Harmonic vibrations of silica glasses in the terahertz frequency range

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Glasses are quasi-crystalline on the near atomic scale, and isotropic solids at macroscopic scales. Somewhere there ought to be a crossover from the local crystalline arrangement to macroscopic isotropy. If this structural crossover would be sufficiently abrupt, one could imagine that it might also mark in reciprocal space the upper frequency end of the isotropic acoustic dispersion branches. We investigate the vibrational modes of glasses at these frequencies.

Here, we discuss our recent experimental observations on normal and densified silica glasses. We find that propagating acoustic modes enter a regime of strong scattering as their wavelength is decreased, and that this leads to an Ioffe-Regel crossover at frequencies of the order of the terahertz. At similar frequencies, an excess in the density of states of optical modes, generally called the boson peak, is observed. Hyper-Raman spectroscopy of these modes clearly shows that in silica they are associated to the rocking of SiO_4 tetrahedra.