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Numerical simulation of the superconducting proximity effect in 3D including magnetic and spin-orbit interactions: vortex excitations and anomalous supercurrent flow MORTEN AMUNDSEN, JACOB LINDER, Norwegian Univ Tech (NTNU) — In numerical studies of superconducting hybrid structures, one often resorts to effective one dimensional models. This introduces a layer of abstraction between experiments and theory where many of the geometrical effects are neglected. In addition, inherently higher dimensional phenomena such as charge/spin Hall effects and topological excitations like vortices and skyrmions may not be described by this approach. The main obstacle when including higher dimensional effects is the large amount of computer resources required and the difficulty in describing experimentally relevant geometries with the commonly used finite difference methods. Here, the Usadel equation is solved in two and three dimensions by means of the finite element method, thereby simulating the superconducting proximity effect in the diffusive limit. Both normal metals and ferromagnets with spin-orbit interactions will be considered. Through relevant examples, it will be demonstrated the ease with which the method handles realistic systems exhibiting higher dimensional effects, such as non-trivial geometries and complicated magnetization textures, and that it predicts new physical phenomena related to vortex physics and supercurrent flow which cannot be captured in 1D models.

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