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Multiple states in highly turbulent Taylor-Couette flow SANDER HUISMAN, ROELAND VAN DER VEEN, CHAO SUN, DETLEF LOHSE, University of Twente — The ubiquity of turbulent flows in nature and technology makes it of utmost importance to fundamentally understand turbulence. Kolmogorov's 1941 paradigm suggests that for strongly turbulent flows with many degrees of freedom and its large fluctuations, there would only be *one* turbulent state as the large fluctuations would explore the entire higher-dimensional phase space. Here we report the first conclusive evidence of multiple turbulent states for large Reynolds number Re = $\mathcal{O}(10^6)$ (Taylor number Ta = $\mathcal{O}(10^{12})$ Taylor-Couette flow in the regime of ultimate turbulence, by probing the phase space spanned by the rotation rates of the inner and outer cylinder. The manifestation of multiple turbulent states is exemplified by providing combined global torque and local velocity measurements. This result verifies the notion that bifurcations can occur in high-dimensional flows (i.e. very large Re) and questions Kolmogorov's paradigm.

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