Fluctuation theorem in non-equilibrium vortex systems

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The second law of thermodynamics states that the entropy production rate is always positive for large systems over long time scales. However, the fluctuation theorem (FT) allows observable violations of the second law in finite size systems [1, 2, 3, 4]. We have computationally studied the FT predictions as a function of the system temperature, in the context of a two-dimensional vortex matter by using a combination of statistical Monte Carlo calculations and deterministically driven dynamics of point vortices. Our preliminary results suggest that the long-range interactions in the vortex matter cause deviations from the FT prediction on short time scales and that these deviations become more pronounced in negative absolute temperature systems. We will discuss potential explanations and implications of our findings.

[1] D. J. Evans, E. G. D. Cohen, and G. P. Morriss, Phys. Rev. Lett. **71**, 2401 (1993).

[2] D. J. Evans and D. J. Searles, Phys. Rev. E **50**, 1645 (1994).

[3] G. M. Wang et al., Phys. Rev. Lett. **89**, 050601 (2002).

[4] D. M. Carberry et al.,Phys. Rev. Lett. **92**, 140601 (2004).