HIGH PRESSURE SOUND DISPERSION IN TETRACHLOROMETHANE BY BRILLOUIN SCATTERING

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Abstract: Sound dispersion in liquid tetrachloromethane was measured by Brillouin scattering for 298.15 K, 323.15 K and 348.15 K at high pressures up to 1500 bars. From these data the sound dispersion was derived as a function of temperature for two constant densities 1.585 g/cm^3 and 1.677 g/cm^3 respectively.

There are only a few papers dealing with Brillouin scattering in liquids at high pressures [1-4]. Carbon tetrachloride is a tetrahedral molecule and has four vibrational degrees of freedom (458 cm^{-1}, 218 cm^{-1}, 776 cm^{-1}, and 314 cm^{-1}). It shows considerable dispersion of the sound speed in the hypersonic range. Since the dispersion is directly correlated to the relaxing specific heat, it was of interest to find out if there is a change, or not, in the dispersion as a function of pressure at different temperatures. Therefore, Brillouin spectra were measured at 298.15 K, 323.15 K and 348.15 K between 1 bar and 1500 bar.

The experimental setup consisted of a high pressure vessel with sapphire windows containing liquid carbon tetrachloride, a five pass Fabry-Perot interferometer with servo-control, and a cooled photomultiplier as the light detector. The scattering angle was 90^o.
The hypersound speed, the hypersonic damping and the non-relaxing bulk viscosity were determined by fitting experimental Brillouin spectra to theoretical spectra according to Mountain´s theory of light scattered by a fluid containing internal degrees of freedom with consideration of the instrumental half width of the Fabry-Perot. The parameters necessary for the evaluation were taken either from the literature or calculated by us: the index of refraction at 514.5 nm, the ultrasound speed, the ultrasound absorption, the density, the isobaric expansivity, the isothermal compressibility, the specific heat capacities at constant pressure or constant volume, and the shear viscosity, all as function of pressure and temperature.
The dispersion remains constant as a function of pressure for all three temperatures (see Figures 1 through 3), while its variation with temperature at constant pressure is rather small.
From our data, the variation of the dispersion with temperature at constant density was derived for r = 1.585 g/cm3 and r = 1.677 g/cm3 (Figure 4). At 298.15 K, the corresponding speeds are v_0 = 924 m/s and v_h = 1046 m/s., and at higher density v_0 = 1149 m/s and v_h = 1273 m/s, respectively..
A short discussion is given in the framework of the IBC-model.

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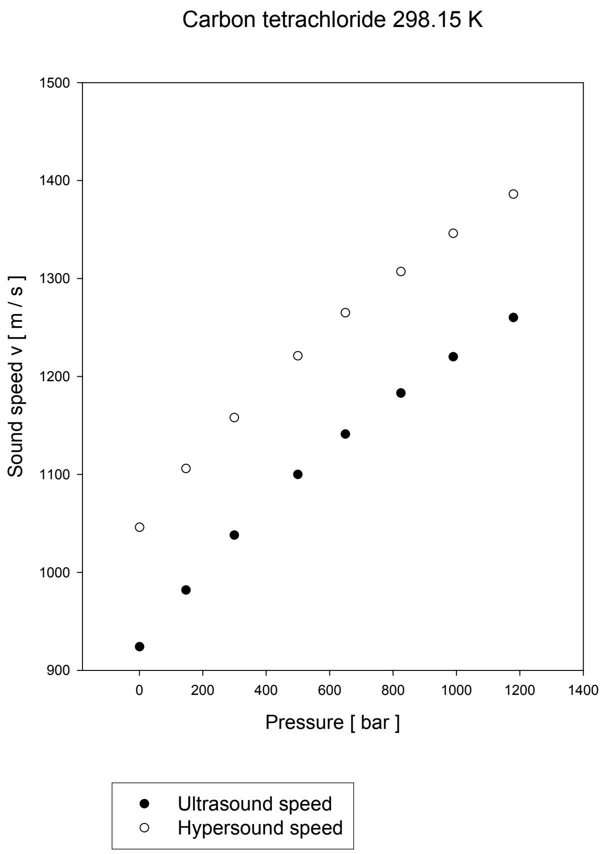

Figure 1: Sound dispersion at 298.15 K

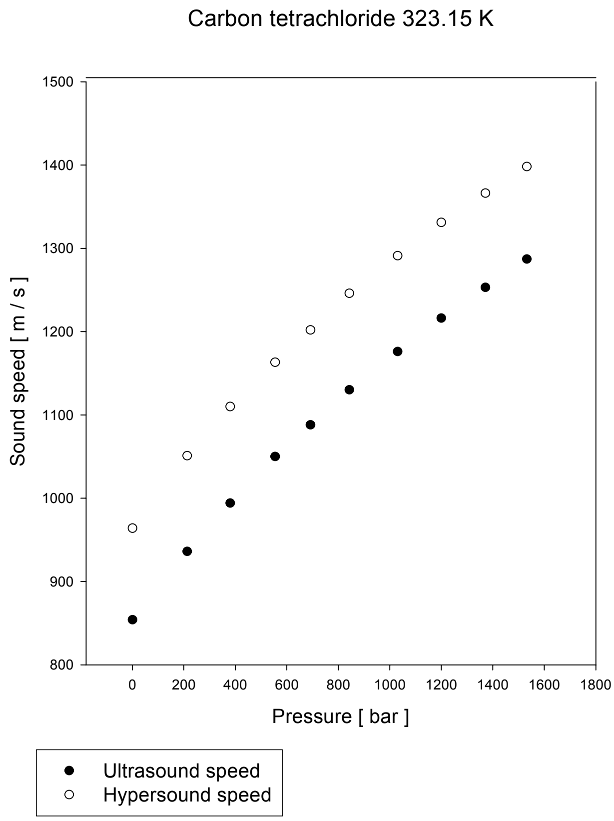

Figure 2: Sound dispersion at 323.15 K

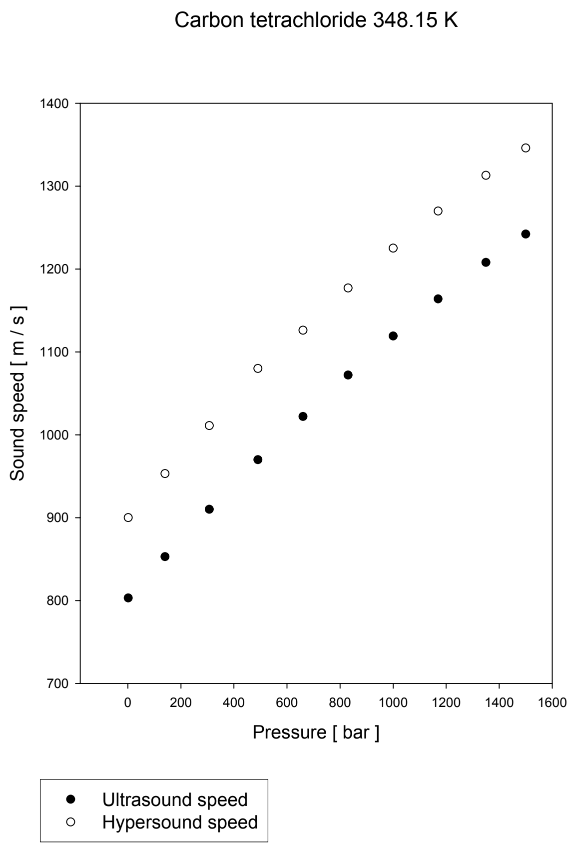

Figure 3: Sound dispersion at 348.15 K

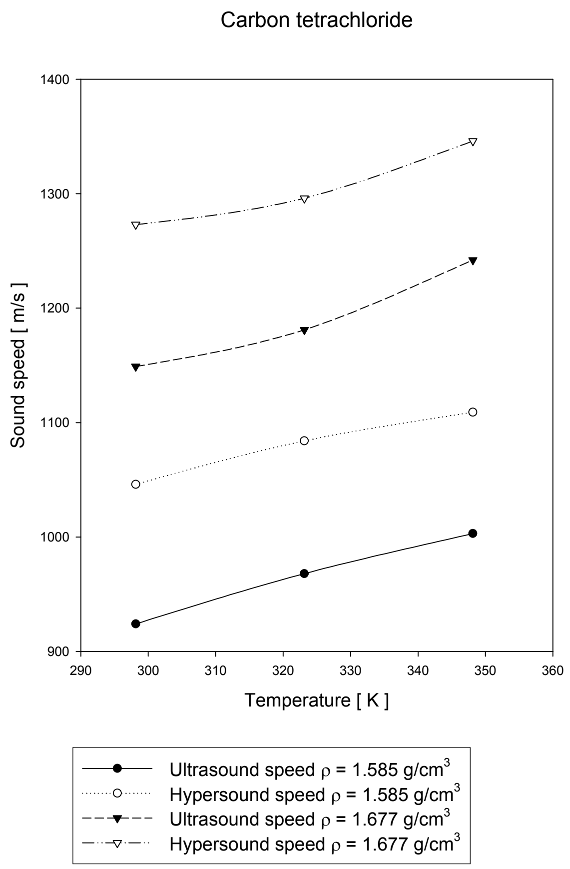

Figure 4: Sound dispersion at constant density