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Phase transitions of liquid water at nanoscale

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The behaviour of fluids confined within nanometric pores significantly differs from that of the bulk. The effect of confinement, surface forces, and reduced dimension is to shift the phase transitions of the confined fluid (condensation, freezing and crystallisation). By postponing or avoiding the inconvenient crystallization process it is often suggested that confinement allows a deeper penetration into the supercooled regime and helps in the understanding the glass formation; in the case of water, confinement might helps to extend the liquid state into the so-called "no-man's land." However below confining conditions of about 10σ, σ being the size of the molecule, water or van der Waals liquids are strongly perturbed by the presence of a surface. Thus a question always remains whether the confined liquid, water or any other fluid, is an extension of the "bulk" supercooled regime or refers to specific behavior controlled by external parameters such as the size and the surface interactions imposed to the system. Despite the obvious fundamental interest in understanding bulk water, this situation corresponds to most of the cases in biological and geological systems and deserves particular attention per se. However a prerequisite is to understand and quantify how pores are filled and how much; so we studied the processes of entrance and saturation to a pore (adsorption, imbibition and intrusion) in connection with the structure and the local dynamics of liquid water. Then, we will present new experimental results on the thermodynamic, structural and vibrational properties of water confined within nanometric pores (size of a few molecular diameters).