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Positron study of liquids confined in nanovoids

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Water confined in spaces of nanometer size do not form ice crystals at lowered temperature. Instead, it remains stable in a supercooled and amorphous state. This allows to reach the "no man's land", i.e. deeply supercooled state of water, which is hardly accessible for experiments on bulk water. On the other hand, studies under conducted under the "negative" pressure (i.e. below the saturated vapor pressure) provide interesting information concerning behavior of water. Favorably, such conditions can easily be achieved for confined water, where the double metastable area (in relation to steam and ice) becomes completely stable due to the capillary condensation effect. Positron annihilation lifetime spectroscopy (PALS) allows to observe phase transitions of nanoconfined water from the supercooled liquid to the plastic-like phase, and then to the amorphous glass-like phase. The temperature shift of the phase transitions with the change of the negative pressure is observed. In addition, the positron lifetime observed at different pressures is clearly different. This suggests that the properties of each phase change due to the increase in the curvature of the meniscus on the liquid surface or the weakening of the water's interaction with the pore walls. Understanding this effect should allow for the extrapolation of the obtained results to the expected values for bulk water. Therefore, the results obtained for water are compared with the ones for nano-confined n-heptane, which should allow to distinguish water-specific effects from those that are common to all liquids.

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