

EVIDENCE OF STRAIN-INDUCED VIOLATION OF THERMODYNAMIC LAWS IN MESOSCALE LIQUIDS

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ABSTRACT

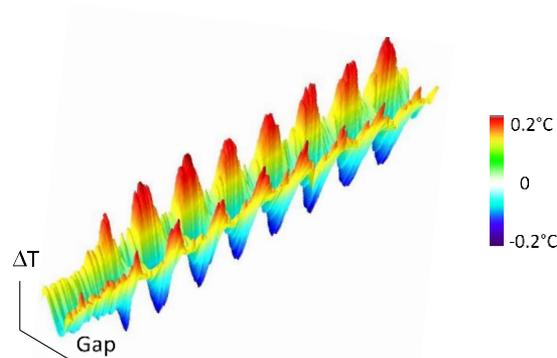


Figure 1: By applying a low frequency mechanical stimulus (\sim Hz), the liquid emits a modulated thermal signal synchronous with the stimulus. Real-time temperature mapping of glycerol confined in a $240\mu\text{m}$ gap (gap view) excited with a low frequency oscillatory shear strain (room temperature measurements at $\omega=0.5$ rad/s).

Thermo-elasticity couples the deformation of an elastic (solid) body to its temperature and vice-versa. It is a solid-like 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. We will show that ordinary liquids (glycerol, Polypropylene glycol...) 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 non-uniform thermodynamic states. 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].

REFERENCES

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