

Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

The effect of thermal non-equilibrium in decaying turbulence using direct numerical simulations SUALEH KHURSHID, DIEGO DONZIS, Texas A&M University — We study effects of thermal non-equilibrium (TNE), in particular vibrational non-equilibrium, in decaying turbulence using Direct Numerical Simulation (DNS). The exchange mechanism between molecular vibrational and translational energy modes is introduced using the well-known Landau-Teller approximation. A change in the fundamental cascade is observed with dissipation (ϵ) increasing significantly relative to cases without TNE at time scales of $O(\tau_v)$ where τ_v is the characteristic relaxation time of vibrational energy. This is also found to depend on the initial degree of TNE (ΔE_{v0}). The relative contributions of energy transfer through classical energy cascade and transfer through TNE exchanges can be represented by a new non-dimensional parameter $S = \frac{\Delta E_{v0}}{\tau_v \epsilon}$. For example, S can be used to understand DNS data, in particular to distinguish different regimes in the interaction. S is also useful to characterize the time at which dissipation peaks as well as its peak value. Results are compared satisfactorily with experimental evidence available. Turbulence is also observed to decelerate the transfer from vibrational to translational mode in flows with initial vibrationally hot states.

Sualeh Khurshid
Texas A&M University

Date submitted: 01 Aug 2014

Electronic form version 1.4