Comment on “Glass-Specific Behavior in the Damping of Acousticalike Vibrations”

In a recent Letter [1], Rufflé et al., collecting literature data on the high frequency dynamics on different glasses, reported on a correlation between the energy position of the “boson peak” (BP) and the Ioffe-Regel energy. The first quantity, $E_{BP} = h \Omega_{BP}$, is taken as the energy position of the maximum of the function $g(\omega)/\omega^2$, where $g(\omega)$ is the density of vibrational states. The second quantity, $E_{IR} = h \Omega_{IR}$, is defined by the authors as the energy pertaining to the longitudinal acoustic modes that fulfill the condition $\Gamma = \Omega/\pi$ (here $\Gamma$ is the FWHM of the peak centered at $\Omega$). Plotting the quantity $E_{IR}$ against $E_{BP}$ the authors of Ref. [1] find a correlation [see Fig. 1(a)] strongly suggesting that $E_{IR} = E_{BP}$ for a large class of glasses.

Examining the current literature, including the papers cited in Ref. [1], we reached the following conclusions. (i) Other systems can be added to the plot: some data were not known to Rufflé et al. at the time of their submission (NiZr [2], GeO$_2$ [3]), while other glasses were not included (CKN [4]). All of these three new systems do not fit to the correlation [systems 11, 12, and 13 in Fig. 1(b)]. (ii) The point for d-SiO$_2$ (system 3 in Fig. 1(b)) violates the correlation. (iii) The system reported as polycarbonate—and hence classified as a polymer—(Ref. [40] in [1]) strongly suggesting that $E_{IR} = E_{BP}$ for lithium-borate glasses the BP positions reported by Rufflé and co-workers were taken from Raman spectra. It is well known that the quantity measured in Raman scattering is not $g(\omega)/\omega^2$, but $g(\omega)C(\omega)/\omega^2$, and that the presence of the Raman coupling coefficient $C(\omega)$ shifts toward higher energy the position of the maximum of $g(\omega)/\omega^2$. It is, therefore, misleading to put in the same plots $E_{BP}$ data coming from Raman spectra and from the maximum of $g(\omega)/\omega^2$. We report on Fig. 1(b) the data for the two lithium-borate glasses using the $E_{BP}$ values derived from inelastic neutron scattering [13]. The points no longer lie on a line.

Summing up, on the basis of Fig. 1(b) one can conclude that (i) no correlation exists between $E_{IR}$ and $E_{BP}$, and (ii) the Ioffe-Regel limit for almost all the investigated glasses lies above the boson peak position.

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[5] The placing of other systems can be questioned. Specifically, for selenium Ref. [1] reports $E_{IR} = 2.4$ meV and $E_{BP} = 1.7$ meV, while literature data are $E_{IR} = 3.3$ meV [6] and $E_{BP} = 1.4$ meV [7]. In the case of glycerol, the literature reports a $T$-independent $E_{IR}$ [8] and a strong $T$ dependence of $E_{BP}$ [9]. For ethanol, $E_{BP}$ is 1.8 meV [10], not 2.4 meV as reported in [1].