Scale invariance in a turbulent quantum gas: Cascade front dynamics and nonthermal steady states

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The recent production of homogeneous Bose gases [1] has opened exciting possibilities to study far-from-equilibrium many-body dynamics in clean uniform quantum fluids. In this talk, I will present our study of the emergence of a turbulent cascade in a homogeneous Bose fluid forced out of equilibrium on a large scale using a spatially-uniform force [2]. In contrast to classical fluids where the dissipation scale is set by the viscosity of the fluid, the turbulent cascade of our quantum gas ends when the particles kinetic energy exceeds the laser-trap depth. This simple mechanism allows us to effectively tune the dissipation scale where particles (and energy) are lost. Using this new knob, we directly measure turbulent fluxes and observe in real time the propagation of the cascade front in momentum space [3]. Once the cascade front has reached the dissipation scale, a scale-invariant steady state is established over the entire inertial range.

[1] A. L. Gaunt et al., Phys. Rev. Lett. 110, 200406 (2013).

[2] N. Navon et al., Nature 539, 72 (2016).

[3] N. Navon et al., arXiv:1807.07564.