Hidden Mesoscopic Liquids properties: from “static” elasticity to thermo-elasticity

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Thermo-elasticity couples the deformation of an elastic (solid) body to its temperature and vice-versa. It is a solid property. Highlighting such property in liquids is a paradigm shift: it requires long-range collective interactions that are not considered in current liquid or viscoelastic descriptions. We present pioneering studies providing evidence for such solid-like correlations in ordinary fluids. We show that ordinary liquids (glycerol, Polypropylene glycol, liquid water...) emit a modulated thermal hot and cold signal when applying a low frequency (Hz) mechanical shear stress (figure 1) [1]. The thermal wave reaches a sizable amplitude. As consequence, the liquid converts the energy of shear waves in a non-uniform thermodynamic state. These dynamic thermal changes support the hypothesis of the excitation of macroscopic shear elasticity which range is limited to small scale, in accordance with recent non-extensive theoretical models [2,3] and the identification of the generic sub-millimeter shear elasticity revealed in polymer melts, glass formers, ionic liquids and molecular liquids a couple of years ago [4]. It should thus no longer be assumed that liquids exhibit (shear) elasticity at high solicitation frequencies (MHz or GHz) only.

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FIGURES

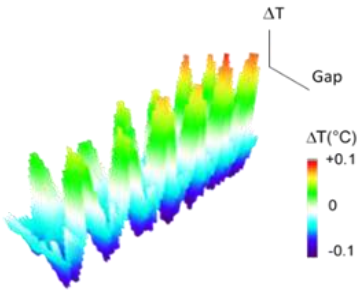

Figure 1: By applying a low frequency mechanical stimulus (~ Hz), the liquid emits a modulated thermal signal synchronous with the stimulus (real-time mapping of the temperature of the PPG-4000 confined in a 240µm gap). E. Kume et al, Scie. Reports (2020) 10, 13340.