FIG. 4. Temperature dependence of c_{long} as determined from a single-domain crystal in the tetragonal ordered phase. The solid line shows the smooth-curve variation of c_{11} in the disordered phase (Ref. 4). The circles indicate data obtained on crystal Ib, and the crosses denote data obtained on the crystal with path length $2L = 1.4132$ cm.

Possible systematic errors arise not only from the ambiguity in the orientation of the tetragonal axis but also from the choice of the $n = 0$ condition[7] for the pulse-superposition method. For shear waves, where the echo pattern could be followed through the transition region, the choice of $n = 0$ was made by matching the present c_{44} values above T_λ with those reported previously.[4] For longitudinal waves, it was necessary to establish the choice of $n = 0$ independently in the ordered phase. As a check on this choice, c_{long} was measured on two crystals of different lengths, and Fig. 4 shows that the results are in good agreement.

IV. DISCUSSION

There are no elastic constant data in the tetragonal phase with which to compare our present results except for the average shear stiffness $\bar{c}$ obtained from measurements on multidomain crystals.[4] As shown in Fig. 3, the temperature variation of $\bar{c}$ is qualitatively similar but quantitatively very different than the c_{shear} variation determined in a single-domain crystal. It was thought previously that $\bar{c}$ represented the average $(2c_{44} + c_{66})/3$, which would result from a random orientation of the tetragonal axes of the domains along the directions of the three equivalent axes of the disordered cubic crystal. This now seems questionable. If the assignment of c_{shear} as c_{44} is correct, then c_{66} would have rather low values (a minimum value of 0.637×10^{11} dyn cm^{-2} at ~ 190 °K and 0.658×10^{11} at 130 °K). Such a large tetragonal

"splitting" between c_{44} and c_{66} seems unlikely. Another possible explanation for the low $\bar{c}$ values could be that the effective acoustic pathlength is larger in the multidomain crystal owing to reflections of the wave at domain boundaries. It should also be noted that the minimum in c_{shear} occurs at ~ 210 °K, whereas the minimum in $\bar{c}$ is at ~ 190 °K. A minimum value near 210 °K is more reasonable in view of the lattice-parameter variation.[10] It is known that the shear stiffness c_{44} is a sensitive function of volume in the case of NH$_4$Cl.[12] By analogy, the rapid decrease in c_{shear} for NH$_4$Br

TABLE II. Smooth-curve values of the elastic constants c_{long} and c_{shear} (in units of 10^{11} dyn cm^{-2}) for a single-domain crystal of NH$_4$Br in the tetragonal phase. The number of significant figures does not indicate the absolute accuracy.

T (°K)	c_{long}	c_{shear}	T (°K)	c_{long}	c_{shear}
120	2.941	$\cdots$	200	2.605	0.7654
130	2.920	0.8056	205	2.555	0.7648
140	2.898	0.7981	210	2.498	0.7643
150	2.870	0.7910	215	2.429	0.7645
155	2.854	0.7876	220	2.342	0.7660
160	2.838	0.7842	225	2.225	0.7689
165	2.813	0.7810	229	2.092	0.7730
170	2.790	0.7779	230	2.048	0.7742
175	2.767	0.7751	231	1.998	0.7758
180	2.745	0.7726	231.5	1.980	0.7768
185	2.718	0.7703	232	$\cdots$	0.7775
190	2.685	0.7683	233	$\cdots$	0.7796
195	2.648	0.7665	234	$\cdots$	0.7825