Bull. Amer. Phys. Soc. 16, 438 (1971)

HE 4 Liquid Helium Films Adsorbed on Surfaces of CaF_2, SrF_2, and BaF_2. E.S. SABISKY and C.H. ANDERSON, RCA Lab.--We have recently shown that the thickness of adsorbed films of liquid helium on cleaved surfaces of the alkaline earth fluorides can be measured by observing the interference of acoustic waves across the films. More extensive and accurate measurements have now been obtained of the van der Waals potential for helium as a function of distance from the substrate. It was found that for thin films (less than 100 Å) the potential can be represented by αd^{-3}. Our results give α to be 18 ± 1°K (where d is measured in statistical layers of helium). This value for α is found to be in excellent agreement with the calculated value of 17°K which is based on the theory of Dzyaloshinskii, et al.[1] Also, in agreement with theory, the van der Waals potential deviates from the simple inverse cube law for thick films.

[1] I. E. Dzyaloshinskii, E. M. Lifshitz, and L. P. Pitaevskii, Soviet Phys. JETP 37, 161 (1960).

HE 5 Magnetization Cooling and Magnetosolidification of ^{3}He. R. E. WALSTEDT, L. R. WALKER, and C. M. VARMA, Bell Telephone Laboratories, Murray Hill, N.J. 07974.--The behavior of antiferromagnetically ordered solid ^{3}He in a magnetic field has been studied in the approximation of spin wave theory. Near the critical field value $H_c = 2ZJI/\gamma\hbar$, the spin wave spectrum changes from characteristically antiferromagnetic to characteristically ferromagnetic form, with a corresponding sharp increase in specific heat. Thus, isentropic magnetization leads to a cooling of the solid at $H = H_c$ which becomes more pronounced as T is lowered. This cooling effect becomes appreciable for $S \lesssim R\ln 2/10$. Further, the intersection point of the solid and liquid ^{3}He entropy curves S(T), which is relevant to the Pomeranchuk cooling technique, is reduced at $H = H_c$ by about two orders of magnitude from its H = 0 value. In a second calculation, we have examined the effect of a field $H \sim H_c$ on the melting curve $P_m(H,T)$. The field displaces this curve to lower pressures, suggesting that a two-phase mixture can be isentropically solidified (and thus cooled) by application of a field $H \lesssim H_c$ from starting temperatures of 4-5 m°K, i.e. well above the Néel temperature. An approximate calculation of this effect will be discussed.

HE 6 Melting of He, Ne, A, and Kr at High Pressures.* R.K. CRAWFORD, Solid State and Materials Laboratory, Princeton Univ.--The P-T melting curves of He, Ne, A, and Kr have been measured over the pressure range 0.5 - 10 kbars with an accuracy of better than one bar (relative to a provisional pressure scale based on the melting curve of mercury). The Simon melting equation $P=AT^c+B$ shows significant deviations from the data. Reasons for these deviations are discussed. A classical corresponding-states analysis of the data is carried out and the lack of correspondence caused by quantum mechanical effects is considered.

*Work supported in part by the National Science Foundation under grants GP-7739 and GP-18573

HE 7 Low Temperature Phase Diagram of Solid Methane.* M.S. COSTANTINO, W.B. DANIELS, and R.K. CRAWFORD, Solid State and Materials Laboratory, Princeton Univ.--The low temperature phase diagram of solid methane is determined using a capacitive technique. The existence of three phases in crystals grown in the range 160K and 3.4 Kbar to 240K and 8.6 Kbar is demonstrated by examining the static dielectric constant as a function of temperature at constant density. The possibility of a ferroelectric phase is discussed.

*Work supported in part by National Science Foundation under grant GP-7739 and GP-18573.

HE 8 Liquid Structure Factors and Radial Distribution Functions of Neon. L. DEGRAAF and B. MOZER, National Bureau of Standards--The structure factors S(κ) for liquid neon at 35.05 and pressures of 21.4, 78.0, and 140.0 atmospheres were obtained from neutron scattering experiments performed at the National Bureau of Standards Research Reactor. The sample cell was constructed of titanium alloy with very little structure in its scattering properties. Boron nitride plates were used in the cell to reduce multiple scattering. Transmission of the neon samples was about 90%. Neutron diffraction data were measured using 2.47, 1.06, and 0.745Å neutrons covering values from 0.2 to 3.5, 3.2 to 9.0, and 8.6 to 13.25 Å^{-1} respectively with overlap for joining. The diffraction data were corrected for background for the cell, multiple scattering, incoherent scattering and inelastic scattering in each region and then smoothly joined to yield S(κ) for each pressure. Significant structure is observed in S(κ) out to 13.25Å^{-1} and the radial distribution function obtained numerically from S(κ) exhibits interesting behavior.

HE 9 Measurement of the Volume Dependence of the Heat Capacity of Solid Neon.* R. Q. FUGATE and C. A. SWENSON, Iowa State Univ. -- High precision constant volume heat capacity data are reported for solid neon at four molar volumes from 13.24 to 12.37 cm^3/mole. These blocked capillary measurements extend to the melting line in each case. The specific heat at the P=0, T=0 molar volume (V_{00} = 13.39 cm^3/mole) determined from these measurements provides accurate experimental C_V data for comparison with theory. The values of θ_0 vary from 75.0 K at V_{00} to 91.5 K at the smallest molar volume. These data give the 0 K Grüneisen parameter as $\gamma_0 = -d\ln\theta_0/d\ln V = 2.47 \pm 0.05$, and the heat capacities at all temperatures and volumes scale to within 1.5% when plotted in terms of T/θ_0. The remaining volume dependence of C_V can be interpreted in terms of a slight temperature dependence of the thermodynamic Grüneisen parameter γ, with γ/γ_0 increasing by about 4% with increasing T. Comparison is made with other measurements and with theory. The best apparent theoretical model, which is based on the Improved Self Consistent phonon theory, accounts for the specific heat above 10 K to within a few percent.

*Work performed in the Ames Laboratory of the USAEC.

HE 10 Lattice Dynamics for bcc Helium. H.R. GLYDE & F.C. KHANNA, Atomic Energy of Canada Ltd., Chalk River Nuclear Laboratories, Chalk River, Ontario. -- The self consistent harmonic approximation due to Koehler[1] with the cubic anharmonic term included as a perturbation is used to compute the elastic constants, phonon dispersion curves and phonon lifetimes in bcc helium. The Beck (and Lennard-Jones) potential with a Jastrow treatment of the hard core describes the interatomic potential. No anomalous upward dispersion of the T_2[110] branch such as suggested by Horner[2] is found. The neutron scattering response function was found to have only a single maximum in all cases, although the function often showed considerable structure. Results using a Brueckner treatment of the hard core will also be presented.

1. T.R. Koehler, Phys. Rev. Lett. 17(1966)89.
2. H. Horner, Phys. Rev. Lett. 25(1970)147.

HE 11 The Velocity of Sound in Solid Krypton.* D. S. KUPPERMAN and R. O. SIMMONS, Univ. of Illinois at Urbana-Champaign.-- Ultrasonic pulse-echo measurements at 10 MHz have been carried out on polycrystalline krypton specimens of various lengths. Values of veloc-