Comment on "Brillouin scattering measurements on optical glasses"

J. Pelous and R. Vacher

Laboratoire de Spectrométrie Rayleigh-Brillouin, Equipe de Recherche Associée au Centre National de la Recherche Scientifique N° 460, Place Eugène Bataillon, 34060 Montpellier, Cedex, France

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It is shown that a frequency variation of the attenuation $\gamma \sim \omega^2$, which agrees with current relaxation theories, is not too far outside the uncertainties of the available Brillouin-scattering experiments. Ultrasonic measurements, on the other hand, indicate a similar frequency dependence, when compared to the Brillouin-scattering values.

In a recent paper,[1] Heiman, Hamilton, and Hellwarth (HHH) have pointed out an anomalous frequency dependence of the hypersonic damping in vitreous silica, based on Brillouin-scattering measurements by themselves and Pine[2] as well as on our previous results.[3] In this comment we would like to show that, on the basis of these experimental results, this anomaly is not unquestionably established.

First, it can be seen from Table I that the measurements by HHH are systematically higher than ours at the same frequency. This could result from differences between samples. Systematic errors can also originate from the experimental techniques used. HHH used a triple-pass plane Fabry-Pérot while our experiments were performed with a tandem arrangement of a double-pass plane and a confocal Fabry-Pérot interferometers.[4] A typical trace of our spectra is shown in Fig. 1. The first interest of this arrangement is that the Rayleigh line has a very small intensity, and therefore does not modify the profile of the Brillouin line. Second, for high-frequency resolutions, the luminosity of the confocal Fabry-Pérot interferometer is higher than that of the plane one,[5] and the signal-to-noise ratio is improved. Third, the resolving instrument—the confocal Fabry-Pérot—is used in single pass. The instrumental profile can thus be known with a good accuracy. In the case of the triple-pass, the choice between a triangle and an Airy-cubed function or something intermediate is always a delicate question.

On the other hand, our feeling is that it is hard to establish with a good accuracy the frequency dependence $\gamma \sim \omega^m$ of the damping from measurements in a frequency interval as small as 24–34 GHz. The Brillouin-scattering measurements in vitreous silica are plotted in Fig. 2 with the error bars indicated by the authors, including the value

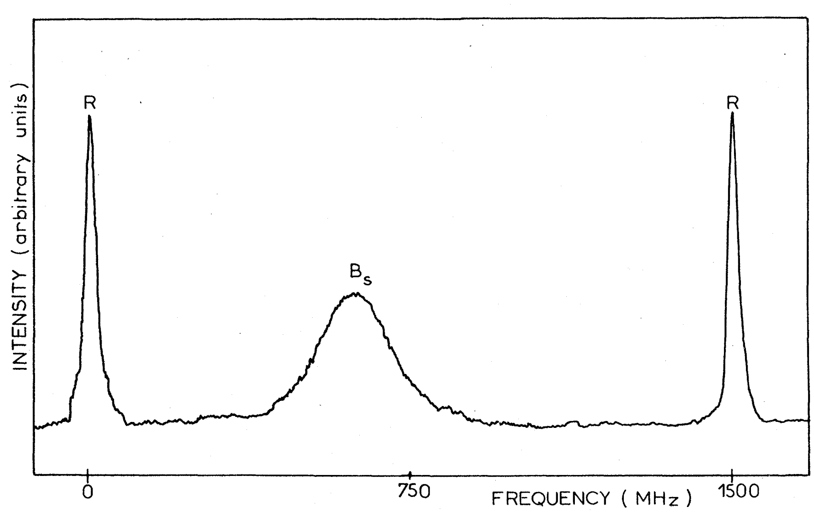

FIG. 1. Brillouin spectrum at room temperature in a silicate glass. R: Rayleigh line (instrumental functions). B_S: Stokes-Brillouin line.

TABLE I. Brillouin frequencies and linewidth in three different glasses.

Glass material	Frequency (GHz)	Linewidth (MHz)
	(Ref. 1)	
SiO_2	34.7	170 ± 20
BK_7	37.0	190 ± 20
$LaSF_7$	43.0	300 ± 10
	(Our results) (Refs. 3, 9, and 10)	
SiO_2	33.8	145 ± 10
BK_7	35.7	150 ± 10
$LaSF_7$	41.1	250 ± 20

given by Bucaro and Dardy[6] which was not taken into account by HHH. The straight lines on this figure correspond to $m = 2.7$ as suggested by HHH and to $m = 2$ which can agree with usual relaxation theories. While m appears to be greater than 2.0, it is certainly less than 2.7 and a value of 2.0 is not too far outside the uncertainties.

A better knowledge of m can be obtained from a comparison of Brillouin scattering and ultrasonic measurements. We have performed such a comparison in the frequency range 1 MHz to 16 GHz for transverse waves in vitreous silica.[7] m was found equal to 2 ± 0.2. For longitudinal waves in vitreous silica, Jones *et al.*[8] give $\alpha = 8$ dB cm^{-1} at 507 MHz. The comparison with the Brillouin-scattering measurements in Fig. 2 leads to $m = 1.6$.

Such a comparison is questionable because (i) the ultrasonic attenuation is small and difficult to measure and (ii) the Brillouin-scattering and ultrasonic measurements have not been performed on the same sample. New measurements in a large frequency range on the same material should be worthwhile to clarify the frequency dependence of the damping in optical glasses.

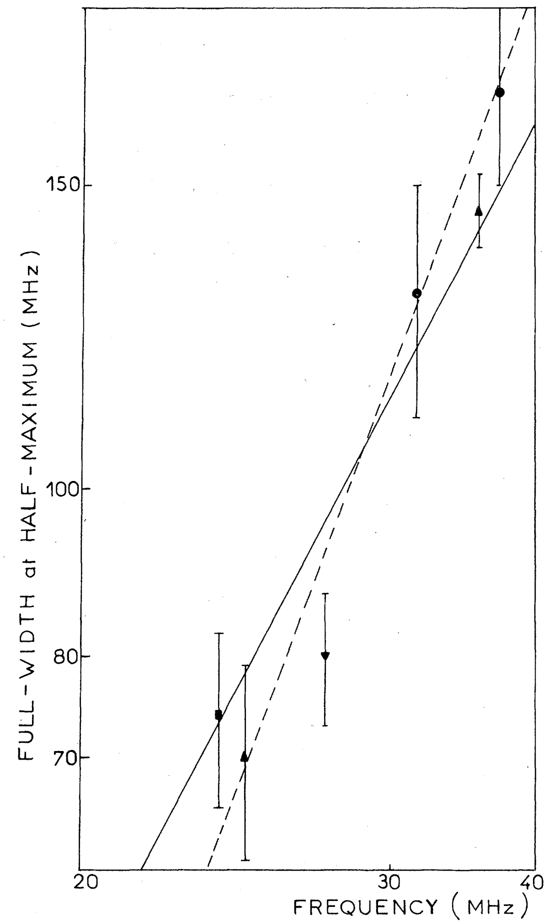

FIG. 2. Variation with frequency of the damping in vitreous silica. The measurements are from Ref. 1 (●), Ref. 3 (▲), Ref. 2 (▼), Ref. 6 (■). The solid line corresponds to $\gamma \sim \omega^2$, the dashed line to $\gamma \sim \omega^{2.7}$.

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