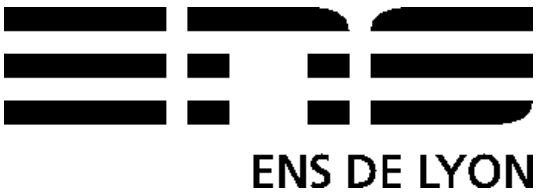
Mini-Workshop on Glasses: Recent experimental results and perspectives

Organisers: D. Carpentier, E. Bertin, E. Orignac and P. Holdsworth
École Normale Supérieure de Lyon,

12-13 April 2011

Book of Abstracts



Tuesday April 12th, 2011

RELAXATION AND NOISE EXPERIMENTS IN SPIN GLASSES AND OTHER GLASSY STUFF

Éric Vincent
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M-I 1

CHIRAL ORDER IN SPIN GLASSES

Hikaru Kawamura
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Pedagogical review is given on the chirality scenario of experimental spin-glass transitions. In this scenario, the spin glass order of weakly anisotropic Heisenberg-like spin-glass magnets including canonical spin glasses are essentially chirality driven. Chirality represents the handedness of the noncollinear or noncoplanar spin configurations induced by frustration, whose sign tells us whether the local spin structure is either right- or left-handed. The scenario, proposed aimed at solving some of the long-standing puzzles concerning the experimental spin-glass ordering, is based on a spin-chirality decoupling picture for the fully isotropic Heisenberg spin glass. Recent numerical and experimental results are discussed in conjunction with this scenario.

M-I 2

NONLINEAR SUSCEPTIBILITY IN SUPERCOOLED LIQUIDS: HEATING EFFECTS AND COMPARISON TO THE BOX MODEL.

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M-I 3

Starting from the conclusion of the previous talk (by Denis L'Hôte) where the Temperature dependence of the number of dynamically correlated molecules has been drawn from the nonlinear dielectric susceptibility, the heating contribution to the measured nonlinear susceptibility will be discussed. First we shall briefly focus on homogeneous heating, i.e. on the small global temperature increase coming from the dissipation of electrical energy: this unwanted effect comes from the finite thickness of the samples, and it will be showed that it yields a contribution much smaller the intrinsic nonlinear response the supercooled liquid. In a second (and major) part, we shall discuss the "box model" which was introduced in the nineties to interpret other nonlinear experiments, namely the famous Non resonant Hole Burning experiments. In the (phenomenological) box model, it is assumed that the dissipation of electrical energy increases the temperature by an amount which depends on the relaxation time of each dynamical heterogeneity (inhomogeneous heating). This model, which intends to account for the intrinsic nonlinear responses of supercooled liquids, will be compared to our nonlinear susceptibility measurements on glycerol. It will be shown that its ability to account for experiments depends very much on the considered observable. The reason of this "variable success" will be discussed: in particular we shall show that, despite its "space free" character, the predictions of the box model display a formal similarity with those derived by J.-P. Bouchaud and G. Biroli where the spatial correlations are at the heart of the analysis. The consequences of this qualitative similarity for the interpretation of nonlinear experiments will be discussed.

TO BE ANNOUNCED

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A-I
1

TO BE ANNOUNCED

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A-I
2

LENGTHSCALES IN AMORPHOUS MATERIALS

Ludovic Berthier

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A-I 3

I will discuss recent progress made in our understanding of the relevant length scales characterizing amorphous materials. I will start with the concept of dynamic heterogeneities, and the consequences following their numerical and experimental observation. I will then move to the newer territory of point-to-set correlation functions which are emerging as powerful new tools to characterize amorphous order in disordered systems.

LOOKING AT THE CONFIGURATIONS IN THE LIQUID AND THE GLASS PHASE

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A-I 4

The random first order, or indeed, the Kauzmann, scenario for glasses implies a certain number of relations between the configurations observed in the equilibrium liquid phase and in the glass phase. These things might well be observable.

Wednedsay April 13th, 2011

OUT OF EQUILIBRIUM FLUCTUATIONS IN AGING SYSTEMS : GELS, POLYMERS

Sergio Ciliberto

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M-II 1

In this talk we will summarize a series of measurements performed in various aging systems such as gels and polymers. The results concern dielectric measurements, rheology and microrheology The case of the quench at the critical point will be discussed too. Starting from this short summary of the known experimental results in these systems we will discuss the open problems such as for example the dependence on different observables, the relevant time scales and the contrast in the results obtained in various experiments.

DYNAMICS OF GLASSY AND JAMMED COLLOIDAL SYSTEMS

Luca Cipelletti

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M-II 2

I'll review recent experiments on the slow dynamics of colloidal hard spheres, a model system for the glass transition, and other soft materials, where particle interactions and/or high particle concentration lead to jamming. I'll describe new scattering methods to investigate not only the average dynamics, but also their spatial and temporal fluctuations. In particular, I'll show that while in colloidal hard spheres spatial correlations of the dynamics increase only modestly on approaching the glass transition, in other jammed materials the slow dynamics are correlated over macroscopic length scales.

LOCAL FLUCTUATIONS AND RESPONSES IN GLASSY POLYMERS

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Recent developments have have made it clear that finding a dynamical correlation length, and its spatio-temporal behavior on approach to the glass transition are the keys to explaining the dramatic growth of viscosity near the glass transition, and testing leading theory candidates. Several lines of indirect evidence (e.g. Berthier et. al. Science 2005) point to a weak but growing temperature-dependence of this length on approach to the glass transition. In this talk I will discuss an approach based on scanning probe microscopy, for probing and imaging spontaneous dipolar noise and dielectric response. We used these methods to study nanoscale spatio-temporal dynamics in polymer glasses and polymer blends. Various space-time correlation functions are analyzed in an effort to search for growing correlation length scales near the glass transition. We are working to extend the instrumental resolution closer to these intrinsic length scales thought to control the glass transition. The ability to quantitatively measure on the nanoscale both fluctuations and responses also allows us to test the validity of the global and local fluctuation-dissipation-relation (FDR) in equilibrium and out-of equilibrium. Using this approach, we have been able to study, for the first time, FDR violations in the strong aging regime in structural glasses (Oukris, Nature Physics, 2010). The results give insight into the equilibrium glass order parameter.

NONLINEAR SUSCEPTIBILITY EXPERIMENTS IN A SUPERCOOLED LIQUID: EVIDENCE OF GROWING SPATIAL CORRELATIONS CLOSE TO T_G

Denis L'Hôte

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M-II 4

The possible existence of a growing correlation length associated with the strong increase of relaxation times of glass-formers close to the glass transition is still a major open question in glass physics. It has been recently proposed by J.-P. Bouchaud and G. Biroli that the ac nonlinear susceptibility of a supercooled liquid close to the glass transition temperature T_g is a probe of dynamical correlations, i.e. of the number $N_{\rm corr}$ of dynamically correlated molecules. As for spin glasses, where the nonlinear susceptibility diverges at the transition, this quantity is tailored to reveal the "hidden" critical behavior of the glass transition. We have developed a high sensitivity experiment to measure the nonlinear dielectric susceptibility of an insulating liquid at finite frequency, by measuring the third harmonics of the current flowing out of a capacitor with the supercooled liquid as the dielectric layer. It is based on a bridge with two capacitors, and reaches a sensitivity better than 10^{-7} (ratio of third to first harmonics). Our first of the kind results on glycerol will be presented and discussed. We shall show that, for a given temperature T, the modulus of the nonlinear susceptibility has a humped shape and reaches its maximum for a frequency close to the relaxation frequency of the liquid at that temperature. Moreover the magnitude of this hump increases as T decreases toward T_g: this reveals directly the the growing of N_{corr} when approaching the glass transition. Our results thus reinforce the picture of an underlying critical nature of the glass transition.

LARGE DEVIATIONS AND HETEROGENEITIES IN KINETICALLY CONSTRAINED MODELS AND GLASSES

Estelle Pitard

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Kinetically Constrained Models (KCMs) have been widely studied in the context of glassy dynamics, focusing on the influence of dynamical constraints on the slowing down of the dynamics of a macroscopic system. In these models, it has been shown using the thermodynamic formalism for histories, that there is a coexistence between an active and an inactive phase. This coexistence can be described by a first-order transition, and a related discontinuity in the derivative of the large deviation function for the activity. We will show how these results can have implications for experiments on glasses, supported by recent numerical simulations. Moreover, we will show that adding a driving field to a KCM model does not destroy the first-order transition for the activity. A singularity is also found in the large deviation function of the current at large fields. We relate this property to microscopic structures, in particular the heterogeneous, intermittent dynamics of the particles, transient shear-banding and blocking walls. We describe both the shear-thinning and the shear-thickening regimes.

A-II 1

WHAT CAN WE LEARN ABOUT THE GLASS TRANSITION LOOKING AT GRANULAR MATERIALS?

Olivier Dauchot

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Despite many years of intense activity the glass transition is still not a solved issue. More specifically, the issue is to understand how the relaxation dynamics of a liquid can slow down by more than ten orders of magnitude on a small range of temperature variation, whereas no significant modification (understand no structural phase transition) has been reported. Either the transition has purely kinetics origins, or there is some hidden phase transition to uncover. At the macroscopic scale, granular materials exhibit strong similarities – such as dynamical slowing down or aging – with glasses. In this presentation I will discuss how the study of the dynamics at the scale of the grain can explain those effect, and to what extend it can be an insightful field of study for the understanding of the glass transition.

A-II 2

AN OVERVIEW OF THE THEORIES OF THE GLASS TRANSITION

Gilles Tarjus

LPTMC, CNRS UMR7600/Université Pierre et Marie Curie, Paris

A-II 3

The topic of the glass transition gives rise to a a wide diversity of views. It is, accordingly, characterized by a lack of agreement on which would be the most profitable theoretical perspective. In this talk, I provide some elements that can help sorting out the many theoretical approaches, understanding their foundations, as well as discussing their validity and mutual compatibility. Along the way, I describe the progress made in the last twenty years, including new insights concerning the spatial heterogeneity of the dynamics and the characteristic length scales associated with the glass transition. The insight brought from experimental studies as well as their present limitations will be addressed.

Index