Amorphous Ices: Crystal-Clear?

At: 14:00 in A8/309

Johannes Bachler

Institute of Physical Chemistry, University of Innsbruck

From a simple point of view, water is just two hydrogen atoms connected to an oxygen atom. However, once you have so many molecules that they form a liquid, H_2O suddenly shows over 70 anomalous properties where most are poorly understood even at the present day [1]. Many of the anomalies are thought to originate from a transition between two distinct liquids, one water of low- and one water of high-density [2]. However, this so-called liquid–liquid transition would occur in a temperature/pressure regime where water nearly instantaneously crystallizes to ice and thus, it is not accessible experimentally [3]. Only at sufficiently low temperatures, it could be possible to observe these two liquids in their immobilized glassy states and find a glass–glass transition [4]. Support for such a transition was immediately met with criticism as most data were gathered from amorphous ices, which were commonly prepared from crystalline ice [5]. Many considered them as collections of nanocrystals rather than glasses. Now, after 30 years of raging debate, the haze clears. We have studied amorphous ice prepared by rapidly cooling liquid water yielding a genuinely glassy state [6]. What will be the implications for water science and fields working with aqueous solutions?

Workshop on phase transitions (At 16:00)

The workshop aims at giving insight into the physics of phase transitions, in particular of amorphous materials. In the first half, we will work towards the understanding of general principles of phase transitions from the perspective of both thermodynamics and kinetics. In the second half, we will assess the complex behavior of glass-forming liquids. With the help of experimental data, we will discuss ways of classifying glass-forming liquids, which will then be applied on a selection of real systems.
This workshop is suited for Master or PhD students who are interested in physicochemical properties of materials. Experience with a scientific graphic program (such as OriginLab) is required.

1. M. Chaplin, Water Structure and Science, http://www1.lsbu.ac.uk/water/, Accessed 08 June, 2020.
2. P. H. Poole, F. Sciortino, U. Essmann and H. E. Stanley, *Nature*, 1992, **360**, 324.
3. P. H. Handle, T. Loerting and F. Sciortino, *Proc. Natl. Acad. Sci. U.S.A.*, 2017, **114**, 13336–13344.
4. O. Mishima, *J. Chem. Phys.*, 1994, **100**, 5910–5912.
5. J. S. Tse, D. D. Klug, C. A. Tulk, I. Swainson, E. C. Svensson, C.-K. Loong, V. Shpakov, V. R. Belosludov, R. V. Belosludov and Y. Kawazoe, *Nature*, 1999, **400**, 647–649.
6. J. Bachler, J. Giebelmann and T. Loerting, *Proc. Natl. Acad. Sci. U.S.A.*, 2021, **118**, e2108194118.