Coherent Picture of Low-Density, High-Density, and Very-High-Density Bulk Liquid and Amorphous Water

Giancarlo Franzese ^{C, S} and Luis Enrique Coronas

Seccio' de Fisica Estadistica i Interdisciplinaria-Departament de Fisica de la Materia Condensada, Universitat de Barcelona, Barcelona, Spain gfranzese@ub.edu

Valentino Bianco Faculty of Physics, University of Vienna, Vienna, Austria

Many-body interactions can play a relevant role in water and hydrogen bonded systems. They can be the key to understand the anomalous properties of water and its supercooled phase diagram. We consider the Many-Body (Many-b) Model for bulk water [1], initially proposed for water at interfaces [2]. Thanks to its efficiency at extreme low temperatures in a wide range of pressures, it allows us to establish analytic and numerical relations, e.g., between the water's anomalies and the existence of cooperative rearranging regions [3], haxatic phases [4], or structural effects of ions in solution [5]. Here we focus on the liquid-liquid phase transition that, after five lustra of investigation since its proposal by Poole et al. [6], is still matter of theoretical debate [7] and a trigger for new experiments [8-12]. We show that the Many-b water elucidates the mechanisms of (i) low-density-liquid, high-density-liquid phase transition and critical point with the Widom line, and (ii) very-high-density-liquid, high-density-liquid crossover with a line of weak maxima of response functions [1], giving a coherent picture with all recent experiments [8-12] and simulations [7,9].

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