

Dottorato di Ricerca in Fisica dell'Università degli Studi di Messina
24 Maggio 2012, ore 15.00, Aula E. Majorana, Dip.to di Fisica,
V.le F. Stagno d'Alcontres 31, S. Agata, Messina

Seminar title:

**Universal Relaxation and Diffusion in Interacting Complex Systems:
Fundamental Physics and Rich Applications**

K.L. Ngai

Dipartimento di Fisica, Università di Pisa, Largo B. Pontecorvo 3, I-56127, Pisa, Italy

Abstract

Relaxation and diffusion are fundamental processes in physics and chemistry that determine not only the physical properties of the condensed matter, but also its potential for applications. In most condensed matter of current interest, the basic units involved in the relaxation/diffusion process have mutual interaction/constraint. Hence this is necessarily a many-body problem, which has yet to be solved in theoretical chemistry and physics. One purpose of my talk is to make the audience aware of the *universality* of the dynamic properties of many-body relaxation/diffusion processes of different kinds manifested in experiments and simulations on condensed matter with diverse chemical compositions and physical structures [1]. This remarkable experimental fact indicates that many-body relaxation/diffusion is governed by some fundamental physics.

I shall demonstrate the universality of dynamic properties of many-body relaxation/diffusion principally from the dynamic processes related to glass transition in glass-forming systems. This is reinforced by few examples of strikingly similar properties of different processes in other interacting systems having nothing to do with glass transition. Examples include pharmaceuticals, hydrated and solvated proteins, nano-structured materials, and energy storage materials..

The existence of universal dynamic properties is perhaps not surprising because many-body relaxation and diffusion stem from fundamental physics and the consequences should be general. The search for this fundamental physics that leads to solution of the problem is a challenging and important task. If successful, it is an important advance and it will benefit many research areas. It had been suggested that nonlinear Hamiltonian dynamics (i.e., classical chaos) is the fundamental physics giving rise to the universal dynamic properties. The Coupling Model of the author based on classical chaos indeed has predictions that are consistent with the experimental findings [1]. Although the Coupling Model is not yet a complete solution of the many-body relaxation, its precepts and predictions can be used as a stepping stone for others to construct rigorous theory to fully solve this fundamental problem with rich applications.

[1] *Universal Relaxation and Diffusion in Complex Systems*, K.L. Ngai, Springer (New York, 2011).

<http://www.springer.com/physics/condensed+matter+physics/book/978-1-4419-7648-2>