Conference Report II

The 96th Statistical Mechanics Conference

Rutgers University, New Brunswick, USA
December 17–19 , 2006

The 96th Statistical Mechanics Conference, held at Rutgers University, met December 17-19, 2006. This is a semiannual conference, organized by Prof. Joel Lebowitz since its inception in 1959, and is the premier serial meeting devoted to the broad subject of statistical mechanics. On December 18 there was a round table discussion within the conference devoted to the question: Is there a statistical mechanics of static sand piles? Granular media is occasionally the subject of a talk at these statistical mechanics meetings, but the focus of the meetings has always been on the equilibrium and nonequilibrium properties of matter analyzed at the molecular (or sometimes colloidal) level, since statistical mechanics is much more advanced in modelling assemblies of particles below micron size than it is for granular media, for which gravitational effects are so significant. The aim of the round table was therefore to apprise the audience of the current understanding of the possible use of statistical mechanics methods for static granular media.

The round table consisted of five panelists: Dr. Jasna Brujic (Columbia University), Prof. Andrea Liu (University of Pennsylvania), Prof. Sidney Nagel (University of Chicago), Prof. Charles Radin (University of Texas), Prof. Salvatore Torquato (Princeton University), and a moderator: Prof. Michael E. Fisher (University of Maryland).

In the background throughout the discussion was the proposed statistical mechanical formalism for static granular media first put forward in 1989 by Prof. S. Edwards et al. Variations on that proposal have evolved, but it is still the essence of the main contender for a statistical mechanical-like theory for these materials.There was a short outline of the theory by Dr. Brujic. For such an ensemble theory to succeed it is necessary that the particular state of the material being measured be "typical" for states within some bulk restrictions such as mass and/or energy density. This is presumably achieved for molecular systems by its natural dynamics, constituting the "ergodic hypothesis" of equilibrium statistical mechanics. This circumstance is more problematic for static granular media. Two special methods of preparation were described at the round table which are claimed to achieve such a random sampling of phase space: Prof. Nagel described a 1998 experiment, utilizing controlled shaking, by a Chicago group; and Prof. Radin discussed recent experiments, based on fluidization, by a Texas group. Both of these preparations are claimed to justify the use of an Edwards-style ensemble theory.

Two particular phenomena of granular materials were emphasized at the round table as being relevant to its central question: the applicability of a statistical mechanical theory for static granular matter. One was the claim of the Texas group that by its fluidization preparation one could detect a sharp phase transition in granular media as its density is varied, at or near its critical state density. This was said to call for an ensemble theory, as has traditionally been necessary for phase transitions of matter in thermal equilibrium. The other phenomenon was that of random close packing, which concerns a supposed upper limit of about 64% to the volume fraction of granular matter prepared in any "random" way. Contrary views were expressed on this subject. Prof. Torquato discussed evidence that there is no sharp value for the upper limit, from which he concludes that the concept is actually ill-defined. Prof. Liu gave an outline of a way to understand the supposed phenomenon based on an ensemble method. Many of the physics publications on static granular media concern computer simulations based on geometric restrictions of "jammed" assemblies of spheres, without friction and without any direct role of gravity. It was noted in the round table that progress on a theory for granular media will probably require more care in categorizing computer and laboratory experiments by the features governing the preparation of the computer or laboratory sample, since a successful theory might well apply only to a limited range of preparations.

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