Tuning the dissipation scale of a quantum-gas turbulent cascade

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Many turbulent flows form so-called cascades, where excitations injected at large length scales, are transported to gradually smaller scales until they reach a dissipation scale. We initiate a turbulent cascade in a dilute Bose fluid by pumping energy at the container scale of an optical box trap using an oscillating magnetic force [1,2]. In contrast to classical fluids where the dissipation scale is set by the viscosity of the fluid, the turbulent cascade of our quantum gas finishes when the particles kinetic energy exceeds the laser-trap depth. This mechanism thus allows us to effectively tune the dissipation scale where particles (and energy) are lost, and measure the particle flux in the cascade at the dissipation scale. We observe a unit power-law decay of the particle-dissipation rate with trap depth, which validates the prediction that in a wave-turbulent direct energy cascade, the particle flux vanishes in the limit where the dissipation length scale tends to zero.

[1] A.L. Gaunt, T.F. Schmidutz, I. Gotlibovych, R.P. Smith, Z. Hadzibabic, Phys. Rev. Lett. 110, 20406 (2013)

[2] N. Navon, A.L. Gaunt, R.P. Smith, Z. Hadzibabic, Nature 539, 72 (2016)