# NEW FRONTIERS FOR THE PHYSICS OF WATER

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The physics of water has been fascinating scientists for many years. The negative volume of melting, the density maximum in the normal liquid range and the apparent divergence of the transport properties in the supercooled temperature region are some of the puzzling properties of this intriguing system. Different models have been proposed to explain the anomalous behavior of water: 1) the existence of two liquid phases where a second critical point is supposed to be situated in the "*no man's land*" temperature region, 2) a singularity-free scenario model in which the thermodynamic anomalies are ascribed to the presence of structural heterogeneities, and 3) the Mode Coupling Theory (MCT) which describes water features without resorting to an underlying thermodynamic singularity. Experimental evidences did not allow, until now, discriminating among those models, therefore new experimental efforts are strongly needed.

The natural tool for probing the dynamics of condensed systems is the study of sound waves at different wavelengths and under different thermodynamic conditions. Traditional techniques cannot cover the whole range between interatomic distances and the macroscopic scale. In fact, ultrasonic and light scattering techniques are limited to wavelengths longer than 200 *nm* and neutron and inelastic x-ray scattering give access to wavelengths shorter than 10 *nm*. The *mesoscopic* region extending between these two limits, which is of great interest for the physics of amorphous systems, has now been made accessible at the Elettra synchrotron in Trieste thanks to the construction of the Inelastic Ultra Violet Scattering (IUVS) beamline, the first scattering experiment in the world to meet the challenge of bridging the gap between macroscopic continuum and atomic scale wavelengths.

We performed IUVS measurements of the dynamic structure factor of liquid water in the temperature range where the divergence of the transport quantities starts to be relevant. The measured relaxation time and stretching (see Fig. 1) as function of temperature are in good agreement with the Mode Coupling Theory, showing that the slowing down of the dynamic properties of water can be explained without the need of thermodynamic critical behavior.

Reference paper: "*Structural relaxation in liquid water by inelastic UV scattering*" By: C. Masciovecchio, S. C. Santucci, A. Gessini, S. Di Fonzo, G. Ruocco, and F. Sette – Phys. Rev. Lett. **92**, 255507 (2004).

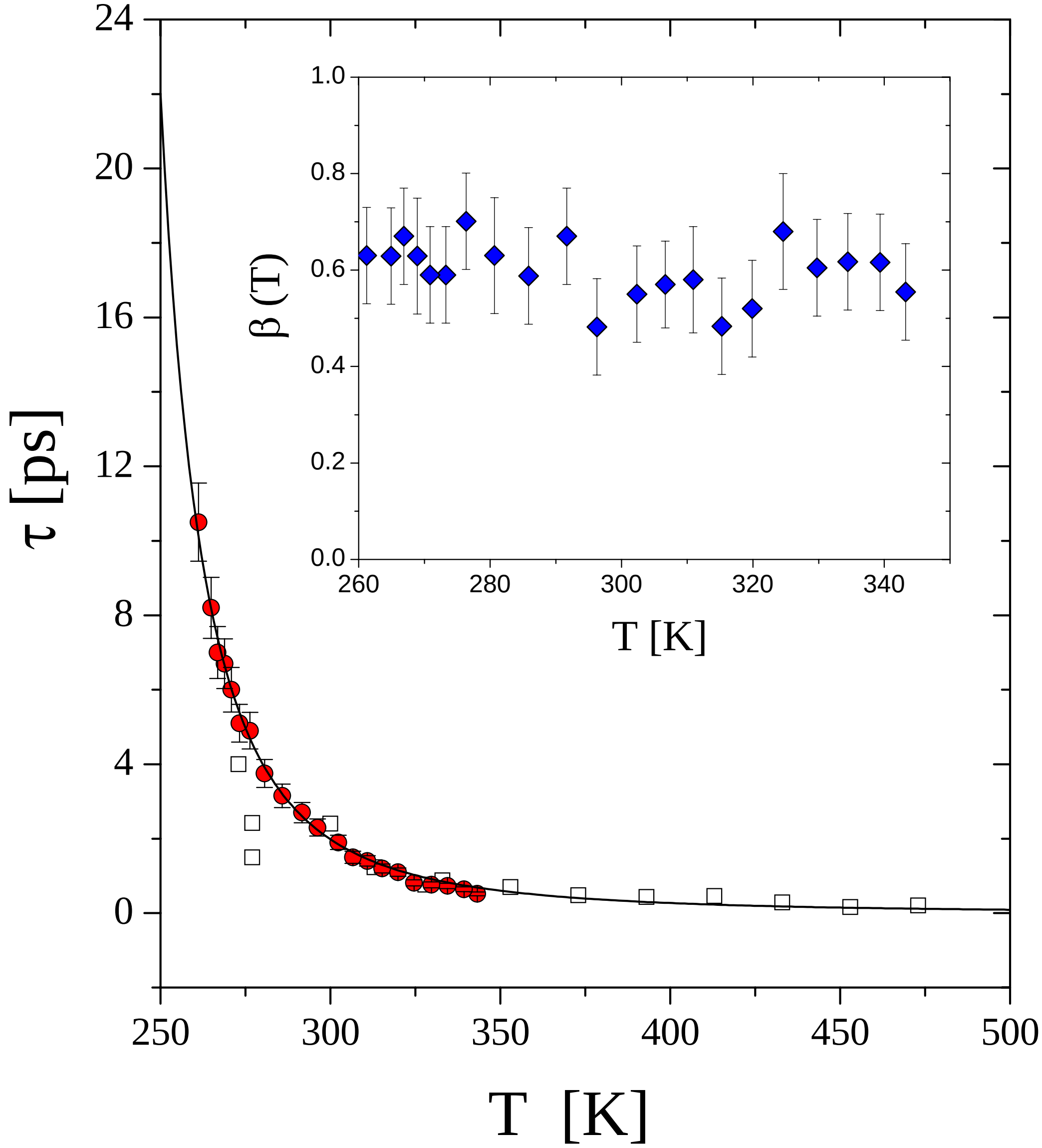


Fig. 1 - Temperature dependence of the structural relaxation time τ of water as obtained by IUVS (red circles). For the sake of comparison Inelastic X-ray Scattering data are also shown (open squares). The solid line represents the Mode Coupling Theory prediction fitted over the displayed experimental points. In the inset we show the temperature dependence of the structural stretching parameter β (blue diamonds). MCT predicts $\beta<1$ and temperature independent.