A Lower Bound for Transient Enstrophy Growth of Two-Dimensional Internal Traveling Waves

A lower bound for transient enstrophy growth of two-dimensional internal traveling waves

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This study[1] provides the temporal monotonic decay region of the wavenumber-Reynolds number stability map, for the enstrophy of any two-dimensional perturbations traveling in the incompressible and viscous plane Poiseuille and plane Couette flows. Mathematical difficulty related to this problem was due to the unknown boundary conditions on the perturbation vorticity, which left the problem open since the first historical studies conducted by J. L. Synge[2][3][4] (1930s). By extending Synge's work to the non-modal approach, we provide the smallest Reynolds number, Re_Ω, allowing transient growth of perturbations' integral-enstrophy. As a noticeable result, the enstrophy monotonic decay region inside the parameters space is wider than the kinetic energy one. The shape, evolution and wall vorticity of optimal-enstrophy streamfunctions will also be discussed.

Concurrently, this study considers the dispersive nature of wavy perturbations. Building on our previous study[5], we show how the coexistence of dispersion and nondispersion at fixed value of the flow control parameter can affect the morphology and evolution of wave packets in the plane Poiseuille flow. Short waves experience mild growth but travel nondispersively and generate compact structures. Dispersive wave components show the largest enstrophy growth and are responsible for the morphology of the spot core. Both components are relevant in the dynamics of transitional structures[6].

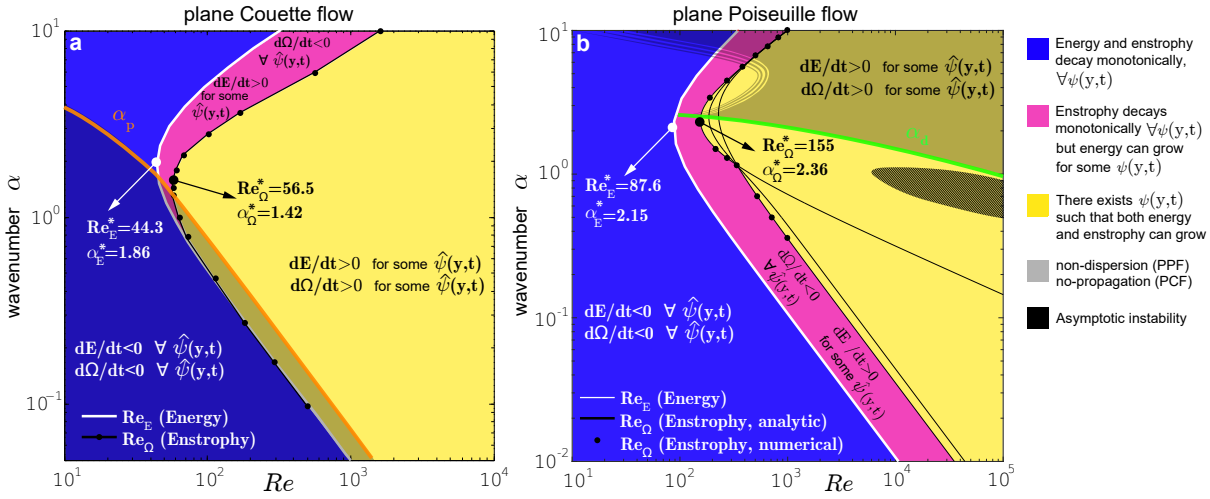

Figure 1: Lower bounds for the enstrophy and kinetic energy growth of 2D waves. Propagation properties.

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