A study of momentum entanglement and negativity in Bardeen-Cooper-Schrieffer states at finite temperature

CHUN KIT CHUNG, CHI KWONG LAW, Department of Physics and Institute of Theoretical Physics, The Chinese University of Hong Kong, Shatin, Hong Kong SAR, China — We study the momentum entanglement between the spin-up and spin-down particles of the homogeneous Bardeen-Cooper-Schrieffer (BCS) state at finite temperature. To achieve this, we construct from the BCS state the partial transposition $\rho_2^T$ of the two-particle density matrix in momentum space. The structure of $\rho_2^T$ and its corresponding negativity $N_2$ are examined. We show that $\rho_2^T$ consists of infinitely many decoupled $2 \times 2$ submatrices, and momentum entanglement coexists with the pairing order parameter $\Delta$. It is found that pairs with momenta slightly above a surface related to the Fermi energy contribute this entanglement most significantly. We propose an entanglement witness operator as a measurable quantity to detect momentum entanglement in BCS states.