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Minutes of the Cambridge Meeting, February 4, 1933

The second regular meeting of the New England Section was held in Cambridge, Massachusetts on Saturday, February 4, jointly with a meeting of the Eastern Association of Physics Teachers. The morning sessions of the two Societies were separate, while the afternoon session was a joint one. The Presiding Officers for the morning sessions of the Physical Society were Professor E. C. Kemble, Chairman of the Section, and Professor G. F. Hull. The Presiding Officers of the joint afternoon session were Professor E. C. Kemble and Mr. L. A. Wendelstein, President of the Eastern Association of Physics Teachers.

About 80 were present at the Physical Society's morning sessions, and about 250 at the afternoon session.

The morning sessions were devoted to the reading of contributed papers, the abstracts of which appear below.

A meeting of the Program Committee was held at noon. The date of the fall meeting at Middletown, Connecticut was tentatively set as October 14, 1933. A number of suggestions were made for subjects for the invited papers at that meeting. It was decided that since the program of the Section's meetings was still in an experimental stage, further efforts would be made to get suggestions from members as to possible improvements in these programs.

A vote of thanks was extended to the members of the Department of Physics at M.I.T. for their hospitality.

Luncheon was held at the Walker Memorial Dining Halls.

The afternoon session was devoted to invited papers. The first three constituted a Colloquium on *Nuclear Physics*. Dr. M. A. Tuve of the Carnegie Institute of Washington, Bureau of Terrestrial Magnetism, talked on *Recent Advances in Nuclear Physics*, Dr. R. J. Van de Graaff of M.I.T. talked on *High Voltage Methods in Nuclear Physics*, and Mr. E. H. Bramhall of M.I.T. demonstrated an Electrostatic High-Voltage Generator.

The fourth invited paper was by Professor D. H. Menzel of Harvard Observatory on *Physics of the Sun*.

The Program of the Section consisted of 16 papers, the abstracts for which are given below.

Philip M. Morse, *Secretary-Treasurer*

Abstracts

1. The Weiss law for Rochelle salt. Hans Müller, *Massachusetts Institute of Technology*.—The dielectric constant of Rochelle salt has been measured between 23° and 50° with help of a capacitance bridge by using 1000 cycle a.c. Between 34° and 50° Weiss's law is satisfied. The Curie constant is 128.5 and the "dielectric" Curie point 24.9°C. From these data the Lorenz-Lorentz factor is calculated to 2.315. Assuming the dielectric effect is due to the freely rotating molecules of the water of crystallization the same factor must be 2.314. Below 34° the dielectric constant is a function of the applied field. The maximum value 1540 of the dielectric constant is reached at the "ferromagnetic" Curie point 23.75°.

2. X-ray study of crystal structure of Rochelle salt and effect of temperature. B. E. Warren and H. M. Krutter, *Massachusetts Institute of Technology*.—From oscillation and rotation patterns of small crystals of Rochelle salt an orthorhombic unit cell has been found with dimensions $a=11.85$A, $b=14.25$A, $c=6.21$A and space group V^3. The unit cell contains four molecules of $NaKC_4H_4O_6 \cdot 4H_2O$. With the low symmetry of V^3 a structure determination by direct methods is impossible. Unusually large values of dielectric constant have been found between +20°C and −20°C and it was of interest to see whether there was an appreciable change in structure above and below this region. Integrated intensities were measured with a Bragg ionization spectrometer for h00, 0k0 and 00l at −50°C and +25°C. The measurements at −50°C showed only a normal increase such as would be expected from the usual Debye temperature factor.

3. Variational atomic wave functions. Philip M. Morse and L. A. Young, *Massachusetts Institute of Technology.*—Wave functions are chosen for 1*s*, 2*s* and 2*p* states of the form suggested by Slater (Phys. Rev. **42**, 33 (1932)). They are made mutually orthogonal, to simplify calculations. Four parameters are used, giving more possibilities of variation than the forms used by Zener (Phys. Rev. **36**, 51 (1930)). The values of all the integrals occurring in the energy expression are computed for a wide range of these parameters. The energies and wave functions of any atom with less than eleven electrons can be computed by taking the proper linear combination of these integrals and minimizing the resulting function of the four parameters. The procedure is not complicated. The discrepancy between these calculated energies and the observed ones for lithium-like atoms is no greater than the difference between the observed energies of helium-like atoms and the $2(Z-5/16)^2$ value.

4. Application of the mechanical interval recorder to analysis of the spectrum of Os I. Walter Albertson, *Massachusetts Institute of Technology.*—A number of energy levels of Os I have been found with the aid of the mechanical interval recorder (G. R. Harrison, R.S.I. **3**, 753 (1932)). The wave numbers of the 184 strongest lines were punched on a tape by using a scale of 1 mm per wave number. Intervals up to 9400 cm^{-1} were recorded on the machine. A rapid survey of the chart showed several intervals for which a comparatively large number of coincidences appeared. Most of these intervals when linked together were found to give a term array. Comparison with the term array of Os I by C. P. Snyder (unpublished data through courtesy of Dr. W. F. Meggers) shows that all of Snyder's terms except one are included in the new array and that the new array is more extensive. Further application of the machine to analysis of this spectrum is being carried out by the inclusion of weaker lines in the record.

5. Predissociation and the crossing of molecular potential energy curves. O. K. Rice, *Harvard University.*—The calculation of the width and shape of a line which is broadened because of predissociation has been extended so as to include perturbations of intermediate size. By "perturbations of intermediate size" we mean perturbations which are not so great that lines (of given rotational quantum number) belonging to two adjacent vibrational levels are broadened so as to overlap appreciably; they may be any size up to that limit. These calculations have been applied to the case where a potential curve giving molecule formation is intersected by a repulsive curve at a point corresponding to a rather great distance between the two atoms forming a diatomic molecule, the curves which cross being the unperturbed curves. It is found that the discrete lines are not only broadened, but they are distorted in shape and shifted in position. The exact amount of broadening of a line depends very greatly upon its energy relative to the energy at which the potential curves cross, and in general a line which is much broadened will also be much shifted in position. Further, there is present a series of subsidiary maxima of the absorption coefficient. It is found that this theory gives a satisfactory explanation of many of the features of the complex predissociation phenomena (isolated groups of sharp and diffuse lines superimposed on a faint background of blurred bands) observed by Brown and Gibson (Phys. Rev. **40**, 529 (1932)) in the case of iodine chloride.

6. On a molecular spectrum emitted from atomic iodine vapor. O. Oldenberg, *Harvard University.*—Iodine vapor at high temperature shows a paradox in its spectrum (W. Gerlach and F. Gromann, Zeits. f. Physik **18**, 239 (1923)). Although *monatomic* to 99.9 percent, it emits an intense continuous band which in a previous discussion (O. Oldenberg, Zeits. f. Physik **25**, 142 (1924)) was shown to belong to *molecules*. It was concluded that in the discharge through *atomic* iodine *excited molecules* are formed by the collision of two atoms, which must possess a store of energy sufficient for emitting this spectrum. It was suggested that a positive and a negative atomic ion, pulled together by the Coulomb force, meet this requirement. In recent experiments, however, it was found that the intensity of the continuous spectrum decreases strongly with decreasing pressure. The obvious interpretation is that it is emitted from a molecule just formed by a pair of atoms, one of which is excited; the small intensity at low pressure is explained by a lifetime of the excited state shorter than the interval between collisions at low pressure.

7. A new modulator for use in Kennelly-Heaviside layer recording. Harry R. Mimno, P. H. Wang and P. B. King, *Harvard University.*—Satisfactory automatic devices for recording the effective heights of the Kennelly-Heaviside layers have recently been constructed. These devices impose new requirements on the design of the associated transmitting circuits. The simple synchronous grid-blocking circuit, developed for our eclipse expedition, is well adapted for such field measurements, but it should not be used in a permanent laboratory installation. A more elaborate system is now being employed in order to reduce all possible sources of interference with other radio channels. The carrier frequency is determined by a temperature-controlled crystal. A multi-stage radiofrequency amplifier is modulated by a Thyratron pulse generator. The duration of the pulse may be altered at will. When taking 24 hour records, the number of pulses per minute may be greatly reduced, without loss of accurate synchronization. The transmitting station is identified by call letters transmitted at 15 minute intervals.

8. The elastic constants of rocks and their relation to seismic wave speeds. W. A. Zisman, *Harvard University.*—Previous comparisons between the elastic constants of rocks determined statically and those computed by applying the theory of elastic waves to the seismically observed wave speeds had led to serious discrepancies. In attempting to clarify this situation, measurements were made on Young's modulus, E, Poisson's ratio σ, and the compressibility, χ, of rocks taken from quarries in which Leet had measured the speeds of explosion waves. Discrepancies existing in already published values of E and σ were found to be due to neglect of previous experimenters to study the large changes in E and σ with the mean applied stress. Inconsistencies in the compressibility determinations of Adams and Williamson were shown to exist and suggest the presence of a 10 percent error in their methods. Their prediction of a rapid increase in compressibility with decreasing pressure was verified and shown to be caused by the porosity of rocks. It was also discovered that water contained in the rocks had an important influence upon the elastic constants, Leet's values of χ for Quincy Granite and for Norite from Sudbury, Canada agreed with our static measurements to within a few percent. These results are of fundamental importance to geophysicists, for they establish their right to apply the theory of elastic waves to the results of seismologists in order to determine from the wave speeds the values of E, σ, and χ for that locality, and hence make it possible to identify the kind of rock existing there.

9. Ferromagnetism of the iron nickel alloys under hydrostatic pressure. R. L. STEINBERGER, *Harvard University.*—The application of pressure to a well annealed specimen causes a relatively large change in flux density; usually a decrease, and an incomplete recovery on release of pressure. In pure iron, 20 percent and 80 percent nickel the change is negative and linear. Forty, fifty, ninety percent nickel alloys and pure nickel exhibit pressure hysteresis of varying amounts. In the 30 and 60 percent specimens the rate of change of flux decreases with increasing pressure. The change is nearly 100 percent in the case of the 30 percent specimen. That is, the metal is made nonmagnetic by the application of pressure.

10. The effect of tension on the electrical resistance of the single trigonal crystals, bismuth and antimony. MILDRED ALLEN, *Harvard University.*—The compensated potentiometer method of measuring small changes in resistance developed by P. W. Bridgman has been used in the study of the effect of tension, applied parallel to the direction of current flow, on the resistance of the two trigonal single crystals, bismuth and antimony. The adiabatic tension coefficient of resistance at 30°C of both has been found to depend on the orientations of the principal and secondary cleavage planes. For the limiting cases of the principal cleavage plane perpendicular and parallel to the tension, the coefficient is found to be independent of the secondary orientation. The coefficient shows trigonal symmetry, as is to be expected. Professor Bridgman has shown on the basis of symmetry considerations that six constants are sufficient entirely to define the change of resistance of trigonal crystals under deforming forces. These have been found for both bismuth and antimony; the constants for antimony are about ten times smaller than for bismuth. The changes in resistance resulting from the *deformation* due to the tension, have been computed and applied as corrections to the observed changes.

11. The viscosity of mixtures of liquids at high pressures. R. B. DOW, *Harvard University.*—The effect of pressure on the viscosity of organic, binary mixtures has been investigated by methods developed and used by P. W. Bridgman. Six mixtures have been examined over the entire composition range at two temperatures, 30° and 75°C, and at pressures extending to 12,000 kg/cm^2. The isobaric curves on the viscosity-composition graphs for *n*-hexane-*n*-decane and *n*-hexane-carbon disulphide are linear at both temperatures. The corresponding curves for *n*-hexane-chlorobenzene, *n*-hexane-diethyl ether, and uegenol-carbon disulphide are complex. Irregularities in certain regions of composition and sags in the curves appear. The qualitative and quantitative natures of these vary both with change in pressure and temperature. The *n*-pentane-*n*-benzene isobaric curves show unusual sags, with few irregularities, which are functions of temperature. The thermodynamic properties of the mixtures give no explanation of these effects. It is probable that the interlocking between molecules of unlike sizes and shapes is the cause of the great increase in viscosity with increase in pressure.

12. Energy distribution of photoelectrons from zinc surfaces. NORRIS E. BRADBURY, *Massachusetts Institute of Technology.*—The energy distribution of photoelectrons emitted from zinc surfaces by the 2537 line of mercury has been studied for various surface conditions. The classical method of retarding potentials was employed by using a small spherical source with a large collecting sphere. Machined and polished zinc gives a distribution curve of which the most probable energy lies at approximately 0.4 of the maximum energy. The work function determined from this maximum energy is about 3.1 volts in agreement with results of other investigators. If the zinc is heated to 375° with consequent evaporation of the surface, the work function increases to 3.24 volts and the character of the energy distribution curve changes. This change consists of a displacement of the most probable energy to about 0.55 of the maximum and a decrease in the number of electrons emitted with lower velocities. Allowing the surface to stand in contact with nitrogen restored the original broad distribution but did not bring the work function down to the value for the polished surface.

13. Recent advances in nuclear physics. M. A. TUVE, *Bureau of Terrestrial Magnetism, Carnegie Institution of Washington.*

14. High-voltage methods in the investigation of nuclear structure. R. J. VAN DE GRAAFF, *Massachusetts Institute of Technology.*

15. Demonstration of an electrostatic high-voltage generator. E. H. BRAMHALL, *Massachusetts Institute of Technology.*

16. Physics of the sun. D. H. MENZEL, *Harvard Observatory.*