One-day **MAINZ** tutorial on

Dynamical Arrest

2015 • July 20th • Mainz

preceding the CECAM Workshop

The Role of Structure in Dynamical Arrest

BACKGROUND

Dynamically arrested states (in contrast to thermodynamic equilibrium) play an increasingly important role in *materials science*. Examples encompass next-generation technology such as high-performance *optical storage media*, non-volatile *hard drives* based on chalcogenide materials, and *metallic glasses* with superior mechanical properties. It is closely related to the transformation of materials (how to achieve or avoid crystallization?) and transport properties. More fundamentally, the exact nature of the *glass transition* remains a mystery.

This tutorial offers the unique possibility to get a compact introduction into this exciting field from leading international experts. The tutorial consists of two sessions with tandem (one theoretical and one experimental) lectures aimed at PhD students.

LOCATION AND TIME

Monday, July 20th, 2015. The venue is Schloss Waldthausen. The tutorial runs from 9.30 am to 5 pm.

SHORT PROGRAM

Session I: The Physics of Dynamical Arrest

- Gilles Tarjus, Université Pierre et Marie Curie (France)
- C. Austen Angell, Arizona State University (USA)

Session II: Dynamical Heterogeneities and Structure

- Peter Harrowell, University of Sidney (Australia)
- Kenneth F. Kelton, Washingon University in St. Louis (USA)

REGISTRATION AND DEADLINE

To register, please send an email to **cecamglass@gmail.com** with your name and affiliation. The final deadline is **June 26st**. For MAINZ students costs are covered by the MAINZ school, otherwise the fee is **€50** to be paid on-site.

CONFERENCE WEBSITE

http://www.staff.uni-mainz.de/thospeck/workshops/15-cecam

ORGANISATION

- Thomas Speck, University of Mainz (Germany)
- C. Patrick Royall, University of Bristol (UK)

JG|U

cecam Centre Européen de Calcul Atomique et Moléculaire

MATERIALS IN SCIENCE MAINZ

DETAILED PROGRAM

9:30 *Gilles Tarjus*

Supercooled liquids and the glass transition: A theoretical overview

10:45 *break*

11:00 *C. Austen Angell*

Fundamentals of, and challenges concerning, the transition from mobile liquid to glass, including cases with intermediate phases

In this tutorial, I give a bare bones outline of the phenomena that I see as important to know about as one seeks to understand the formation of glasses from mobile liquids of all types (metallic, ionic, molecular, covalent and polymeric), and the many variations in the way they go about it - and in the sort of glasses that they generate. The material is presented from the experimentalist-phenomenologist's viewpoint, with some attempt to recognize the seminal steps (both conceptual and instrumentational) taken along the way to present day understanding. Given the time restrictions, I will not discuss the kinetics of crystallization, even though it is obvious that, in all but a few model systems ("ideal glassformers"), one can only obtain glasses if crystallization can be bypassed.

12:15 *lunch*

14:00 *Peter Harrowell*

The Significance of Structure in Condensed Phases that Flow

The subject of structure in liquids and glasses invites us to think more deeply about how we define structure and how we establish its physical significance. The history of structural representations of liquid metals is as old as liquid theory itself. In this talk we shall briefly review this history and then examine three areas of current interest: i) the description of amorphous configurations in terms of favoured local structures, ii) the global character of the mechanical response of an amorphous materials, and iii) the quasi-local character of collective dynamics in supercooled liquids.

15:15 *break*

15:30 *Kenneth F. Kelton*

Metallic Glasses – An Overview

While silicate glasses have been known and used for thousands of years, metallic glasses were discovered only a little more than a half-century ago. In many ways, metallic glasses are similar to their silicate relatives; they are amorphous, have a distinct glass transition temperature, structurally relax upon annealing, and can be controllably crystallized. They have interesting properties, such as soft-magnetic behavior, high surface hardness, corrosion resistance, high elasticity, and only recently demonstrated, an ability to be thermoplastically molded into intricate shapes. Apple's purchase of the exclusive rights to use thermoplastic molding of metallic glasses in cell phone applications in 2010 and their award of a patent for the process in 2014 is an indication that metallic glasses are now moving from a laboratory curiosity to a potentially important technological material. However, to realize their full potential, many questions must be addressed. Why some alloy liquids easily form glasses while others do not is unclear. Short-range and medium-range ordering in the liquid appears to be important for the formation and stability of the glass and for establishing the properties of the glass. Glass formation also appears to often correlate with fragility, a concept that is typically defined from the temperature dependence of the viscosity, but which has recently been tied to the rate of structural ordering of the liquid. In this review, some of these questions will be addressed, focusing particularly on structure and how that relates to glass formation, crystallization and selected properties.