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General stability criteria for inviscid rotating flow

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The general stability criteria of inviscid Couette flow between two coaxial cylinders with angular velocity $\Omega(r)$ are obtained analytically. First, a necessary instability criterion for centrifugal flows is derived as $\xi'(\Omega - \Omega_s) < 0$ (or $\xi'/(\Omega - \Omega_s) < 0$) somewhere in the flow field, where ξ is the vorticitiy of profile and Ω_s is the angular velocity at the inflection point $\xi' = 0$. Second, a criterion for stability is found as $-(\mu_1 + 1/r_2) < f(r) = \frac{\xi'}{\Omega - \Omega_s} < 0$, where μ_1 is the smallest eigenvalue. The new criteria are the analogues of the criteria for parallel flows, which are special cases of Arnol'd's nonlinear criteria. Specifically, Pedley's cirterion is proved to be an special case of Rayleigh's criterion. Moreover, the criteria for parallel flows can also be derived from those for the rotating flows. These results extend the previous theorems and would intrigue future research on the mechanism of hydrodynamic instability.