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Finite-temperature valence-bond-solid transitions and thermodynamic properties of interacting SU(2N) Dirac fermions[1] YU WANG, Wuhan University — We investigate the SU($2N$) symmetry effects with $2N > 2$ on the two-dimensional interacting Dirac fermions at finite temperatures, including the valence-bond-solid transition, the Pomeranchuk effect, the compressibility and the uniform spin susceptibility, by performing the determinant quantum Monte Carlo simulations of the half-filled SU($2N$) Hubbard model on a honeycomb lattice. The columnar valence-bond-solid (cVBS) phase only breaks the three-fold discrete symmetry, and thus can survive at finite temperatures. The disordered phase in the weak coupling regime is the thermal Dirac semi-metal state, while in the strong coupling regime it is largely a Mott state in which the cVBS order is thermally melted. The calculated entropy-temperature relations for various values of the Hubbard interaction U show that, the Pomeranchuk effect occurs when the specific entropy is below a characteristic value of S^* — the maximal entropy per particle from the spin channel of local moments. The SU($2N$) symmetry enhances the Pomeranchuk effect, which facilitates the interaction-induced adiabatic cooling. Our work sheds new light on future explorations of novel states of matter with ultra-cold large-spin alkaline fermions.

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