

TRANSPORT PROPERTIES IN SUPERCONDUCTING HYBRID NANOSYSTEMS

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The recent advancements nanotechnology has expanded considerably the possibility to create hybrid devices. At the same time the development of the topological materials[1] in the last decades has further extended the interest for hybrid devices which mix superconductors, normal metals, ferromagnetic and/or material with strong spin-orbit[2]. Hereafter we discuss three different examples. We firstly consider the thermal transport properties of a Josephson junction[3]. We review how the galvanic term depends on the phase difference, discussing the recent experimental advancements in the field[4]. We also compare those terms with other contributions such as the radiative ones, which are expected to be very small for Josephson junctions[5]. As second example we consider the thermo-electrical properties of a normal-metal-ferromagnetic-insulator-superconductor system[6]. We will discuss how those systems may present strong Seebeck coefficient, as recently measured[7], than can be used for high sensitivity thermometry up to 30nK Hz^{-1/2}. We discuss different configurations of the device in order to extract the information on temperatures and we discuss how the non-equilibrium conditions guarantees the maximal temperature sensitivity[8]. As a third example we investigate the Josephson current of a nanoring in the presence of a finite size topological superconductor[9]. Here we propose an alternative and complementary experimental recipe to detect topological phase transitions in these systems[10]. We show in fact that, for a finite-sized system with broken time-reversal symmetry, discontinuities in the Josephson current-phase relation correspond to the presence of zero-energy modes and to a change in the fermion parity of the groundstate[11]. Such discontinuities can be experimentally revealed by a characteristic temperature dependence of the current, and can be related to a finite anomalous current at zero phase in systems with broken phase-inversion symmetry.

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