Flow-induced phase transitions in superfluid ^{3}He films[†]

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Confinement of superfluid ^{3}He to films with thicknesses of order $D \lesssim 15\,\xi_0$, where $\xi_0 = \hbar v_f / 2\pi k_{\rm B} T_c \approx 200 - 800\,\text{Å}$, is the bulk coherence length, provides a unique environment to stabilize quantum phases that are not stable in bulk ^{3}He. Pair-breaking at interfaces, combined with correlations between the nine complex order parameter components, $A_{\alpha i}$, leads to suppression of certain components and enhancement of others. Transitions between different phases can be tuned via film thickness, pressure and temperature. In this presentation we describe a new degree of freedom - *superflow* - which in the context of confinement leads to several unique ordered phases. Superflow breaks time-reversal symmetry, axial rotation symmetry, and leads to new collective states. The quasiclassical equations of Eilenberger, Larkin and Ovchinnikov are solved self-consistently to identify the flow-stabilized phases of superfluid ^{3}He in cavities. Results for the inhomogeneous order parameter structures, their residual symmetry groups, and the film phase diagram are presented. The latter depends on the film thickness, D, flow velocity, v_s, and the surface boundary conditions. We present results based on microscopic models for specular, diffuse and retro reflection by the surface. The phase diagram is compared with existing experiments carried out in film and slab geometries. We also show the Fermionic spectrum of quasiparticles confined to the interface, and discuss the effects of flow-induced symmetry breaking, and of surface quality, on the Majorana spectrum.

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