

Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Experimental evidence of a phase transition in a closed turbulent flow FRANÇOIS DAVIAUD, PIERRE-PHILIPPE CORTET, ARNAUD CHIFFAUDEL, BÉRENGÈRE DUBRULLE, CEA, IRAMIS, SPEC, CNRS URA 2464, Groupe Instabilités & Turbulence, 91191 Gif-sur-Yvette, France — Using stereoscopic particle image velocimetry, we experimentally study the susceptibility to symmetry breaking of a closed turbulent von Kármán swirling flow from $Re = 150$ to $Re \simeq 10^6$. The susceptibility of the mean flow is shown to increase from 1 to 45 as transition to turbulence proceeds from the laminar flow to the highly turbulent flow. We report a divergence of this susceptibility at an intermediate Reynolds number $Re = Re_\chi \simeq 90\,000$ which gives experimental evidence that such a highly space and time fluctuating system can undergo a “phase transition”. This transition is furthermore associated with a peak in the amplitude of fluctuations of the instantaneous flow symmetry corresponding to intermittencies between metastable states. These states break spontaneously the symmetry of the forcing while the very long time-averaged mean flow respects the forcing symmetry.

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Date submitted: 14 Oct 2010

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