Approximate Globally-Regular Solutions of the Navier-Stokes Equations via Spectral Methods

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Abstract

We introduce spectrally-modified versions of the hyperviscous Navier-Stokes equations and the LANS-\(\alpha\) equations, in which the extra averaging effects of these models is concentrated or restricted to the high wavenumbers. We establish global regularity of solutions and some higher-order bounds that depend only as a fractional power of \(m\), where \(m\) is such that the extra damping occurs after the first \(m\) wavenumbers. For distinguished cases of our models, we establish weak subsequence convergence to Leray solutions of the standard Navier-Stokes equations (NSE). Thus our models can be viewed as globally-regular approximation models of the NSE. We also discuss our models in the general context of modeling turbulence and in particular discuss intuitive connections to the Kolmogorov theory.