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What is a "Length Scale" in Variable Density Turbulence?[1]
DONGXIAO ZHAO, HUSSEIN ALUIE, University of Rochester — A "length scale" in a fluid flow does not exist as an independent entity but is associated with the specific flow variable being analyzed. While this might seem obvious, we often discuss the "inertial range" or the "viscous range" of length scales in turbulence as if they exist independently of a flow variable, which in incompressible turbulence is the velocity field. How should we analyze "length scales" in flows with significant density variations, such as across a shock or in multiphase flows? A choice can be made according to the so-called *inviscid criterion*. It is a kinematic requirement that a scale decomposition yield negligible viscous effects at sufficiently large "length scales." Recently, we proved that a Hesselberg-Favre decomposition satisfies the inviscid criterion, which is necessary to unravel inertial-range dynamics and the cascade. We present numerical demonstrations of those results, where we also show that other commonly used decompositions can violate the inviscid criterion and, therefore, are not suitable to study inertial-range dynamics in variable-density turbulence.

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