An equation of state and the order parameter for the liquid-liquid critical point in supercooled water

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We have developed a scaled parametric equation of state to describe and predict thermodynamic properties of supercooled water. The equation of state, built on the growing evidence that the critical point of supercooled liquid-liquid water separation exists, is universal in terms of theoretical scaling fields and is shown to belong to the Ising-model class of universality. The theoretical scaling fields are postulated to be analytical combinations of the physical fields, pressure and temperature. The equation of state enables us to accurately locate the "Widom line" (the locus of stability minima) and determine that the critical pressure is considerably lower than predicted by computer simulations. While the order parameter for the liquid-liquid critical point in water is a scalar and thus thermodynamically belong to the Ising-model class of universality, its dynamic properties, in contrast to the vapor-liquid critical point, may be described by a relaxation dynamics, rather than by diffusion. In this presentation we discuss a coupling of the order parameter with experimentally observed properties, the density and entropy. This coupling, while being unimportant for the equation of state, makes dynamics of supercooled water near the liquid-liquid critical point more complicated.

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