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Chaos Synchronization in Navier-Stokes Turbulence[1] CRISTIAN LALESCU, CHARLES MENEVEAU, GREGORY 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 coupled dynamical systems when a specific property of each system has the same time evolution for all, even though the evolution itself is chaotic. The Navier-Stokes (NS) equations describe the velocity for a wide range of fluids, and their solutions are usually called turbulent if fluctuation amplitudes decrease as a power of their wavenumber. There have been some studies of CS for continuous systems (Kocarev et al 1997), but CS for 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. Our DNS results show that high-wavenumbers in turbulence are fully slaved to modes with wavenumbers up to a critical fraction of the Kolmogorov dissipation wavenumber. The motivation for our work is to study deeply sub-Kolmogorov scales in fully developed turbulence (Schumacher 2007), which we found to be recoverable even at very high Reynolds number from simulations with moderate resolutions.

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