reversible (Fig. 3) it is easily shown that the variation in ln (r_2/r_1) is less than 1 per cent over the pressure range concerned, and this change was therefore neglected.

The greatest uncertainty in these measurements of λ is no doubt due to incomplete knowledge of the pressure variation of l, the length of the specimen. As the pressure is increased, the length is influenced, not only by the compressibility of KCl, but also by the plastic deformation of the sample due to non-hydrostatic conditions. The deformation was investigated experimentally in the following way. A coil of manganin wire was wound on the cylindrical surface of the sample, and pressure was applied under conditions similar to those used in the thermal measurements. The resistance of the coil was measured in the interval 0–19 kbar. From the pressure coefficient of resistance of manganin [9], the variation of the coil diameter was then calculated. These experiments revealed that large distortions of the sample took place during the first pressure cycle, and therefore all thermal conductivity data collected during the first run were invariably rejected. The average result for the second run of two such experiments was that the sample diameter increased at a rate of 0·07 per cent/kbar. The length could now be obtained from compressibility data for KCl [10].

The results are shown in Fig. 3 as a solid line obtained by a least squares fit to the experimental points from the second and third pressure cycles of three different specimens of KCl, for which the measured value of λ at atmospheric pressure did not deviate by more than 13 per cent from a published value [11]. The slope of the line is (3·3 ± 0·3) per cent/kbar. Experimental points from a typical pressure cycle are also shown in this figure.

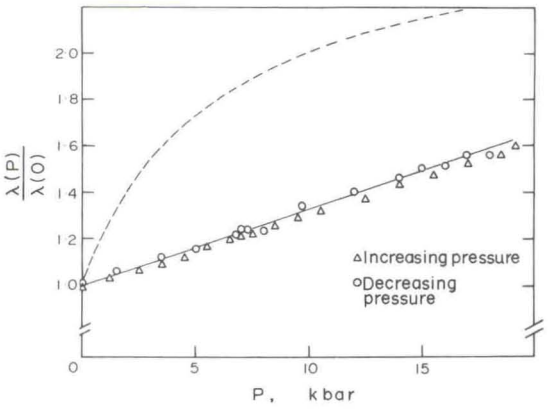

Fig. 3. Relative thermal conductivity of KCl as a function of pressure. Solid curve: average result from three different samples; open circles and triangles: results from one pressure cycle; dashed curve: result from the interpolation formula (25°C) of Hughes and Sawin [2].

4. DISCUSSION

In Fig. 3 our results are compared to those of Hughes and Sawin [2], as expressed by their interpolation formula for 25°C. Since the curves only represent relative values of λ, it should be pointed out that the atmospheric pressure value of Hughes and Sawin [2] is higher by the factor 4·5 than those found in the literature [11]. The slopes of the curves evidently agree quite well above 6 kbar. In the region below 6 kbar, however, the enigmatic discrepancy noticed in our preliminary measurements [4] remains.

Many possible reasons for this discrepancy have been analysed. The methods of measurement and the geometries were similar, but the pressure medium was a solid in one case and a gas in the other [2]. Generally speaking, the gas technique is superior in that hydrostatic conditions may be assumed to prevail, which also implies that a single crystal would remain single as the pressure is increased. In our experiments there is a pronounced plastic deformation, and the sample is certainly polycrystalline after the first pressure excursion to 10 kbar, after which all our data were taken. However, the change to polycrystalline KCl seems to have little effect on the thermal conductivity, since our atmospheric pressure values agree quite well with the value published [11] for single crystals. From the absence of pressure hysteresis in our results, we furthermore conclude that the change in grain size from atmospheric pressure to 19 kbar in a pre-strained specimen does not produce a detectable effect on the thermal conductivity. The discrepancy could thus not be due to the polycrystallinity produced by our solid pressure medium.

At least some of the discrepancy may be explainable by the procedure used by Hughes and Sawin [2] to prepare their samples. A cylindrical crystal was split in halves, and slots were machined in one of the halves for the heater and the thermocouple. The parts were then cemented together with collodion, containing ether and alcohol, which leaves a porous substance after evaporation. At low pressure the collodion layer could be insulating and most of the heat current could be conducted by the half-cylinder containing the heater and the thermocouple. If this was the case, the resulting λ would be too small. As the pressure is increased, however, the collodion could become a better

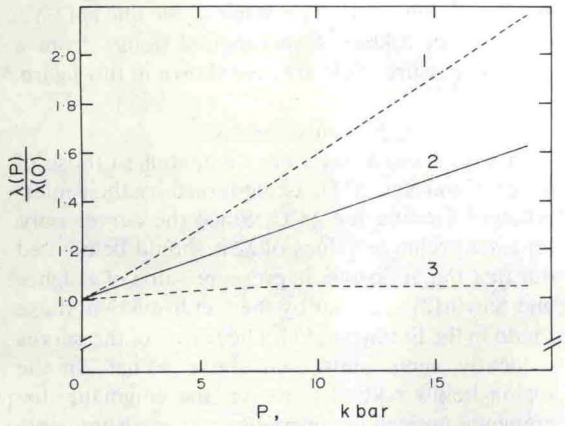

Fig. 4. Relative thermal conductivity of KCl vs pressure. Curve 1: equation (2) with γ and θ calculated from Bohlin[21]; curve 2: experimental results; curve 3: equation (2) with θ from Dobretsov and Peresada[18].

thermal conductor, and at 6 kbar axial symmetry could be approached. Such a mechanism would account for the agreement in slope of λ at higher pressures. In conclusion, we suggest that the initial strong increase observed by Hughes and Sawin was due to a systematic error in their experiment.

It was argued above that the change in λ with pressure which we report could not to a measureable extent be due to grain scattering. As to point defect scattering, measurements on doped KCl crystals [12–15] with impurity contents which well exceed that in our crystals, reveal that this effect contributes less than 10 per cent to the thermal resistance at room temperature. Finally, isotope scattering[16] increases the thermal resistance by approximately the same amount as point defect scattering due to impurities. These small contributions are furthermore not expected to be particularly sensitive to pressure. We therefore attribute most of the variation in λ with pressure to *umklapp* scattering.

For the thermal conductivity limited by *umklapp* processes at $T > \theta$, where θ is the Debye temperature, Leibfried and Schlömann[17] derived the following expression:

$$\lambda = \text{constant} \cdot Ma\theta^3/\gamma^2 T \qquad (2)$$

M being the mean atomic mass, a^3 the volume occupied per atom, and γ the Grüneisen parameter. The pressure dependency of the lattice parameter a may be taken from compression data, and θ may be determined from the elastic constants[18], using an averaging procedure described by Betts *et al.* [19]. If the Grüneisen γ is assumed to be independent of pressure[20], the increase in λ according to equation (2) will be only 5 per cent to 19 kbar. A volume dependency of γ may be obtained by direct integration of an equation derived by Bohlin[21] $v(\partial\gamma/\partial v) = 2\gamma^2$. Assuming the Debye model to be valid, which is highly doubtful in this case, an expression for the volume dependency of θ may then be obtained from γ. However, these calculations predict $\lambda(P)/\lambda(0) = 2{\cdot}1$ at $P = 19$ kbar. The theoretical results as well as the experimental data are shown for comparison in Fig. 4.

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