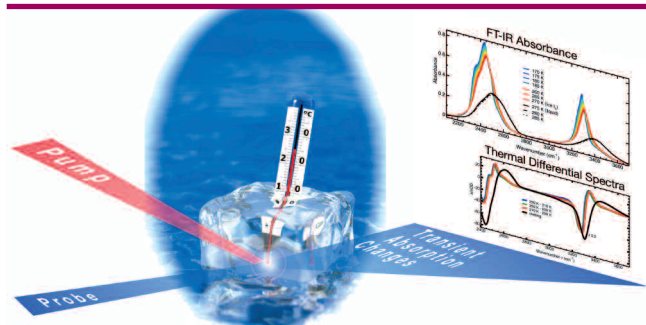


### Experimental test of Anderson localization theory

Anderson predicted in 1958 that waves diffusing through a disordered, three-dimensional medium should come to a halt at some critical amount of disorder [Anderson, *Phys. Rev.* **109** (1958) 1492]. This phase transition is due to constructive interference of waves propagating on reciprocal multiple scattering paths. Because the path has the same length in both counter-propagating directions, the probability of returning to the starting point is increased twofold and hence transport is hindered. This is called weak localization. At high disorder, when the mean free path becomes comparable to the wavelength, the multiple scattering paths form closed loops leading to a phase transition where diffusion breaks down. While this concept has had many applications in solid-state physics, photonics and acoustics, there has not yet been an unequivocal experimental verification of the existence of the localization transition. This is because in electronic systems, electron-electron interactions or bound states may similarly lead to a metal-insulator transition. In optical systems however, such effects are absent. Nevertheless, static transmission or reflection measurements cannot distinguish between localization and absorption. Using time resolved measurements of light diffusion in highly scattering materials we have now provided clear experimental evidence for the existence of a transition to Anderson localization of visible light [Störzer *et al.*, *Phys. Rev. Lett.* **96** (2006) 063904]. In particular there is an increase of photons traversing the sample at late times (see Figure). This slowing down of diffusion is consistent with the rescaling of the diffusion coefficient predicted by scaling theory more than 25 years ago [Abrahams *et al.*, *Phys. Rev. Lett.* **42** (1979) 673]. In addition, the deviations from diffusion can be used to determine the length scale on which photons

are localized as the phase transition is approached. This gives a measurement of the critical exponent of scaling theory. Such experimental information on the critical exponent is of great importance in the theoretical controversy concerning the properties of the localization transition. ■

C.M. Aegerter, M. Störzer and G. Maret,  
 “Experimental determination of critical exponents in Anderson localisation of light” *Europhys. Lett.*, **75**, 562 (2006).

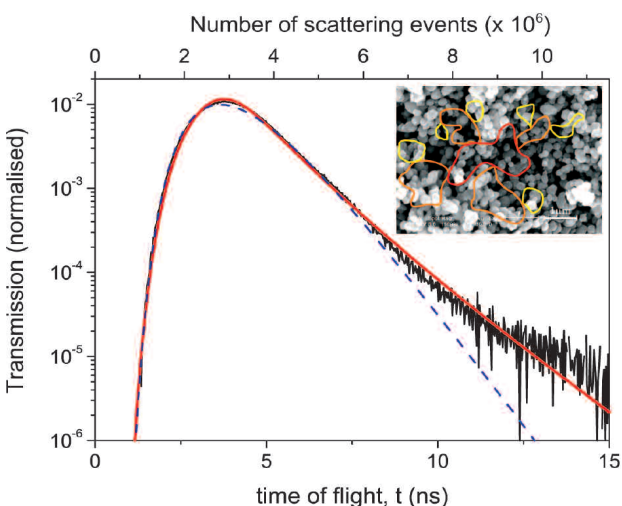


▲ A picosecond pulse is passed through a powder of TiO<sub>2</sub> (the inset shows a scanning electron micrograph of the sample). The localization of photons on closed loops leads to a slowing down of transmission as indicated by the non-exponential tail in the time of flight distribution (main figure). The red line is a fit to diffusion theory with a rescaled diffusion coefficient ( $D(t) \propto t^{-1}$  as required by localization, whereas the dashed blue line corresponds to classical diffusion.

### Picosecond jumps of temperature and pressure in ice

Water in its liquid and solid phase is ubiquitous for human life. Almost every physical and chemical process in an aqueous material strongly depends on temperature and pressure. An increasing interest for studying such processes on shorter timescales makes it also necessary to have a sensitive probe of transient thermodynamic quantities on an ultra-short timescale.

The present paper demonstrates a novel spectroscopic method to measure temperature and pressure changes of an ice sample on the picosecond timescale. The technique can be extended to other hydrogen-bonded systems. The method utilizes the pronounced temperature and pressure dependency of the absorption band of



the hydroxilic stretching vibration. The effect is due to the strong coupling of the OH vibration to the hydrogen bonds between the molecules. The sample is heated by sub-picosecond IR laser pulse. The temporal evolution of temperature and pressure in the sample is determined by comparing the time-resolved absorption changes conventional IR absorption. Here it is important to consider the isochoric character of the ultra-fast temperature jump of constant volume leading to a pressure increase.

The amplitude and the spectral shape of the steady-state differential spectra for a fixed temperature jump depend only slightly on initial sample temperature since the spectral position shows a nearly linear dependency on initial temperature. The feature allows the extrapolation of the steady-state thermal differential spectra above the melting point and measurement of a possible transient superheating of the sample.

The method is verified for isotopic mixtures of ice at 200 K and ambient. The results show that the use of a temperature scale is meaningful for ice as early as 20 ps after the energy deposition. Using this technique for measurements close to the melting point a superheating of the ice lattice up to 25°C without melting for more than 1.3 ns was observed for the first time. ■

M. Schmeisser, A. Thaller, H. Iglev and A. Laubereau,  
 “Picosecond temperature and pressure jumps in ice” *New J. Phys.* **8**, 104 (2006)

Figure: Cartoon of a pump-probe experiment for measuring picosecond temperature and pressure changes in ice.