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Chaos Synchronization in Navier-Stokes Turbulence[1] CRISTIAN C. LALESCU, CHARLES MENEVEAU, GREGORY L. EYINK, The Johns Hopkins University — Chaos synchronization (CS) has been studied for some time now (Pecora & Carroll 1990), for systems with only a few degrees of freedom as well as for systems described by partial differential equations (Boccaletti et al. 2002). CS in general is said to be present in a pair of coupled dynamical systems when a specific property of each system has the same time evolution for both, even though the evolution itself is chaotic. There have been some studies of CS for systems with an infinite number of degrees of freedom (Kocarev et al. 1997), but CS for Navier-Stokes (NS) turbulence seems not to have been investigated so far. We focus on the synchronization of the small scales of a turbulent flow for which the time history of large scales is prescribed. We present DNS results which show that high-wavenumbers in turbulence are fully slaved to modes with wavenumbers up to a critical fraction of the Kolmogorov dissipation wavenumber. We compare our results with related ideas of "approximate inertial manifolds." The motivation for our work is to study deeply sub-Kolmogorov scales in fully developed turbulence (Schumacher 2007), which we show are recoverable even at very high Reynolds number from simulations that only resolve down to about the Kolmogorov scale.

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