Comment on "Observable Fast Kinetic Eigenmode in Binary Noble-Gas Mixtures?"

Campa and Cohen[1] show, on the basis of kinetic theory, that there exist two very different "sound" propagation frequencies $\omega_s^{(i)}(k)$ $(i=1,2)$ in a dense disparate mass fluid mixture of 80% He ($i=1$, "light") and 20% Xe ($i=2$, "heavy") for wave numbers k in the neutron scattering regime. Here $\omega_s^{(1)}(k)$ $[\gg\omega_s^{(2)}(k)]$ manifests itself clearly through visible side peaks at $\omega=\pm\omega_s^{(1)}(k)$ in the partial dynamic structure factor $S_{11}(k,\omega)$ of the light component.

This result differs from that in hydrodynamics, where only one sound propagation frequency exists, but is consistent with molecular-dynamics data for the $S_{ii}(k,\omega)$ of a very dense mixture of 80% Li ($i=1$, "light") and 20% Pb ($i=2$, "heavy").[2] For the $S_{11}(k,\omega)$ we have clear side peaks at $\pm\omega_s^{(1)}(k)$, and the $S_{22}(k,\omega)$ shows weak wings at $\pm\omega_s^{(2)}(k)$ and $\omega_s^{(1)}(k)\gg\omega_s^{(2)}(k)$.[2]

We note that the two $\omega_s^{(i)}(k)$ are very hard to observe in actual neutron scattering experiments on dense He-Xe mixtures (because of pressures of a few thousand bars needed for the experiment) and in Li-Pb mixtures [since then mainly $S_{\mathrm{Pb,Pb}}(k,\omega)$ is measured].

Since neutron scattering experiments are much easier to perform on He-Ne mixtures (because of lower pressures) and since Campa and Cohen conjecture that two different propagation frequencies might also occur then, we determined the $S_{ii}(k,\omega)$ by molecular-dynamics for a fluid of 80% He and 20% Ne at 47 K with a total number of 20 particles per nm^3, using Aziz interaction potentials.[3] The results for $S_{ii}(k,\omega)$ with $i=$He and $i=$Ne are shown in Fig. 1 for $k=0.35$ Å^{-1}. As for a simple fluid,[4] we find that $S_{ii}(k,\omega)$ can be represented by one central Lorentzian in ω and two Lorentzians located at $\omega=\pm\omega_s^{(i)}(k)$. Then $\omega_s^{(\mathrm{Ne})}(k)\ll\omega_s^{(\mathrm{He})}(k)$ (cf. Fig. 1) and $\omega_s^{(\mathrm{He})}(k)$ manifests itself through visible side peaks in $S_{\mathrm{He,He}}(k,\omega)$. Thus, He-Ne is similar to He-Xe and Li-Pb mixtures. Neutron scattering experiments on He-Ne mixtures are in preparation.

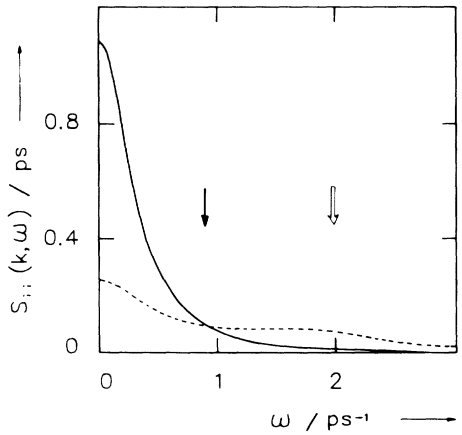

FIG. 1. $S_{ii}(k,\omega)$ for $i=$He (dashed curve) and $i=$Ne (full curve) and $\omega_s^{(\mathrm{He})}$ (open arrow) and $\omega_s^{(\mathrm{Ne})}$ (filled arrow).

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