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Glimpses of Kolmogorovs spectral energy dynamics in nonlinear acoustic waves PRATEEK GUPTA, CARLO SCALO, School of Mechanical Engineering, Purdue University — Gupta, Lodato, and Scalo (AIAA 2017) have demonstrated the existence of an equilibrium spectral energy cascade in shock waves formed as a result of continued modal thermoacoustic amplification consistent with Kolmogorovs theory for high-Reynolds-number hydrodynamic turbulence. In this talk we discuss the derivation of a perturbation energy density norm that guarantees energy conservation during the nonlinear wave steepening process, analogous to inertial subrange turbulent energy cascade dynamics. The energy cascade is investigated via a bi-spectral analysis limited to wave-numbers and frequencies lower than the ones associated with the shock, analogous to the viscous dissipation length scale in turbulence. The proposed norm is derived by recombining second-order nonlinear acoustic equations and is positive definite; moreover, it decays to zero in the presence of viscous dissipation and is hence classifiable as a Lyapunov function of acoustic perturbation variables. The cumulative energy spectrum wavenumber distribution demonstrates a -3/2 decay law in the inertial range. The governing equation for the thus-derived energy norm highlights terms responsible for energy cascade towards higher harmonics, analogous to vortex stretching terms in hydrodynamic turbulence.

Prateek Gupta
School of Mechanical Engineering, Purdue University

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