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Criteria for instability of helical disturbances in inviscid, swirling flows CHRISTOPHER DOUGLAS, BENJAMIN EMERSON, TIMOTHY LIEUWEN, Georgia Institute of Technology — This work considers the linear inviscid instability of columnar vortices with axial flow in unbounded domains subjected to 3D perturbations. The base flow parameters have a general dependence on the radial distance from the swirl axis. Following Howard and Gupta's approach, we develop two stability conditions in terms of an infinite set of helical disturbances via a normal modes expansion. We develop a generalization of Fjørtoft's necessary criterion which states that a wave-like disturbance may be unstable if the base shear velocity has an inflection point in the binormal direction of the helix which is also a vorticity maximum. A necessary condition for instability is that

$$(W' - W_0')d(\kappa\dot{\gamma}')/dr < 0$$

must be satisfied somewhere for any real constant W_0' where κ is the curvature of the helix, W' is the binormal base velocity, and $\dot{\gamma}'$ is the binormal base shear rate. The second condition leads to a generalization of Rayleigh's criterion for centrifugal instability for helical disturbances. We find that a necessary and sufficient condition for instability is that

$$V d\Gamma'/dr < 0$$

be satisfied somewhere, where V is the base azimuthal velocity and Γ' is the base circulation due to the flux of vorticity tangent to the helical vortex tube.

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