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Collective effects in liquids and melts: what Rheology says and what it does not say...

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Abstract: A solid body deforms under shear while a liquid flows. The absence of mechanical resistance to a shear stress indicates thus a liquid behavior. However, is this common definition really satisfying?

Looking at the mesoscopic scale, we show that liquids and melts are actually endowed with shear elasticity but that it is hidden in standard rheological measurements. To prove the elastic nature of "liquids and melts", a new series of experiments highlight that ordinary liquids and polymer melts (glycerol, Polypropylene glycol, liquid water ...) are able to emit a modulated thermal (hot and cold) signal when submitted to a mechanical shear stress. Thermal response is a collective effect. It is similar to the thermo-elasticity, coupling the deformation of an elastic (solid) body to its temperature and vice-versa. Such properties require long-range elastic interactions that are absent in current viscoelastic descriptions. Our approach is an invitation to consider liquids as not fundamentally different from solids, highlighting on basis of numerous examples that liquids can also exhibit splendid collective effects. More than ever, a phononic interpretation and various possible coupling between a liquid and a solid modifying both sides energy,