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Topological States in a One-Dimensional Fermi Gas with Attractive Interactions JONATHAN RUHMAN, EREZ BERG, EHUD ALTMAN, Weizmann institute of science — We show that a single one-dimensional Fermi gas with Rashba-like spin-orbit coupling, a Zeeman field and intrinsic attractive interactions exhibits a novel topological superfluid state, which forms in spite of total number conservation and the absence of a single particle gap. Topological ground state degeneracy is associated with interfaces between two distinct phases that naturally form in the harmonic confining potential due to the spatial variations of the chemical potential. We find that backscattering by impurities, or simply by the interfaces themselves, effects a splitting in the topological degeneracy which generally scales as $1/L^{K/2}$, where L is the size of the system and K is the Luttinger parameter. However, when the interfaces are sufficiently smooth, as in the case of a harmonic confining potential, the splitting becomes exponentially small in the system size. We also discuss the experimental implications of the novel ground state degeneracy, as manifest for example in the response to simple dipole modulations of the harmonic trap potential.

Jonathan Ruhman
Weizmann institute of science

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