Reversible to Irreversible Flow and Absorbing Transitions in Sheared Vortices

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We present evidence that a reversible to irreversible flow transition, as reported in driven colloidal particles, occurs in periodically sheared vortices in a Corbino-disk superconductor under increasing a displacement d of vortices per cycle. We determine a threshold displacement d_c for the reversible-irreversible transition as the onset of flow noise. A relaxation toward a steady state is observed both above and below d_c and the relaxation time τ diverges around d_c, indicative of a dynamic transition. The reversible-irreversible transition has also been interpreted in terms of an absorbing transition. Within the interpretation, the irreversible regime corresponds to a fluctuating active state where particles (i.e., vortices) are diffusing, while the reversible regime corresponds to an absorbing state where the particles are self-organized and absorbed into a nonfluctuating quiescent state. We find that the reversible-irreversible transition exhibits a similar critical dynamics to that of the absorbing transition, as predicted theoretically. These results suggest that both transitions are universal phenomena in driven interacting particle systems with quenched disorder.[1] We also study how the transient vortex dynamics or τ depends on initial vortex configurations. The results look consistent with the view that irreversible vortex motion would occur in correspondence with flow of topological defects in lattice.

[1]S. Okuma, Y. Tsugawa, and A. Motohashi, Phys. Rev. B **83**, 012503 (2011).