Nonlinear Sciences > Chaotic Dynamics

The conservative cascade of kinetic energy in compressible turbulence

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The physical nature of compressible turbulence is of fundamental importance in a variety of astrophysical settings. We present the first direct evidence that mean kinetic energy cascades conservatively beyond a transitional "conversion" scale-range despite not being an invariant of the compressible flow dynamics. We use high-resolution three-dimensional simulations of compressible hydrodynamic turbulence on 512^3 and 1024^3 grids. We probe regimes of forced steady-state isothermal flows and of unforced decaying ideal gas flows. The key quantity we measure is pressure dilatation cospectrum, $E^{PD}(k)$, where we provide the first numerical evidence that it decays at a rate faster than k^{-1} as a function of wavenumber. This is sufficient to imply that mean pressure dilatation acts primarily at large-scales and that kinetic and internal energy budgets statistically decouple beyond a transitional scale-range. Our results suggest that an extension of Kolmogorov's inertial-range theory to compressible turbulence is possible.

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