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A tractable representation of the non-linear terms in spectral space applied to isotropic turbulence LAWRENCE CHEUNG, None, TAMER ZAKI, Johns Hopkins University, Imperial College London — The principal challenge in the analytical treatment of the Navier-Stokes equations in spectral space is the complex nature of the nonlinear triad interactions. In Fourier basis, these interactions are expressed as an infinite convolution sum over all wavenumber pairs. A tractable representation is introduced in terms of a combination matrix which recasts the convolution in a bilinear form. With this new representation, a spectral energy equation is derived, and its bilinear form facilitates the choice of the appropriate canonical basis. The utility of the formulation is demonstrated by considering the problem of homogeneous, isotropic turbulence. By invoking well-established assumptions, for example the presence of an inertial range where the energy decay rate is independent of wavenumber, we derive Kolmogorov's -5/3 scaling analytically, without any dimensional arguments. The same analytical framework also accurately predicts the spectral characteristics of scalar fluctuations.

Lawrence Cheung
None

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