ATELIER « SYSTÈMES DÉSORDONNÉS : VERRES DE SPIN »
8–13 JUIN 2009

WORKSHOP "DISORDERED SYSTEMS: SPIN GLASSES"
JUNE 8–13, 2009

Dynamics in random fields of hard and soft spheres

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We discuss macroscopic PDE descriptions of dilute gases and plasmas, derived from the microscopic Newtonian interactions in appropriate scaling limits. In the hard-sphere model of a dilute gas, particles are distributed according to a Poisson point process and interact via elastic collisions. In the low-density Boltzmann-Grad limit, the Boltzmann equation can be derived as the effective macroscopic description–both for a single particle moving in a random field of stationary particles, and for the case with all particles moving.

By contrast, in the soft-sphere model of a plasma, particles glance off of each other in weak interactions, so we must consider the high-density weak coupling limit to derive the Landau equation as the macroscopic description of the dynamics. We'll include a summary of work in progress with Fraydoun Rezakhanlou, and point forward to the goal of understanding the dynamics of interacting, randomly located particles.