MIDWEST SOLID-STATE PHYSICS CONFERENCE

*By **David W. Lynch***

THE seventh annual Midwest Solid-State Physics Conference was held on Saturday, October 10, at Iowa State University, Ames, Iowa. One of the purposes of the conference is to offer an opportunity for graduate students to attend a conference at modest cost and to present their papers in relatively relaxed surroundings. The conference provides an unusual opportunity for professional contacts as the separation of the participating institutions is sufficiently large to hinder frequent visits to neighboring campuses.

This year's conference was sponsored jointly by The Institute for Atomic Research and the Department of Physics of Iowa State University. It was attended by 120 registrants from 18 colleges and research laboratories. Only eighteen papers were presented in order that the conference be limited to one day without overlapping sessions. The early arrivals had ample opportunity to inspect the facilities at Iowa State and the Ames Laboratory of the Atomic Energy Commission, and to become acquainted at a reception given by J. M. Keller on Friday evening. The laboratory open house was continued before the Saturday morning session. The invited address, following the conference luncheon, was given by J. H. Van Vleck of Harvard University. He presented a review of some of the successes of crystalline field theory in interpreting the magnetic properties of paramagnetic ions in crystals. The talk also included some personal incidents related to the development of the theory and among the technical illustrations was a versatile slide which was projected normally or inverted, depending on the ion under discussion. There then followed discussion by F. H. Spedding (Iowa State University and Ames Laboratory), K. Ruedenberg (Iowa State), and R. E. Rundle (Iowa State) on some of the limitations of crystalline field theory.

A wide range of solid-state subjects was covered in the contributed papers. D. D. Bornmeier and G. J. Van der Maas (Kansas State University) discussed their measurements of circular and longitudinal magnetization in Fe-Ni wires under torsional stress. They found that in a longitudinal magnetic field both the longitudinal and circular magnetization increased with torque in the irreversible region; this increase was in agreement with their calculations.

The ferromagnetic-antiferromagnetic transition in dysprosium at 85°K was the subject of calculations by S. H. Liu and R. H. Good, Jr. (Iowa State University). They assumed the *hcp* lattice to consist of two sublattices with strong ferromagnetic coupling within each sublattice and weak ferromagnetic coupling between the sublattices. The relative stability of the two possible relative orientations of the sublattices was determined by comparing the free energies of the lattice for the ferromagnetic and antiferromagnetic orientations. The ferromagnetic state was found to be the more stable at low temperatures. D. R. Behrendt (Lewis Research Center of the NASA) discussed some calculations on magnetostriction effects to be expected in dysprosium, using a two-sublattice model. He found that a very large magnetostriction term would be needed to account for the anisotropy energy and suggested that quadrupole-quadrupole coupling gives an appreciable contribution to the anisotropy energy. T. D. Rossing (St. Olaf College) described some experiments on ferromagnetic resonance in thin (1000 A) single-domain permalloy films.

N. Bernardes (Iowa State University) described some calculations on the melting curve and nuclear magnetic properties of solid He^3. Experimental work at Duke and Ohio State has recently verified the existence of the predicted "high temperature" minimum in the melt-

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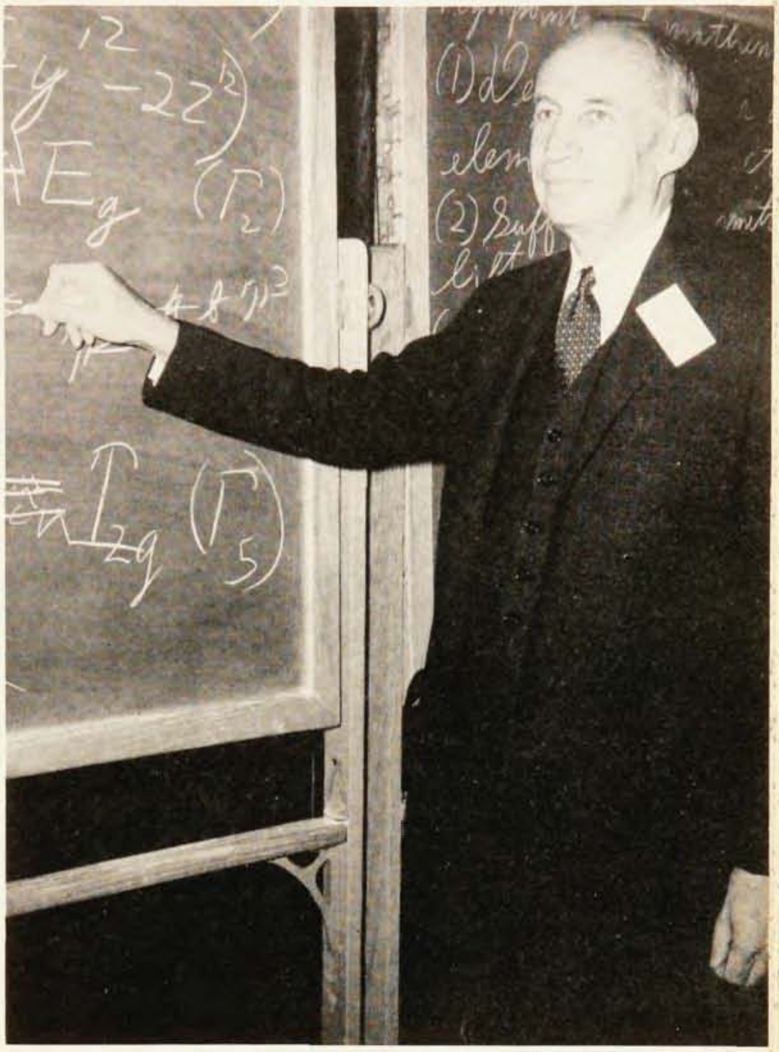
ing curve at 4°K. A predicted low-temperature minimum cannot yet be observed. The calculated Curie temperature for antiferromagnetism (0.1°K) agrees with that found by susceptibility measurements. From estimates of the exchange integral as a function of pressure, a nuclear ferromagnetic state is predicted for pressures in excess of about 100 atmospheres while a nuclear antiferromagnetic state exists at lower pressures. This ferromagnetic-antiferromagnetic transition at low temperature may be identical with a *fcc-hcp* transition at about 100 atmospheres observed at Los Alamos at temperatures above the Curie point.

H. J. Boll (University of Minnesota) reported on some experiments on secondary emission from MgO films. The effect of collector voltage on the yield was ascribed to an alteration of the band structure by the field and hence to an altered escape probability, and not to the field ionization of trapped electrons. The effect of surface traps on the escape probability is currently under study. Experiments on the diffusion of magnesium in nickel were described by D. A. Campbell (University of Minnesota). The magnesium diffuses from the base of an oxide-coated cathode to the base-oxide interface where it reduces the oxide, activating the cathode. The linear dependence of the strontium evolved from the SrO coating on the square root of the time at the elevated temperatures agrees with predictions from a model by D. E. Anderson.

A survey of work on the sodium tungsten bronzes (Na_xWO_3, $0 \leq x \leq 1$) was presented by G. C. Danielson (Iowa State University). The resistivity as a function of x showed a minimum near $x = 0.75$. Hall measurements showed that the concentration of conduction electrons was directly proportional to x from $x = 0$ to at least $x = 0.9$. Electronic specific heat meas-



J. H. Van Vleck of Harvard was invited to review some of the successes of crystalline field theory.

Coffee break and informal discussion.

F. H. Spedding, director of ISU Institute for Atomic Research and the Ames Laboratory, confers with G. C. Danielson and J. H. Van Vleck.

urements gave a small anomaly at $x = 0.75$, but one that was too small to account for the resistivity minimum. A careful search for ordering at $x = 0.75$ was made and ordering was indeed found by neutron diffraction. Ordering may not be responsible for the resistance minimum, however, since in recent experiments no minimum was found for annealed samples carefully selected for homogeneity.

E. B. Dale and S. Kakahana (Kansas State University) reported on electrical resistance and electron diffraction measurements made on thin films of InSb prepared by flash evaporation. Annealing or exposure to the electron beam caused an ordering of the films from their originally amorphous state.

A survey of anomalous resistance effects in dilute solutions of Group IV elements in noble metals was given by A. N. Gerritsen (Purdue University). Early work showed that each noble metal exhibited a minimum in resistance at low temperatures which was dependent on impurities. These minima could often be removed by using carefully grown single crystals of the (impure) metals, but not when the impurity was Fe, Mn, or Co. Resistivity measurements on noble metals doped with these impurities showed that there was a small resistivity maximum at a temperature below that of the resistivity minimum, and at this temperature the magnetoresistance was negative and of large magnitude. Recent work at Purdue shows other strange things occurring in these alloys. There is weak ferromagnetism around 4°K and at about 1°K there is a transition to an antiferromagnetic state for Au + 0.8% Mn. Plots of impurity-induced resistivity change vs. temperature had varying features according to the impurity concentration. These new effects are not explainable on the older model of Korringa for the resistance minimum.

J. R.' Beeler, J. L. McGurn, and L. von Gottfried (General Electric ANPD) described their program for the machine calculation of the kinetics of the growth of long range order by vacancy diffusion in a quenched two-dimensional binary alloy. R. D. Dragsdorf and W. J. Spencer (Kansas State University) described a calculation which showed that dislocations in whiskers of NaCl should be stable against thermally activated glide at temperatures up to at least 650°C. Their x-ray diffraction measurements showed that the dislocations disappeared, apparently by climb, in a series of steps at elevated temperatures.

Careful measurements of lattice parameters and densities of two single crystals of aluminum were described by M. E. Straumanis and T. Ejima (Missouri School of Mines and Metallurgy). From these they calculated the number of atoms per unit cell and found the less pure sample to have slightly more atoms per unit cell than the purer sample, and in each case this number was larger than 4.00000 by an amount greater than the probable error. On the basis of other evidence this difference was ascribed to the aggregation of from two to eight aluminum atoms about each impurity atom.

B. E. Anspaugh (University of Nebraska) described his experiments on the effects of 50–350 kev protons on the resistance of copper. E. B. Hensley and K. Okumura (University of Missouri) presented a new model for the effect of applied fields on BaO-coated cathode emission. Instead of mobile donors which are driven from the surface, deactivating it, mobile acceptors are postulated. These drift toward the surface in a field and lower the Fermi level there, increasing the work function. Experimental evidence was presented which showed that the acceptors are indeed mobile for they were observed to diffuse along the cathode surface. M. E. Glasser and J. W. Weymouth (University of Nebraska) described the detection of dislocations in NaCl whiskers by x-ray diffraction. The Laue spots are displaced as the whisker is moved perpendicularly to the x-ray beam because the dislocation produces a twist in the whisker which alters the diffraction angle. They detected a dislocation with a Burgers vector of about eight lattice parameters in a whisker of NaCl of $32\mu \times 35\mu$ cross section. F. T. Phelps (University of Nebraska) described calorimetric measurements of stored energy in NaCl crystals after room-temperature x irradiation. G. E. Gross (Midwest Research Institute) described a very rapid method for obtaining spectral emission and luminescent efficiency curves for phosphors over a wide temperature range.

The conference was arranged by D. E. Hudson with the help of M. Heller, D. McWilliams, D. Nelson, P. Sidles, C. Trulson, and D. Wallace. The next conference will be sponsored by the Department of Physics of the University of Nebraska in the fall of 1960.