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A new vortex definition for compressible and stratified flows JIE YAO, FAZLE HUSSAIN, Texas Tech University — We propose an objective vortex identification method (call it 'λ_ρ criterion') for flows dominated by compressibility or density variation effects, where the standard λ_2 method is not expected to be valid. The new λ_ρ criterion - which is a direct extension of λ_2 criterion for incompressible flow - defines a vortex to be the region where the second eigenvalue of the tensor $\mathbf{S^m}+\mathbf{S}^\vartheta$ is negative. Here, $\mathbf{S^m}$ is the symmetric part of the tensor product of the momentum gradient tensor $\nabla(\rho\mathbf{u})$ and the velocity gradient tensor $\nabla(\mathbf{u})$; $\mathbf{S}^\vartheta$ is the symmetric part of dilatation-momentum gradient tensor $\nabla(\vartheta\rho\mathbf{u})$; and $\vartheta \equiv \nabla \bullet \mathbf{u}$ is the dilatation rate. We demonstrate the difference between λ_ρ and λ_2 boundaries for the compressible isentropic vortex column. We also compare the λ_ρ and λ_2 structures for several numerically simulated flows, e.g., liquid jet breakup in air, compressible jet, compressible wake, and shock-turbulent boundary layer interactions. For low Mach number ($Ma < 2$) compressible flows, we find that the structures identified by λ_2 and λ_ρ definitions are nearly identical - indicating that λ_2 method can still be used for low Mach number compressible flows.

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