Physics > Fluid Dynamics

Stability Criteria of 3D Inviscid Shears

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The classical plane Couette flow, plane Poiseuille flow, and pipe Poiseuille flow share some universal 3D steady coherent structure in the form of "streak-roll-critical layer". As the Reynolds number approaches infinity, the steady coherent structure approaches a 3D limiting shear of the form ($U(y,z), 0, 0$) in velocity variables. All such 3D shears are steady states of the 3D Euler equations. This raises the importance of investigating the stability of such inviscid 3D shears in contrast to the classical Rayleigh theory of inviscid 2D shears. Several general criteria of stability for such inviscid 3D shears are derived. In the Appendix, an argument is given to show that a 2D limiting shear can only be the classical laminar shear.

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