Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Lower critical magnetic field for a 2-D superconductor in a non-uniform field[1] JOHN DRASKOVIC, THOMAS LEMBERGER, The Ohio State University — Our exploration of nonlinear effects in two-coil measurements of superfluid density in thin superconducting films led us to calculate the lower critical field of infinite-radius, thin superconducting films in the non-uniform field of a nearby coil powered by an external current supply. We obtain an expression for the Helmholtz free-energy of vortices and antivortices added to the vortex-free Meissner state, and for the work done by the current supply when vortices appear. From these quantities we construct the appropriate "Gibbs" free energy ΔG to minimize. We find that ΔG of a vortex-bearing state dips below that of the Meissner state when the applied magnetic field exceeds: $B_0^* \approx \frac{8\sqrt{2}\Lambda}{R} B_{c1}^{2D}$ where the intrinsic 2D lower critical field is defined as: $B_{c1}^{2D} \equiv \frac{\Phi_0}{4\pi\Lambda^2} ln\left(\frac{\Lambda}{\xi}\right)$. Here, Λ is the 2-D penetration depth, $2\lambda^2/t$, and t is film thickness. We show that in amorphous MoGe films, this theoretical field is much smaller than the experimental field where vortices become evident in the data. Experimentally, the onset of vortex physics is close to the point where the Meissner screening supercurrent density approaches its theoretical maximum value.

[1]Supported in part by: DOE-BES Grant No. FG02-08ER46533 and by NSF grant DMR-0805227

Thomas Lemberger
The Ohio State University

Date submitted: 11 Dec 2012 Electronic form version 1.4