Water and its solid form - ice - is a fascinating system. It may look simple but water's puzzling properties are still not understood. In addition to the general importance of water and ice in our environment, it is of common interest to understand the behavior of water itself. An understanding of water's anomalies is closely linked to an understanding of the phase diagram of water's metastable non-crystalline states. The process of pressure induced amorphization of crystalline ice has been discovered by Mishima et al. by pressurizing hexagonal ice at 77 K to yield high-density amorphous ice (HDA). HDA transforms to low-density amorphous ice (LDA) by an "apparently first order transition". The term "polyamorphism" was coined, because this phenomenon was observed for the first time in amorphous ice.

Since then it is controversially discussed, whether these amorphous ices are (a) glassy states of water, which are able to undergo a so-called glass transition to their liquid proxies LDL and HDL or (b) rather a microcrystalline solid, produced by the mechanical collapse of the hexagonal ice lattice. To measure the possible glass transition in ice is a challenge by itself, since crystallisation takes place in the vicinity of the estimated glass transition temperature. All amorphous states observed so far are non-equilibrium states. In my Ph.D. thesis I recently showed that it is possible to produce equilibrated high density amorphous ice (eq-HDA), which undergoes a first order transition to LDAII. My results give evidence that this transition takes place between two ultraviscous states.

Aim of my project is to study these equilibrated amorphous ices and the ultravicous states of water. Glasses always tend to reach an equilibrated state, it is just a question of temperature and time, if they can reach it or not. With two complementary methods (volumetric measurements and solid state NMR) I will careful study the relaxation times as a function of pressure and temperature. In addition measurements will be devoted for analyzing the question, whether there are some nanocrystalline domains within the sample. My Ph.D. provides strong hints that most earlier measurements denying glassy character dealt with the wrong stuff, namely non-equilibrated amorphous ice. Aim of my project is to answer this question with inelastic neutron and X-ray scattering experiments as well as infrared spectroscopy. Besides equilibrated amorphous ices produced from hexagonal ice as starting material, I will also investigate glassy water vitrified directly from the liquid phase.