

To compensate for the large loss in energy the reference beam was attenuated. Attenuation, which simulated the small aperture of the diamond cell ( $\sim 2$  mm), proved to be the most suitable. A diaphragm shutter, such as the type used in a camera worked quite acceptably. A cardboard spacer, with a hole equivalent in size to that of the diamonds, was used in loading the solids in the cell. No attempt was made to optimize the geometry of the optics. Pressures were determined from the calibration of the spring of the high pressure cell.

Only a few results will be discussed. The infrared-active lattice vibration of KBr at about  $120\text{ cm}^{-1}$  was shifted to  $144\text{ cm}^{-1}$  under a pressure of 35,000 atmospheres, representing a 20% shift toward higher frequencies. Figure 3 illustrates the effect of pressure on the lattice infrared spectrum of KBr with increasing pressure. The  $\nu_4$  vibration at about  $622\text{ cm}^{-1}$  in  $\text{Na}_2\text{SO}_4$  shifts  $3\text{ cm}^{-1}$  to  $625\text{ cm}^{-1}$  under a pressure of 35,000 atmospheres, whereas the lattice vibration at  $183\text{ cm}^{-1}$  shifts to  $235\text{ cm}^{-1}$  at these pressures. The lattice vibration in  $\text{NaNO}_3$  at  $212\text{ cm}^{-1}$  splits into two bands under pressure as shown in Fig. 4. One band shifts to  $279\text{ cm}^{-1}$  and the other to  $224\text{ cm}^{-1}$  at about 35,000 atmospheres.

Changes in intensities and shape of bands for solids under pressure were noted. In some cases spectra washed out completely. In general, absorptions became broader with increasing pressure. In most instances these effects were reversible, and lowering of the pressure brought back the original spectrum.

The high pressure effects on solids appear to be more dramatic and more effective in contracting the lattice in solids, than low temperatures. The temperature dependence of the peak position and half-width of lattice vibrational modes consist of

two parts, (i) the purely volume dependent part obtainable from the Gruneisen equation of state, and (ii) the contribution from the various anharmonic (cubic and higher) terms in the potential energy of the lattice. Often the directions of shifts arising from the two effects may be opposite thus resulting in a small apparent temperature dependence. Such studies on the temperature dependence of the lattice vibrations of LiF and MgO have recently been made.<sup>7</sup> On the other hand, the pressure dependence of the peak position arises primarily from (i), and thus for the same amount of volume contraction, may be relatively large for certain solids compared to the temperature dependence of the peak position. One of the purposes of the study of the pressure dependence of lattice vibrations is to enable one to estimate the above two contributions separately, when data thus derived are combined in the data on temperature dependence for the same solid. The elucidation of anharmonic forces in dielectric solids thus becomes possible. The present data do not warrant such detailed treatment. Further study is in progress, the results of which will be treated in detail in a forthcoming publication.

Preliminary results have indicated only small minor shifts (if any) for internal modes of vibrations, while large shifts have been observed for external modes (lattice vibrations). This method can thus possibly be a way of distinguishing between the two modes and would simplify the interpretation of the far infrared spectra of solids. Extension of high pressure studies to the infrared region of  $100\text{ cm}^{-1}$ , aside from a study of lattice vibrations, makes possible studies of the low-lying hydrogen bonded vibrations in hydrogen bonded systems. In addition other solid state effects in the low energy regions may now be studied under high pressure.