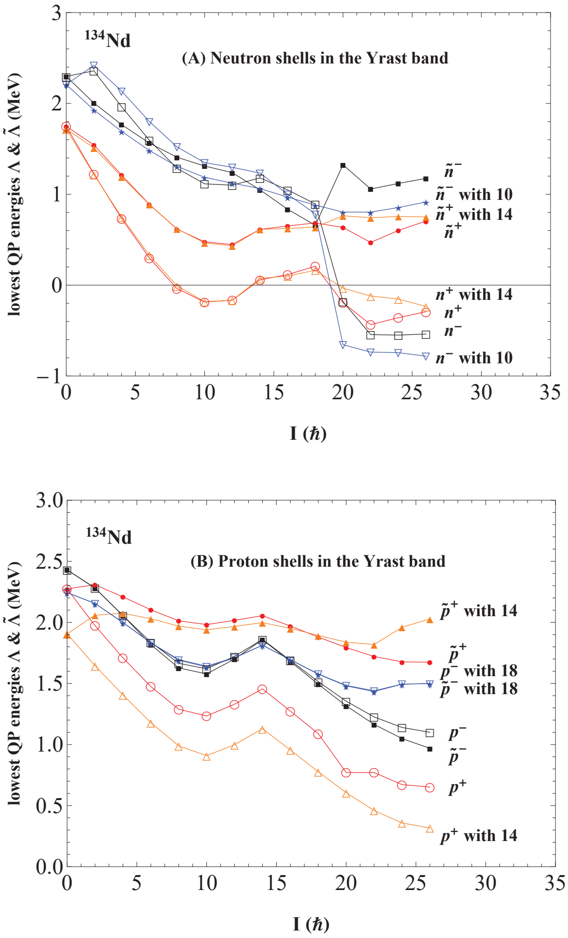

Fig. 1. (A) Lowest QP energies Λ and $\tilde{\Lambda}$ in the neutron shell as functions of angular momentum I. The red open-circles represent Λ, and the red filled-circles represent $\tilde{\Lambda}$ in the n^+ shell by the CHFB3 solutions; the orange open-triangles denote Λ, and the orange filled-triangles represent $\tilde{\Lambda}$ in the n^+ shell by the CHFB5 solutions. The open squares represent Λ, and the filled squares represent $\tilde{\Lambda}$ in the n^-shell by the CHFB3 solutions, while the blue open-triangles-down represent Λ, and the blue filled-triangles-down represent $\tilde{\Lambda}$ in the n^-shell by the CHFB5 solutions. (B) The lowest QP energies of Λ and $\tilde{\Lambda}$ in the proton shell as functions of I. The red open-circles represent Λ, and the red filled-circles represent $\tilde{\Lambda}$ in the p^+ shell by the CHFB3 solutions, while the orange open-triangles represent Λ, and the orange filled-triangles represent $\tilde{\Lambda}$ in the p^+ shell by the CHFB5 solutions. The open squares represent Λ, and the filled squares represent $\tilde{\Lambda}$ in the p^-shell by the CHFB3 solutions, while the blue open-triangles-down represent Λ and the blue filled-triangles-down represent $\tilde{\Lambda}$ in the p^-shell by the CHFB5 solutions.

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