BOULDER SCHOOL FOR CONDENSED MATTER AND MATERIALS PHYSICS

Steven M. Girvin (Indiana University)

II. Introduction to the Kosterlitz-Thouless Phase Transition.

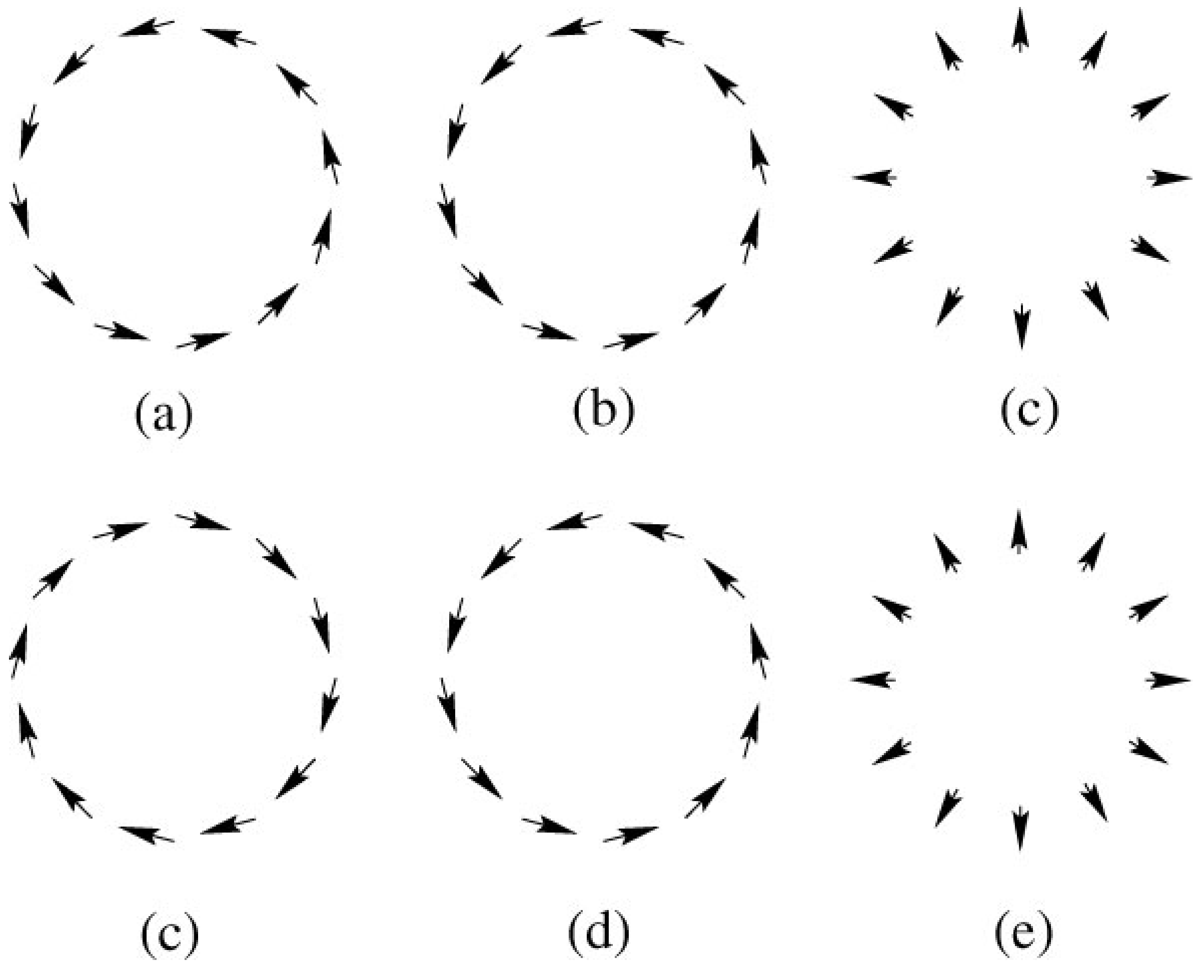

Figure 1: (a) φ field configuration for a vortex with winding number +1. (b) $\vec{\nabla}\varphi$ for this vortex. (c) The field $\vec{D} \equiv \vec{\nabla}\varphi \times \hat{z}$ used in the electrostatics representation. (e-f) corresponding configurations after a global $U(1)$ transformation $\varphi \longrightarrow \varphi + \pi$. Notice that the winding number has *not* changed. It is still +1 and the $\vec{\nabla}\varphi$ and $\vec{D}$ fields (as well as the energy) are left unchanged by the transformation.

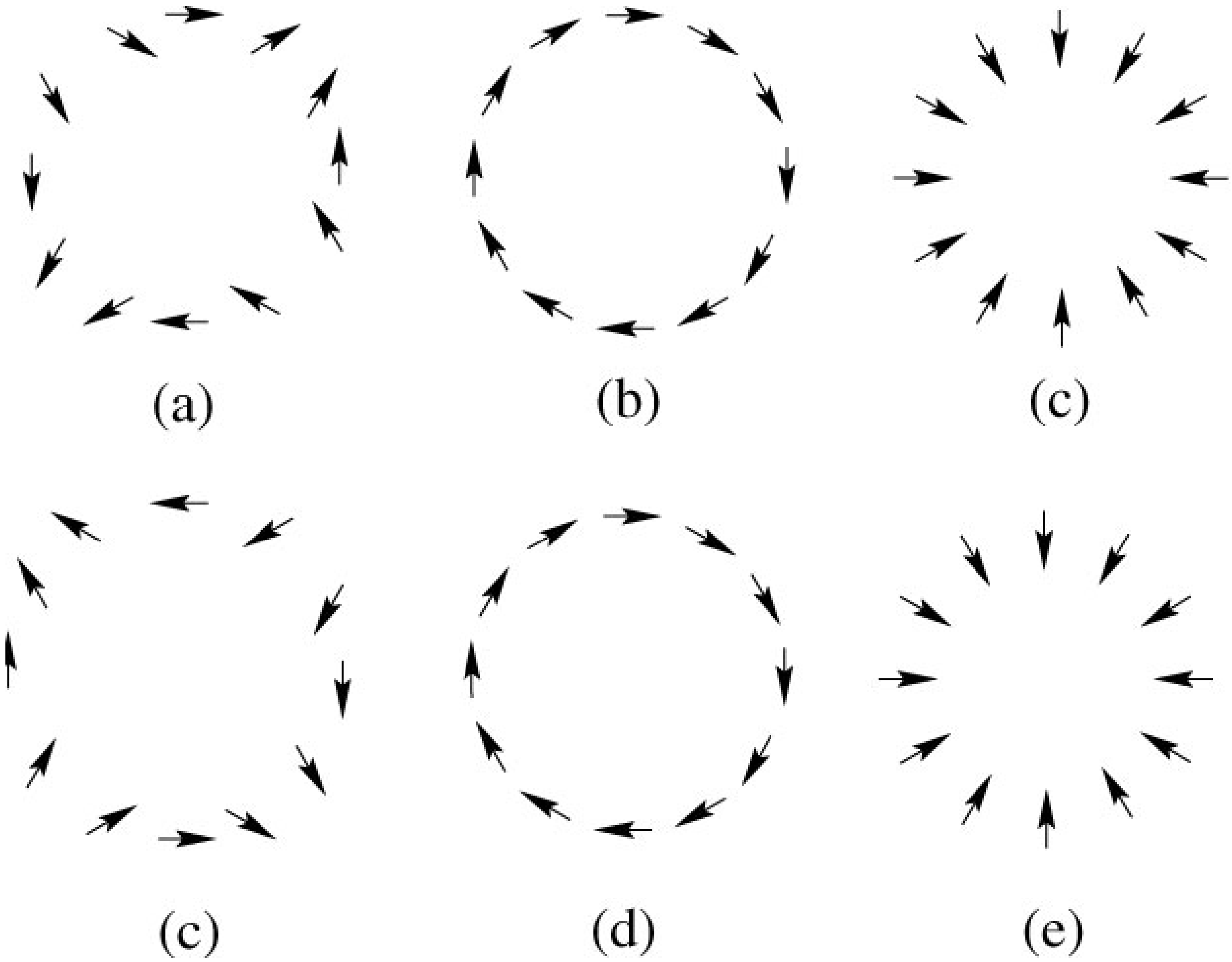

Figure 2: Same as Fig. (1) but for a vortex with winding number -1.

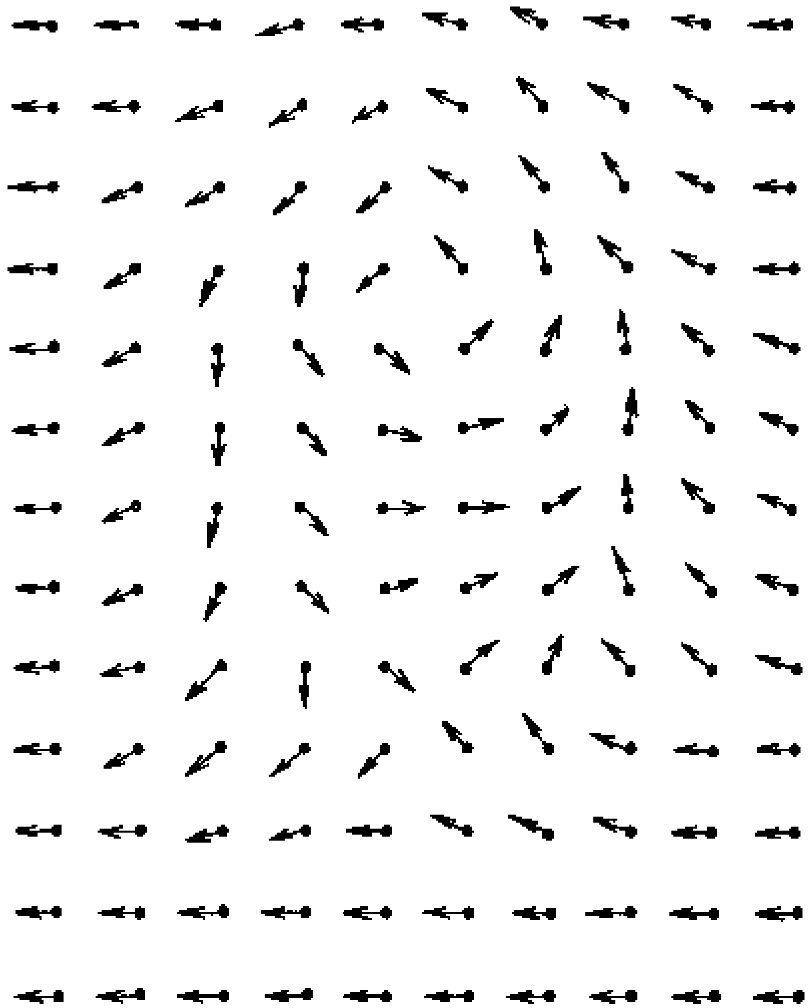

Figure 3: Bound pair of vortices with opposite winding numbers. These objects are bound together by the logarithmic confining potential below T_{KT}.

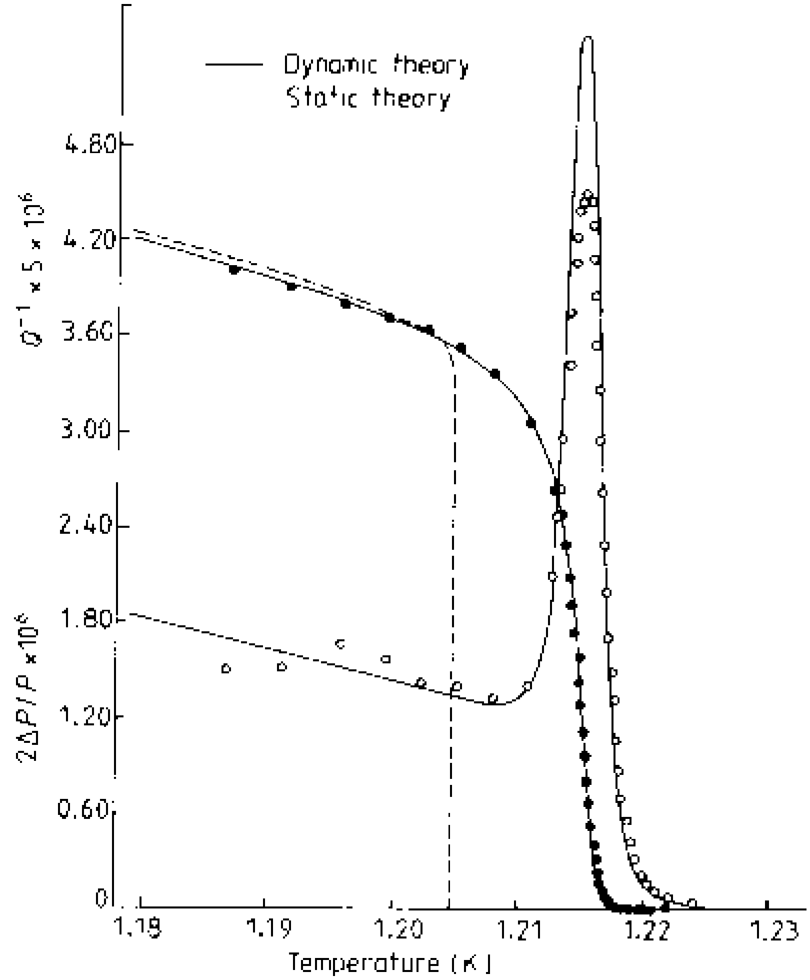

Figure 4: Filled circles: Superfluid density of a ^{4}He film measured with a torsional pendulum. Dashed line is the theoretical curve for a static theory [12] that ignores the finite oscillation frequency of the pendulum. Solid line is a four parameter fit to the dynamical theory of Ambegaokar et al. [13] Data of Bishop et al. [10]

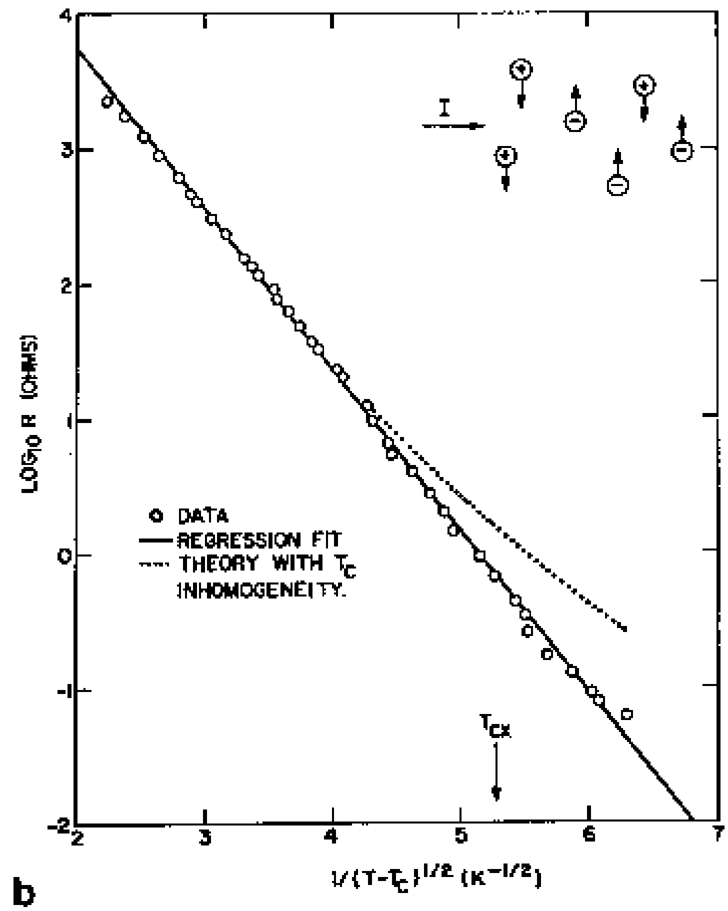

Figure 5: Resistance of a film above the Kosterlitz-Thouless temperature fit to a model in which the resistance is proportional to the vortex density ξ^{-2} with ξ given by Eq.(30). Data of Hebard and Fiory [14].

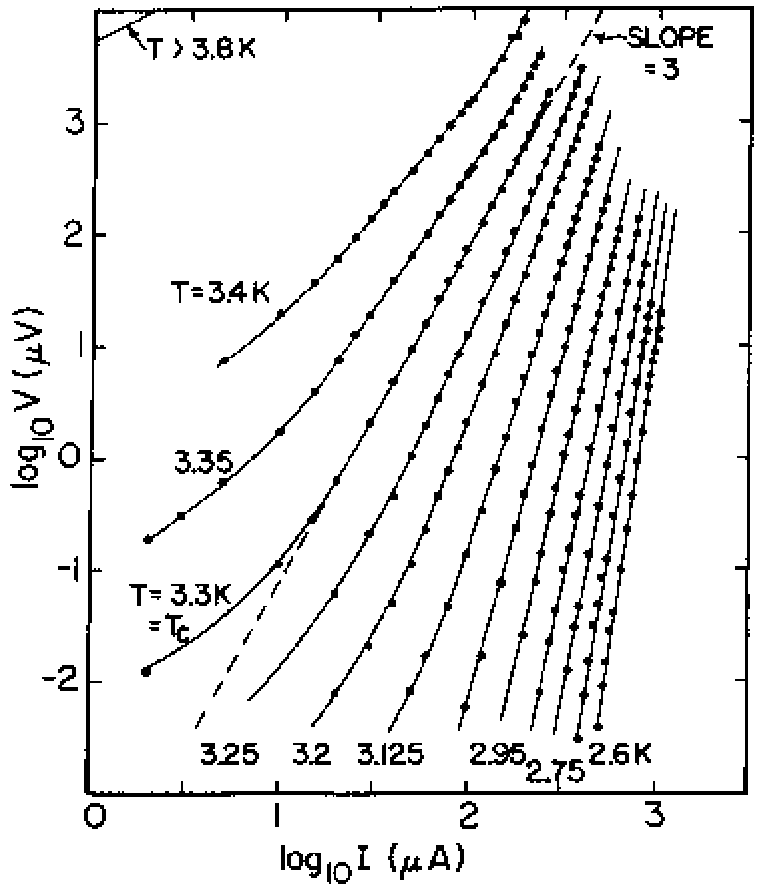

Figure 6: Non-linear IV characteristics of 2D superconducting films at different temperatures. Note that at the critical temperature, $V \sim I^3$ as expected. Data of Epstein et al. [15].

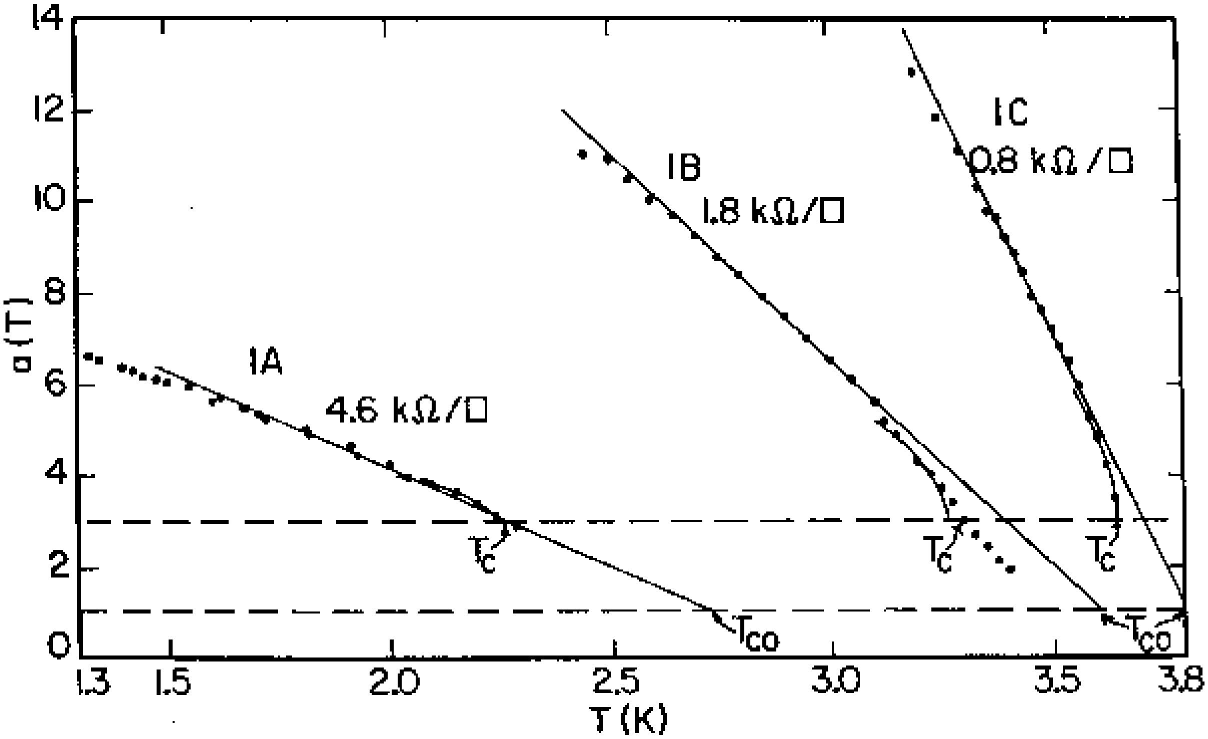

Figure 7: Exponent a in the nonlinear IV relation $V \sim I^a$ as a function of temperature. Data of Epstein et al. [15].