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Observation of a Fragile-to-Strong Dynamic Crossover Phenomenon in Confined Water and Its Relation to the Existence of a Liquid-Liquid Critical Point in Supercooled Water

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We have observed a fragile-to-strong dynamic crossover phenomenon of α relaxation time and self-diffusion constant in deeply supercooled 1-d confined water. The α relaxation time is measured by quasi-elastic neutron scattering and the self-diffusion constant by nuclear magnetic resonance. Water is confined in 1-d geometry in cylindrical pores of porous silica material, MCM-41 and in double-wall carbon nanotubes. The crossover phenomena can also be observed from appearance of a Boson peak in an incoherent inelastic neutron scattering. We observe a pronounced violation of the Stokes-Einstein relation at and below the crossover temperature at ambient pressure. Upon applying pressure to the confined water, the crossover temperature is shown to track closely the Widom line emanating from the existence of a liquid-liquid critical point buried in an unattainable deeply supercooled state of bulk water. Relation of the dynamic crossover phenomena to the existence of a density minimum in supercooled confined water will be discussed. The crossover temperature is shown to be sensitively dependent on the degree of hydrophilicity of the confining substrate.