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New structures and exotic properties of simple molecular systems under extreme conditions: using neutrons to explore planetary interiors

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Simple molecular systems, like water, methane, ammonia, hydrogen, and their mixtures are of paramount importance for many fields, ranging from energy storage applications to condensed matter and planetary physics [1-2]. These systems are widespread on Earth, in various planetary bodies in the solar system and in newly detected water-rich exoplanets, and constitute an incredibly rich gas resource to be exploited. Due to their relatively simple stoichiometry and electronic structure they also represent key systems for the understanding the physical-chemical behavior of more complex molecular systems. Under the extremely broad range of pressure and temperature conditions experienced in planetary interiors these simple molecular systems and their mixtures display a rich phase diagram, anomalous dynamical, thermal and transport properties, super-ionicity, plasticity and enhanced quantum effects [3-12]. In this talk I will review our recent experimental results on the structure and the dynamics of simple molecular systems under extreme conditions probed by neutron, x-ray and light scattering techniques, and will discuss their impact for planetary modelling and energy applications.

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