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On slow–fast generalized quasilinear dynamical systems GREG CHINI, University of New Hampshire, ALESSIA FERRARO, Swiss Federal Institute of Technology Lausanne (EPFL), GUILLAUME MICHEL, Ecole Normale Superieure, CNRS, COLM-CILLE CAULFIELD, Cambridge University (DAMTP)
— The quasilinear (QL) reduction has proved surprisingly useful in the analysis and modeling of anisotropic turbulent flows. As first introduced in the context of fluid turbulence by Stuart (1958), the QL approximation involves parsing flow variables into suitable (e.g., streamwise) mean and fluctuation fields and then retaining fluctuation-fluctuation nonlinearities only where they feed back onto the mean fields through Reynolds stress divergences. Although increasingly invoked as a useful albeit *ad hoc* approximation, the QL reduction can be formally justified in the asymptotic limit of temporal scale separation between the mean and fluctuation dynamics, as arises, e.g., in the asymptotic description of strongly stratified shear turbulence and of certain exact coherent states in wall-bounded shear flows. A fundamental and vexing feature of such systems, however, is that when the slow mean fields are locally frozen in time, the fast linearized dynamics can admit exponential fluctuation growth. In this work, a new multiscale formalism is introduced that obviates the need to co-evolve the mean and fluctuation dynamics on the fast time scale (i.e., the usual fix) by exploiting the necessity of slow–fast QL systems to self-tune toward a marginal-stability manifold.

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