Laue has shown, a change of frequency occurs also in the scattering by elastic waves. According to the "scattering" theory, the intensity maxima correspond to elastic waves of maximum wave-length and minimum frequency. In such a case, therefore, the transition probabilities should be given correctly by the classical dynamics. The intensity maxima should fall off in proportion to the absolute temperature, the more exactly, the nearer the "scattering" maximum is to the Laue spot. Actual observations show, however, that the intensity is practically unaffected by cooling the crystal down to liquid-air temperatures, and this is true irrespective of the setting of the crystal. The observations thus clearly show that the transitions involved correspond to the high frequency infra-red levels and not to the low frequency acoustic ones. They also prove that the modified reflection is a quantum-mechanical effect.

[1] C. V. Raman and P. Nilakantan, Current Science **9**, 165 (1940); Proc. Ind. Acad. Sci. **11**, 379, 389, 398 (1940).
[2] C. V. Raman and N. S. N. Nath, Proc. Ind. Acad. Sci. **12**, 83, 427 (1940); Raman, Proc. Ind. Acad. Sci. **13**, 1 (1941).
[3] W. H. Zachariasen, Phys. Rev. **59**, 207 (1941).
[4] S. Siegel, Phys. Rev. **59**, 371 (1941).
[5] H. A. Jahn and K. Lonsdale, Nature **147**, 88 (1941).
[6] M. v. Laue, Ann. d. Physik **81**, 877 (1926).

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Proceedings of the Ohio Section of the American Physical Society

THE fourth meeting of the Ohio Section of the American Physical Society was held at Muskingum College, New Concord, Ohio, on March 29, 1941. About fifty-five members and guests were present at the luncheon. Fourteen papers were scheduled for presentation, though weather conditions curtailed the programme; abstracts of five are appended.

The fifth meeting of the Ohio Section was held at Cleveland, in the buildings of the Case School of Applied Science and the Western Reserve University, on May 10, 1941; it was a joint meeting with the Ohio Academy of Science. One hundred members and guests were present. Nineteen papers were scheduled for presentation; of these the abstracts of five are appended. It was voted to cooperate with the Ohio Academy in sponsoring the programme of the Junior Academy for the creation of further interest in science in secondary schools, and five members (J. Albright, F. L. Berger, H. J. Kersten, H. P. Knauss, H. H. Roseberry) were chosen to collaborate in the various parts of the state. A symposium on "Light and Lighting" is planned for the meeting intended to be held in Cleveland in October 1941.

Newly elected officers of the Section for the season 1941–42 are the following: Chairman, W. E. Forsythe; Vice Chairman, P. B. Taylor; Secretary-Treasurer, R. H. Howe.

RICHARD H. HOWE, *Secretary*
Denison University, Granville, Ohio

ABSTRACTS OF PAPERS PRESENTED AT THE MUSKINGUM MEETING

1. The Vibrational Spectrum of the Potassium Chloride Crystal Lattice. L. L. FOLDY, *Case School of Applied Science.* (Introduced by R. S. Shankland.)—The methods of Born, v. Kármán, and Blackman for the investigation of the thermal vibrations of crystal lattices are applied in detail to an atomic model representative of a potassium chloride crystal. The potential interaction between ions, assumed of equal mass, is represented as a Coulomb interaction for any ion and its eighty nearest neighbors, a van der Waals attractive interaction varying as the inverse sixth power of the distance between nearest neighbors, and an exponential repulsive interaction also between nearest neighbors. Explicit solutions of the secular equation for the frequencies, which is of the third order, are obtained for waves traveling in certain directions in the crystal. The calculated principal restrahlen frequency was found to be about 10 percent lower than the observed value. The dispersion for short longitudinal waves traveling normal to the 111 planes of the crystal was found to be so great that the frequency increases with wave-length for wave-lengths less than about four and one-half times the distance between nearest neighbors. This extreme behavior was not manifested for transverse waves traveling normal to the 111 planes or for any waves traveling normal to the 110 and 100 planes.

2. The Harmonic Analysis of Geiger Counter Pulses. ROBERT S. SHANKLAND AND RICHARD H. BLYTHE, *Case School of Applied Science.*—The discharge of a Geiger-Müller counter results in a sudden drop in the potential of the wire electrode, followed by a more gradual return of this potential to its normal value. The time variation of potential constitutes a voltage pulse of which the shape and duration depend on both the discharge mechanism in the counter itself and upon the values of the electrical elements that compose the counter circuit. Thus the voltage

pulses observed on a cathode-ray tube may be analyzed to give information about the nature of the counter discharge and the behavior of the circuit. The present method of analysis gives the Fourier integral components making up the pulse in the form of a frequency spectrum of the amplitudes and phases. This is accomplished by charting the pulse to several scales of abscissae and analyzing the resulting curves by means of the Henrici harmonic analyzer according to a method previously described.[1] The pulses analyzed include an idealized pulse and those characteristic of counters used with the Neher-Harper circuit, the Neher-Pickering circuit, and a circuit employing a series resistance.

[1] R. S. Shankland, J. Acous. Soc. Am. **12**, 383–386 (1941).

3. Heat Transfer Across Horizontal Air Spaces. LOUIS B. YOUNG, *Marietta College.*—Heat transfer across horizontal air spaces is encountered in problems involving the calculation of heat transmission through floors and ceilings. Much of the transfer results from radiation exchange between the boundary surfaces; the remainder is due to convection. Convection in the case of upward heat flow, as in winter, is much greater than in the case of downward heat flow, as in summer. In both cases the actual transfer exceeds the possibility of ideal conduction as a transfer mechanism. Test apparatus was a two-foot guarded hot plate. Heat flow was calculated from the temperature gradient through a cork slab of known conductivity which was placed "in series" with the air space. The data enable computation of heat transmission through various floor and ceiling constructions incorporating different methods of insulation. The transfer is the sum of convection, following the five-fourths power law, and radiation exchange, following a modified Stefan's law.

4. Some Observations on an A.C. Resonant Pendulum. DAVID K. WEIMER.—A condenser and an air core inductance in series are tuned to resonance at 60 cycles. A pendulum bob of iron suspended so as to swing into the coil is thereby kept moving at its own frequency. Measurements were made on the current and voltage as the bob swung in and out of the coil in an effort to determine the nature of the driving force acting on the pendulum. It was found that the current is greater as the bob entered the coil than it is in the corresponding position as the bob leaves the coil for the greater part of the cycle of the pendulum.

5. Motion of the Walls of a Cornet. HAROLD P. KNAUSS, *Ohio State University.*—Vibrations of the metal walls of a cornet were studied by using a crystal pick-up in contact with the metal. The cathode-ray oscillograph showed wave forms which are complex for the lower tones of the cornet and sinusoidal for the higher tones. By substituting for the sweep voltage the output of a microphone responding to air-borne vibrations, a kind of Lissajous figure was obtained, which was quite irregular for the lower tones and elliptical for the higher tones. For a range of about half an octave it was shaped like a figure 8, indicating that in this range the metal vibrates at half the frequency of the air column.

ABSTRACTS OF PAPERS PRESENTED AT THE CLEVELAND MEETING

1. Observation of "Forbidden" Bands in the Infra-Red. C. H. TINDAL, *Ohio State University.*—According to the simple theory of tetrahedrally symmetric molecules there are four different normal frequencies designated as ν_1, ν_2, ν_3, and ν_4. The first two of these are optically inactive and are non-degenerate and twofold degenerate, respectively. The latter two are optically active, are threefold degenerate, and should appear as bands with sharp lines forming P, Q, and R branches. While this is essentially true for ν_3 it is not so for ν_4. The complex structure in ν_4 has been explained by Jahn[1] as due to a resonance Coriolis interaction between ν_4 and inactive ν_2, which are only about 100 cm^{-1} apart. Because of this interaction, the wave functions for ν_2 and ν_4 become sufficiently "mixed" so that ν_2 becomes active in the infra-red. The region from 9μ to 13μ has been resolved for SiH_4 and GeH_4 so that rotational lines are clearly distinguishable in two overlapping bands. The two bands are identified as ν_2 and ν_4, the Q branches folding in opposite directions as predicted by the theory of Jahn. The weaker band is identified as ν_2 and the other as ν_4. This identification is further verified since the rotational line spacing satisfies the relation presented by Teller:[2]

$$\Delta\nu_3+\Delta\nu_4=1\tfrac{1}{2}\Delta\nu_2.$$

[1] H. A. Jahn, Proc. Roy. Soc. **A168**, 469, 495 (1938).
[2] E. Teller, *Hand- und Jahrbuch der Chemischen Physik*, Vol. 9, No. 2, p. 152.

2. Absorption Bands of GeH_4 and SiH_4 in the Near Infra-Red. JOSEPH W. STRALEY, *Ohio State University.*—The fundamental vibration-rotation bands J_2, J_3, and J_4 of GeH_4 and SiH_4 have been carefully measured and the moments of inertia and the X–Y distances calculated. Measurements of combination bands J_1+J_4 and J_3+J_4 in SiH_4 have also been made. The discrepancy in the appearance of the satellite structure in GeH_4 reported by Steward and Nielsen[1] with that reported by Lee and Sutherland[2] can now be attributed to difference in the absorbing layers of gas used by these observers. The recent measurements indicate the intensity of the satellites is not more than 10 percent of that of the principal rotation lines. The moments of inertia in g-cm^2 in the various states are as follows—

	I_0	I_2	I_3	I_4
SiH_4	0.986×10^{-39}	0.974×10^{-39}	0.993×10^{-39}	0.993×10^{-39}
GeH_4	1.030	1.021	1.032	1.039

[1] W. B. Steward and H. H. Nielsen, Phys. Rev. **48**, 861 (1935).
[2] E. Lee and G. B. B. M. Sutherland, Proc. Camb. Phil. Soc. **35**, 341 (1939).

3. Studies of Metallic Friction. R. I. STROUGH AND W. E. RUPP, *Case School of Applied Science.*—For the purpose of studying metallic friction under varying conditions of speed and normal load, a rotary testing apparatus was constructed. In this apparatus a flat disk-shaped sample of one material to be tested was mounted on a faceplate and

rotated in contact with three small pads of the other material. These pads were held in place by another stationary faceplate arranged so that the torque acting on it through friction between the samples could be measured. From this the coefficient of friction was computed. Friction phenomena of copper sliding dry on steel were studied with the above apparatus. Both kinetic and static coefficients of friction were observed to be higher for ground (crystalline) surfaces than for polished (non-crystalline) surfaces. Friction was observed to increase uniformly with the number of rotations of the disk for both types of surfaces until a critical point was reached where galling occurred and the coefficient of friction rose rapidly to a high value. Polished surfaces withstood about three times as many rotations as ground surfaces under similar conditions before galling occurred. The coefficient of friction was observed to be independent of sliding speed from speeds of 20 cm per second to the limit of the apparatus (200 cm per second) throughout the experiments.

4. Charge and Mass of Electronic Particles. ALFRED LANDÉ, *Ohio State University.*—The problem of explaining the empirical formula $e^2=c\hbar/137$ is attacked from various angles that gradually seem to yield a reasonable picture of how the electronic charge is determined by quantum theory and relativity. From the *classical* point of view an electron can be characterized (1) by its rest energy E_0 proportional to its mass m, (2) by its "radius," or, better, by a characteristic time period t_0 inversely proportional to the mass. The customary radiation theory yields the wrong result that the energy is infinitely large and the radius is infinitely small. In order to get finite results a change of the theory is indispensable. We have suggested a formal change of the energy expression, analogous to the energy reduction due to radiative damping of a vibrating electron. The resulting finite energy E_0 is connected with a finite "damping radius" r_0 and with a finite time period $t_0=3mc^3/4\pi e^2$ characteristic for the damping. From the *quantum* point of view the product E_0t_0 can have only certain selected values that are obtained by a quantization in the energy-momentum space of Einstein's equation $E^2-(pc)^2=E_0^2$, and in a corresponding space $t^2-(r/c)^2=t_0^2$. The smallest eigenvalue of E_0t_0 turns out to be $\approx h/210$. This together with $E_0=mc^2$ and with the value of t_0 yields $e^2\approx\hbar c/140$. A correction is necessary because t_0 was calculated for infinitely weak fields as against the actually finite self-field.

5. Determination of Mercury Arc Temperatures by X-Rays. CARL KENTY AND W. J. KARASH, *General Electric Co. and Case School of Applied Science.*—Molybdenum radiation at 32,000 volts, filtered through zirconium dioxide was used. Data for a graph of transmission *vs.* moles of Hg per sq. cm in the path of the beam were obtained by measuring transmissions of tubes with known amounts of Hg vapor. Direct-current temperature data were obtained for a hollow electrode, quartz lamp of 20-mm diameter and 29.0-cm arc length. Hg pressures, appendix controlled, were measured with a quartz pressure gauge.[1] Axial transmissions were measured. End corrections were determined by thermocouple measurements of wall temperatures, and pyrometer measurements of electrode temperatures. Axial temperatures were calculated from the perfect gas law. For a constant pressure of 1.0 atmosphere, the axial temperature varied approximately as the 20th root of the input, from 5950 deg. K at 30.7 watts per cm to 6100 deg. K at 58.5 watts per cm. For a constant input of 30.7 watts per cm, the axial temperature increased from 5950 deg. K at 0.22 atmosphere to 6450 deg. K at 0.40 atmosphere and then decreased to 5950 deg. K at 1.0 atmosphere. The probable error of the temperatures is estimated as 150 deg. K.

Carl Kenty, Rev. Sci. Inst. 11, 377 (1940).