The Hong Kong Polytechnic University
Department of Applied Mathematics

Seminar
On

Dynamic Transition Theory and Equilibrium Phase Transitions

by

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Abstract In this talk, I shall present a brief overview of the dynamic transition theory developed recently by Ma and myself, and its applications to equilibrium phase transitions. The main philosophy of the theory is to search for the full set of transition states, giving a complete characterization on stability and transition. The set of transition states --physical "reality"-- is represented by a local attractor. Following this philosophy, the dynamic transition theory is developed to identify the transition states and to classify them both dynamically and physically.

The theory has a wide range of applications in both equilibrium and nonequilibrium phase transitions. The application of the theory to equilibrium phase transitions involves a combination of modeling, mathematical analysis and physical predictions. We adopt the general idea of the Ginzburg-Landau phenomenological approach, and introduce a unified time-dependent Ginzburg-Landau model, based on the le Ch\^atlier principle. Applications to non-equilibrium transitions include typical problems in classical and geophysical fluid dynamics, in climate dynamics, and in chemical reactions. The modeling and the analysis of these problems, on the one hand, provide verifications of existing experimental and theoretical studies, and, on the other hand, lead to various new physical predictions.

To demonstrate the wide range of applications of the theory, I shall present two examples: one is the phase separation of binary systems modeled by the Cahn-Hilliard equation, and the other is superfluidity of liquid helium-3. In both cases, the study leads to some specific physical predictions, which are otherwise unknown from both the physical and mathematical points of view. For example, as a physical prediction, we derive the existence of a new superfluid phase C for liquid helium-3.

Date : 10 December, 2008 (Wednesday)

Time : 3:00 – 4:00 p.m.

Venue : Departmental Conference Room HJ610
The Hong Kong Polytechnic University

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