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Scale locality and the inertial range in compressible turbulence

HUSSEIN ALUIE, Los Alamos National Laboratory — We use a coarse-graining approach to prove that inter-scale transfer of kinetic energy in compressible turbulence is dominated by local interactions. Locality here means that interactions between disparate scales decay at least as fast as a power-law function of the scale-disparity ratio. In particular, our results preclude transfer of kinetic energy from large-scales directly to dissipation scales, such as into shocks, in the limit of high Reynolds number turbulence as is commonly believed. The assumptions we make in our proofs on the scaling of velocity, pressure, and density structure functions are weak and enjoy compelling empirical support. Under a stronger assumption on pressure dilatation co-spectrum, we show that *mean* kinetic and internal energy budgets statistically decouple beyond a transitional "conversion" range. Our analysis demonstrates the existence of an ensuing inertial scale-range over which mean SGS kinetic energy flux becomes constant, independent of scale. Over this inertial range, mean kinetic energy cascades locally and in a conservative fashion, despite not being an invariant. We provide numerical support to our results on locality through an investigation of the cascade in the presence of shocks in Burger's flow.

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