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Dedicated to Prof. Edriss S. Titi on the occasion of his 60th birthday

**The role of BKM-type theorems in 3D Euler, Navier-Stokes and
Cahn-Hilliard-Navier-Stokes analysis**

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Abstract

The Beale-Kato-Majda theorem contains a single criterion that controls the behaviour of solutions of the 3D incompressible Euler equations. Versions of this theorem are discussed in terms of the regularity issues surrounding the 3D incompressible Euler and Navier-Stokes equations together with a phase-field model for the statistical mechanics of binary mixtures called the 3D Cahn-Hilliard-Navier-Stokes (CHNS) equations. A theorem of BKM-type is established for the CHNS equations for the full parameter range. Moreover, for this latter set, it is shown that there exists a Reynolds number and a bound on the energy-dissipation rate that, remarkably, reproduces the $Re^{3/4}$ upper bound on the inverse Kolmogorov length normally associated with the Navier-Stokes equations alone. An alternative length-scale is introduced and discussed, together with a set of pseudo-spectral computations on a 128^3 grid.

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