Mesoscale Atomic Dynamics of Liquids: Unique Properties, Steps Forward, Back, and Forward Again

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The atomic motions of simple liquids on nm length scales is an area of active research, and one in which inelastic x-ray scattering (IXS) has allowed significant strides forward, providing data of a quality that is unmatched by any other technique. This has made direct investigation of basic, if surprising, features of liquid dynamics, such as the presence of **positive dispersion,** relatively straightforward. [In most solids, the longitudinal acoustic (LA) mode disperses roughly sinusoidally, with a phase velocity that *decreases* as one increases momentum transfer. In most liquids, however, the LA mode phase velocity first *increases* as one moves to higher momentum transfer before turning over at the pseudo-zone boundary. This is "positive dispersion".] And, as data quality has further improved, it has also become possible to observe unique features of liquid dynamics such as the **coupling between acoustic and diffusive motions**, which has no analogue in simple crystals, but is intrinsic in the equations of hydrodynamics.

This talk will discuss liquid dynamics on the mesoscale. We will begin by reviewing some basic features of the dynamics of crystals, before discussing liquids from a historical perspective. In fact, work related to light scattering established many of the more basic features of liquid dynamics in the 1960s and 1970s, including providing an explanation for positive dispersion via a relaxing viscosity. However, workers using inelastic neutron scattering (INS), and inelastic x-ray scattering (IXS) possibly responding to a desire to appear new and different, neglected the earlier light scattering work. This is now being rectified. Finally, time permitting, we will mention some of the current directions in liquid research.