Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

The role of bulk viscosity on the decay of compressible, homogeneous, isotropic turbulence ERIC JOHNSEN, SHAOWU PAN, University of Michigan — The practice of neglecting bulk viscosity in studies of compressible turbulence is widespread. While exact for monatomic gases and unlikely to strongly affect the dynamics of fluids whose bulk-to-shear viscosity ratio is small and/or of weakly compressible turbulence, this assumption is not justifiable for compressible, turbulent flows of gases whose bulk viscosity is orders of magnitude larger than their shear viscosities (e.g., CO2). To understand the mechanisms by which bulk viscosity and the associated phenomena affect compressible turbulence, we conduct DNS of freely decaying compressible, homogeneous, isotropic turbulence for ratios of bulk-to-shear viscosity ranging from 0-1000. Our simulations demonstrate that bulk viscosity increases the decay rate of turbulent kinetic energy; while enstrophy exhibits little sensitivity to bulk viscosity, dilatation is reduced by an order of magnitude within the two eddy turnover time. Via a Helmholtz decomposition of the flow, we determined that bulk viscosity damps the dilatational velocity and reduces dilatational-solenoidal exchanges, as well as pressure-dilatation coupling. In short, bulk viscosity renders compressible turbulence incompressible by reducing energy transfer between translational and internal modes.

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Date submitted: 01 Aug 2016

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