Amplification of thermal fluctuations by planar Couette flow

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ABSTRACT

In this presentation we evaluate the flow-induced amplification of the thermal noise in plane Couette configuration. The physical origin of the noise is the random nature of molecular collisions, that contribute with a stochastic component to the stress tensor (Landau's fluctuating hydrodynamics [1]). This intrinsic stochastic forcing is always present, independently of any external perturbation. The thermal noise is then amplified by the mode-coupling mechanisms associated to shear flow.

In a linear approximation, thermal noise amplification can be studied by solving stochastic Orr-Sommerfeld and Squire equations [2]. We use expansions of the fluctuating wall-normal velocity and vorticity in series of the eigenfunctions of the hydrodynamic operators, which can be analytically expressed in terms of Airy functions [3]. We identify two different coupling mechanisms causing amplification: *(i)* self-coupling between wall-normal fluctuations of different wave vector and *(ii)* coupling between vorticity and velocity fluctuations implied by the Squire equation. We compare the efficiency of these two mechanisms, being the most important the latter, *i.e.*, the coupling between Squire and Orr-Sommerfed equations. The main effect is the amplification of wall-normal vorticity fluctuations with an spanwise modulation at wave number around 1.5, a configuration that resembles the streaks that have been proposed as precursors of the flow instability [4].

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