Dynamics in water and aqueous solutions
Mini-colloquium 07

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Water is the most abundant molecule on Earth: it is one of the few substances that exists in liquid, solid and gaseous forms over the range of naturally occurring conditions. Despite its importance and countless studies, the behavior of water remains poorly understood with respect to simple fluids [1]. Water shows more than sixty anomalies. For example, its diffusion increases with increasing pressure and its density decreases with decreasing temperature below 4 °C, allowing ice to float on liquid water and lakes to freeze from the top. Water has, also, an extraordinary capacity to absorb heat, which is essential for regulating the temperature of our body and of our planet. Living beings need water because it is involved in most biological processes, from nutrients metabolism and transport to the tissues to communication between cells. Enzymes and proteins need to be suspended in solution to adopt their active structures. Water diffusion in the porous minerals of the transition zone of the Earth’s mantle has strong incidence on the processes governing volcanic eruptions and intermediate-depth seismicity. Our failure in fully understanding water transport properties of water, in the bulk, in confined media, in solution or in extreme conditions of temperature and pressure, is one of the main limitations we have in predicting bio-chemical and geophysical processes. As few examples of that: unexpected changes in the diffusion and sound propagation velocity have been observed in confined undercooled water, in solutions or in water under pressure [2, 3, 4, 5] which can be to the intriguing possibility of water to exist in two liquids forms or to undergo a glass transition; water unusual mobility in aqueous solutions of proteins with trehalose is the key to understand the cryoprotective mechanisms that microorganisms adopt under conditions of extreme drought [6], water exotic dynamics observed by simulations in ice under extreme conditions, i.e. free molecular rotation (plastic phase) [7] or proton free diffusion (superionic phase) [8] can be at the basis of unexplained planetary observations. With all this in mind, we propose a Minicolloquium that aims to present the most recent advances in measurements and simulations of water dynamics in different environments and thermodynamic conditions, favoring the enhancement of the exchange among different communities involved in the development of water research.
References