FM24S_11454

XXI International Congress of Theoretical and Applied Mechanics
Warsaw, Poland, August 15–21, 2004

# Empirical Galerkin Models for Incompressible Flow–Pressure-Term and 'Subgrid' Turbulence Representations

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Necessary ingredients of *accurate* empirical Galerkin models for incompressible free and wall-bounded shear flows are discussed. These models are based on the Karhunen-Loève (K-L) decomposition of a Navier–Stokes simulation and a Galerkin projection on the Navier–Stokes equation. Specifically, a novel analytical pressure-term representation is first developed and shown to be necessary for accurate Galerkin systems of near-field wakes and of mixing layers. Secondly, a hierarchy of 'subgrid' turbulence models based on Rempfer's (1991) modal eddy viscosities is presented and shown to be helpful if a low-dimensional K-L ansatz does not resolve a significant portion of the fluctuation energy. Finally, the role of 'missing' phase space directions in the K-L ansatz is revisited and additional modes are proposed. The proposed generalizations and improvements have been integrated in a modular Galerkin 'tool-box' with a hierarchy of procedures to determine model coefficients.

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