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Probing Majorana-like states in quantum dots and quantum rings[1] IGOR ZUTIC, BENEDIKT SCHARF, Department of Physics, University at Buffalo, SUNY, Buffalo, NY 14260, USA — Engineering topological superconductivity in semiconductor structures offers fascinating ways to obtain and study Majorana modes in a condensed matter context. Here, we theoretically investigate topological superconductivity in quantum dots and quantum rings [1]. Using both analytical as well as numerical methods, we calculate the quasiparticle excitation spectra in these structures and the corresponding excitation amplitudes and charge densities. In the topological regime, we can observe the chiral edge modes localized at the boundaries and possessing finite energy in quantum dots and quantum rings. By applying a magnetic field which is expelled from the quantum ring, but which creates a flux that is an odd integer multiple of $\Phi_0/2 = \pi\hbar/e$, Majorana modes, that is, (approximately) degenerate edge modes with zero energy and zero charge density, become possible in the topological regime. Furthermore, we investigate finite-size effects that split these degenerate edge modes as well as the effect of a magnetic field penetrating into the superconducting region that can under certain circumstances still support edge modes with approximately zero energy and charge.

[1] Benedikt Scharf and Igor Zutic, arXiv:1409.7735 (2014).

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