

Spin-orbit coupling effect on a particle density correlation in a two-dimensional electron gas

M. Kołodziej and G. Harań

*Institute of Physics, Politechnika Wroclawska,
ul. Wybrzeże Wyspiańskiego 27, 50-370 Wrocław*

Symmetry breaking as an origin of significant physical phenomena, like magnetism or superconductivity, is an important issue in condensed matter physics. Particularly interesting is a presence or a lack of time-reversal and inversion symmetries which determine the symmetry of a superconducting groundstate. Their role has been extensively studied in experiment and theory in non-centrosymmetric superconductors [1]. A unique opportunity to control the time-reversal and inversion symmetry breaking is provided by the spin-orbit coupling interaction in two-dimensional systems where these two symmetries can be lifted by applying external magnetic or electric fields, respectively [2].

The spin-orbit coupling interaction, $\vec{\gamma}(\mathbf{k}) \cdot \hat{\sigma}$, is determined by the scalar product of a gyroscopic vector $\vec{\gamma}(\mathbf{k})$ and the spin operator $\hat{\sigma}$ with $\vec{\gamma}(\mathbf{k}) = \vec{\gamma}(-\mathbf{k})$ representing a time-reversal symmetry breaking and $\vec{\gamma}(\mathbf{k}) = -\vec{\gamma}(-\mathbf{k})$ standing for the inversion symmetry breaking. In both cases the interaction leads to the energy band splitting. We discuss the effect of the above two types of the spin-orbit coupling interaction on a density correlation function in a two-dimensional electron gas and conclude on a possible Cooper pair formation: dominated by the intraband pairing for a broken time-reversal symmetry and with a prevailing interband pairing for a broken inversion symmetry. We also point out that our result can be verified experimentally by the Fourier-transformed scanning tunneling microscopy of a single nonmagnetic impurity in two-dimensional or quasi two-dimensional electron systems [3].

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Monday

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