The transition from the classic to the quantum regimes in simple fluids

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One of the key topics in the study of the dynamics of quantum systems is the transition of from their classic to quantum regimes which gradually occurs either by increasing the exchanged wavevector q or by changing the thermodynamic conditions of the sample.
In fact we can assume that quantum effects emerge only as far as q matches the inverse of the quantum coherence length, namely the de Broglie wavelength. This, in **moderately** quantum fluids, occurs in a region lying by some decades beyond the range covered by Brillouin visible light scattering and, precisely, it occurs in the window explored by higher q techniques, as neutron or X ray inelastic scattering, *INS* and *IXS*. Unfortunately the latter techniques seemed, so far, rather unfit to this kind of study, mainly owing to the lack of a single spectrometer covering the whole dynamic range of interest. However, exploiting some recent technical improvements of *IXS* techniques this kind of study has nowadays become possible.

Being aware of it, we have employed *IXS* to study the evolution of the classic-to-quantum transition of the dynamic structure factor $S(q,\omega)$ of liquid *Ne* and *He*. This has been achieved by changing both the exchanged wavevector and the thermodynamic conditions of the sample.

Such a study covers a q-range extending from 3 to 160 nm^{-1}, *i.e.* including the whole transition region from the collective to the single particle regimes. We propose a novel experimental method to extract the values of the first three spectral moments from the experimental spectra either by direct lineshape integration, or as a result of a best fitting procedure. Among the various results, a direct measurement of physically relevant parameters, such as the mean atomic kinetic energy, is derived. Such result confirm and extends previous *INS* measurements. Moreover it allows the first experimental determination of the kinetic structure function, so far accessible only by numerical simulations.