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Two-point Spectral Modeling of Anisotropic Rapid Distortion

TIMOTHY CLARK, University of New Mexico, SUSAN KURIEN, Los Alamos National Laboratory, CHARLES ZEMACH, Retired — We perform simulations of a two-point spectral model for the evolution of the energy tensor as function of wavevector, for arbitrarily anisotropic turbulence in the limit of rapid distortion. The resulting Reynolds stress tensor for such flow is analysed for the effects of anisotropy during evolution. According to the SO(3) rotation group decomposition of the energy tensor, the leading order isotropic contribution is labelled by rotational mode index $j = 0$, while higher order anisotropic contributions in statistically homogeneous flows contain a potentially very large array of rotational modes $j = 2, 3, 4, \ldots$. We compare our results to those of the classical Launder, Reece and Rodi class of models in the rapid distortion limit. These models only retain anisotropy in a nominal manner up to $j = 2$, due to an a priori angle-averaging procedure on the energy tensor, reducing it to a function of wave-number alone. Although the Reynolds stress itself has maximum $j = 2$ in the SO(3) representation, the terms that contribute to its evolution generate higher order rotational modes. The contributions from the higher order modes are shown to be responsible for the deviation of the LRR solution from the true solution over time.

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