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Shell model of optimal passive-scalar mixing CHRISTOPHER MILES, CHARLES DOERING, Univ of Michigan - Ann Arbor — Optimal mixing is significant to process engineering within industries such as food, chemical, pharmaceutical, and petrochemical. An important question in this field is "How should one stir to create a homogeneous mixture while being energetically efficient?" To answer this question, we consider an initially unmixed scalar field representing some concentration within a fluid on a periodic domain. This passive-scalar field is advected by the velocity field, our control variable, constrained by a physical quantity such as energy or enstrophy. We consider two objectives: local-in-time (LIT) optimization (what will maximize the mixing rate now?) and global-in-time (GIT) optimization (what will maximize mixing at the end time?). Throughout this work we use the H^{-1} mix-norm to measure mixing. To gain a better understanding, we provide a simplified mixing model by using a shell model of passive-scalar advection. LIT optimization in this shell model gives perfect mixing in finite time for the energy-constrained case and exponential decay to the perfect-mixed state for the enstrophy-constrained case. Although we only enforce that the time-average energy (or enstrophy) equals a chosen value in GIT optimization, interestingly, the optimal control keeps this value constant over time.

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