Gradient Stability and Large Time Stepping Methods for Nonlinear Diffusion Equations

T. Tang[1]

Abstract: We shall study numerical methods for nonlinear diffusion equations that describe complicated phase separation and coarsening phenomena. It is observed that most of the existing continuum model simulations have used an explicit integration method in time and finite difference type approximation in space. In this case, the number of spatial grid points must be large and the time step has to be small in order to maintain the stability and to achieve high approximation accuracy. Even with rapidly increasing computational resources, explicit schemes are still limited to simulate early stage evolution or small length scale. It is therefore of practical importance to design more efficient simulation schemes.

The main purpose of this work is to construct and analyze highly stable time discretizations which allow much larger time-step than that for the usual semi-implicit scheme. Several numerical methods, including semi-implicit approaches and operator splitting methods will be investigated. Theoretical analysis on nonlinear stability will be also studied. Some rigorous mathematical theory for the underlying numerical schemes will be established. This talk will concentrate on two classes of nonlinear diffusion equations, namely the Cahn-Hilliard equation and the diffusion equations that model epitaxial growth of thin films.

[1] Department of Mathematics, Hong Kong Baptist University
FSC1102, Fong Shu Chuen Building, Kowloon Tong, Hong Kong
ttang@math.hkbu.edu.hk