GLAXES - X-ray-induced fluidization: a non-equilibrium pathway to reach glasses at the extremes of their stability range

I will address the fundamental question of what exactly are and how to prepare ultrastable, quasi-ideal glasses, disordered materials with a quasi-zero configurational entropy and thus almost no defects. While thermal routes can only reduce defects up to a certain amount - limited usually by the time spent to anneal the glass - I will here employ an X-ray absorption based, out-of-equilibrium pathway to get close to (to reach?) the ideal, defect-free glass, a novel equilibrium state of matter not yet observed. This state, predicted by some theories of the glass-transition, is extraordinary: disordered but yet with zero configurational entropy. It is the unique, perfected realization of an amorphous structure with the densest possible packing. Its importance is however not only fundamental: the reduced (zero?) density of defects makes the ideal glass loss-free in terms of, e.g., optical or mechanical losses. Its properties are therefore enabling for new technological applications ranging from super-transparent optical fibres, noise-free mechanical resonators or superconducting qubits with sufficient coherence for quantum computers.

My project aims at:

1. producing ideal or, at least, quasi-ideal bulk network glasses, e.g. oxide glasses like silica;

2. developing a general procedure to equilibrate glasses by mapping their thermodynamic properties at different stages of equilibration;

3. measuring the density of defects in glasses and establishing its connection to the thermodynamic properties;

4. clarifying the electronic origin of the physical mechanism of this X-ray induced equilibration effect;

5. explaining the glass-specificity of this effect with the help of a new algorithm to realize quasi-ideal computer glasses.

The long-term vision is that by (a) learning how to control the density of defects in glasses and (b) clarifying the role of these defects for macroscopic properties, a new class of technologically relevant applications for glasses will be established.

ERC Grantee: Giulio Monaco

Department: Physics and Astronomy

Coordinator: Università degli Studi di Padova

Total EU Contribution: Euro 2.499.876,00

Call ID: ERC-2021-AdG

Project Duration in months: 60

Find out more: https://cordis.europa.eu/en