

Vortex Loops in Extreme Type-II Superconductors

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Abstract

The influence of thermally induced vortex loops on field induced vortices in extreme type-II superconductors, particularly in the molten phase of the Abrikosov vortex lattice, is investigated via Monte Carlo simulations of the $3DXY$ -model in the presence of a gauge-field. The magnetic filling fractions are in the range $1/f = 20 - 300$, and the systems are cubic $L \times L \times L$, with $L \in [50 - 150]$. Defining a parameter probing vortex-loop ordering/disordering in the presence of a finite field, it is investigated over which field- and temperature regime the molten phase in fact remains a *line-liquid*, i.e. where the line tension of the flux lines remain finite. In the $2D$ non-relativistic superfluid boson analogy of vortex liquids, this amounts to investigating where the boson-mass is finite. Our results indicate that line-liquid physics, and thus also the $2D$ non-relativistic superfluid boson analogy, is invalid over practically the entire molten phase in the low-field regime. [A. K. Nguyen and A. Sudbø, Phys. Rev. **B 57**, 3123, (1998), condmat/9712264, Phys. Rev. **B 58**, Aug. 1, 1998].