

Impact of anisotropic Polar and Anderson-Brinkman-Morel phases of p-wave superconductors on thermoelectric properties of quantum dot based hybrid

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P-wave superconductors [1] host rich quantum phenomena arising from odd-parity, anisotropic, spin-triplet pairing, including nontrivial topology, Majorana physics, and time-reversal symmetry breaking. In particular, chiral and anisotropic p-wave phases strongly influence quasiparticle transport and Andreev reflection, offering promising routes for superconducting spintronics. However, theoretical/computational studies of Quantum dot (a mesoscopic scatterer) based hybrid systems incorporating p-wave superconductors remain comparatively underexplored [2][3]. We theoretically study thermoelectric transport in a hybrid device consisting of a quantum dot coupled to a ferromagnetic lead and a spin-triplet p-wave superconductor. Focusing on the Polar and Anderson-Brinkman-Morel (ABM) phases, we incorporate momentum-dependent tunneling via an angle-dependent coupling modelling and analyze configurations where the superconducting symmetry axis is parallel or perpendicular to the tunneling direction. Using Keldysh Green's function formalism in the linear-response regime, we compute electrical and thermal conductances, thermopower, and the thermoelectric figure of merit. Our results demonstrate that gap anisotropy and orientation play a decisive role in transport, producing strong phase- and geometry-dependent signatures. In particular, anisotropy governs the balance between Andreev reflection and quasiparticle tunneling, allowing the effective triplet Andreev reflection to be suppressed or enhanced by rotating the superconducting axis. In the ABM phase, this behavior is traced to the azimuthal phase structure of the order parameter. Additionally, thermal conductance is enhanced by orders of magnitude compared to the s-wave case[4]. These findings establish thermoelectric transport as a sensitive probe of triplet pairing symmetry and nodal structure in p-wave superconductors. We note that the approach can be extended for non-equilibrium studies and any superconducting states for which the gap function angular dependence is predicted. These results may assist experimental efforts.

References:

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