deuterium mass difference. The wave numbers reported[4,5] for the light hydrogen are very high and range in value from 2800 cm^{-1} to 2400 cm^{-1}, in sharp contrast to our measurement. This energy range is not accessible to our energy gain experiment because these states will not be populated even near the dissociation temperature of the sample; however, the infrared peaks identified as hydrogen bond vibrations are assigned different frequency values by different investigators. They are always broad and very low in intensity. The complementary deuterium frequency is not always detected. The peaks do not sharpen in the ordered ferroelectric phase, in contrast to the other important peaks in the infrared spectrum. Therefore their assignments as hydrogen bond vibrations may be questionable. On the other hand, in KH_2PO_4 a sharp intense infrared reflectance peak at 540 cm^{-1} assigned to a combination mode with the lattice vibrations[3] lies at the high-energy end of the hydrogen vibration band observed in our measurement. This infrared peak becomes the most intense in the ordered ferroelectric phase, supporting our conclusion that it is a hydrogen vibration mode.

Bacon and Pease[6] observe in the paraelectric region an elongated shape for the scattering density of hydrogen, in the bond direction. They assume that it is a result of thermal anisotropy and thus obtain a zero-point energy of 0.08 ev and a low-level spacing of 0.16 ev. This corresponds to a wave number of 1250 cm^{-1}. We do not observe a peak at this energy, although it should be clearly measurable. The elongation therefore may result from a double potential well suggested as the other possibility in their paper.

Pirenne[7] in a theoretical treatment of KH_2PO_4 assumes a very low hydrogen vibration frequency of 148 cm^{-1} to account for the physical properties of the normal and deuterated compound. This energy region in our experiment has other modes of vibration that would make an assignment impossible.

Our observation of low hydrogen vibration frequencies will prove useful in understanding ferroelectric phenomena. The technique utilized in this work of studying fundamental lattice vibrations of correlated compounds can be employed to investigate even complex systems because of the direct interpretation that may be given to the data. It extends the range of observation of vibration modes much below that attainable by infrared technique.

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LOW-TEMPERATURE SPECIFIC HEATS OF BODY-CENTERED CUBIC Cr-Fe AND Cr-Mn ALLOYS[*]

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The electronic structure of the transition elements in the metallic state has not been fully understood as yet. It may be hoped that additional information with regard to the electronic specific heat coefficients and other physical properties of these elements, as well as of their alloys, will help in the interpretation of their structure.

On the basis of the band structure of the transition elements and of the usual interpretation of the electronic specific heat coefficient, it should be possible to trace the shape of the partially filled d-band, i.e., the density of states as a function of the electron concentration, by determining experimentally the electronic specific heat coefficient γ for a series of solid solution alloys of a given crystal structure.

In the present work, low-temperature specific heats were determined for body-centered cubic binary solid solutions in the Cr-Fe and the Cr-Mn systems. Specific heats were measured in the temperature range of 1.6° to 4.2°K to an estimated accuracy of ±2% for most alloys. For a few alloys, where the specific heat depends very sensitively on the alloy composition, the accuracy may have been as low as ±5%. The alloy specimens were prepared by induction melting from electrolytically refined metals, and homogenized by annealing for at least three days at 1170°C in a purified 92% He + 8% H_2 gas mixture and quenched to room temperature.

The low-temperature specific heats were analyzed by means of the usual C_v/T vs T^2 extrapolation to $T = 0$, to obtain the coefficient γ of the temperature-linear term. These γ values are plotted in Fig. 1 as a function of the electron concentration. The γ for Fe was measured and found to be in excellent agreement with the value reported by Keesom and Kurrelmeyer.[1] The γ for $Cr_{0.44}Fe_{0.56}$, as determined by Hoare and Matthews,[2] was plotted in Fig. 1, and it fits the curve for the Cr-Fe alloys very well. A large peak occurs at $Cr_{0.81}Fe_{0.19}$, with a γ value more than ten times that for Cr.[3] The fact that similarly high γ values were found also for specimens in the Cr-Mn alloy series at corresponding electron concentrations suggests that the observed effect may be related to characteristic values of the electron concentration. However, it is as yet uncertain whether or not the γ-peak should be interpreted simply in terms of density of states. The work on the low-temperature specific heat and on other physical properties of these alloys is continuing, and it should eventually make possible proper interpretation.

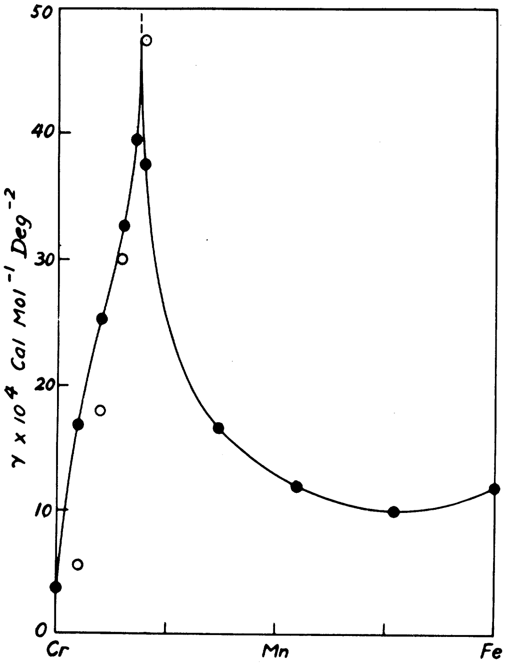

FIG. 1. Coefficient of term linear in temperature in the expression for the low-temperature specific heat, vs electron concentration. Cr-Fe alloys ●, Cr-Mn alloys ○.

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VALLEY-ORBIT SPLITTING OF ARSENIC DONOR GROUND STATE IN GERMANIUM

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A comparison of the density-of-states effective mass obtained from low-temperature Hall measurements on n-type germanium[1] with the effective-mass tensor yielded by cyclotron resonance experiments[2] suggests that, of the two states into which the donor ground state is split by the valley-orbit interaction,[3] the triplet is the lower one.[4] It has further been pointed out[5] that the differences in binding energies among the various donors is not inconsistent with such an assignment. By investigating the far-infrared excitation spectrum of bound electrons[6] in an elastically strained sample, we have now verified that for the arsenic donor the triplet is, in fact, the lowest lying state.

The splitting of the singlet, triplet, and a typical p-state under an applied strain can be calculated.[7] One assumes for this purpose that if the