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**Phase transitions and critical currents in superfluid $^3$He films**[1]
ANTON VORONTSOV, Montana State University, JAMES SAULS, Northwestern University — Using the quasiclassical theory of superfluidity we investigate thermodynamic and transport properties of superfluid $^3$He in confined geometries. Classic flow experiments, as well as more recent NMR and flow experiments on superfluidity in slab and film geometries, exhibit inconsistencies between experimental results and existing theoretical models of confinement effects. In order to explain the origin of some of these inconsistencies we describe a theoretical model for confinement effects based on scattering of quasiparticles from rough surfaces that is more general than the 'specular' and 'diffusive' scattering models. Using the this more general boundary scattering model we report theoretical results for (a) the suppression of the superfluid critical temperature $T_c^{film}$, (b) the confinement-driven transition between A and B phases, $T_{AB}$, and (c) effects of the surface roughness on the critical current. The new scattering model should provide a more complete framework for analysis of the properties of confined superfluid $^3$He.

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