PROCEEDINGS

OF THE

AMERICAN PHYSICAL SOCIETY

MINUTES OF THE KANSAS CITY MEETING,

DECEMBER 28, 29, AND 30, 1925

The twenty-seventh annual meeting (136th regular meeting) of the American Physical Society was held at Junior College, Kansas City, Missouri, on Monday, Tuesday and Wednesday, December 28, 29, and 30. The presiding officers were Professor Dayton C. Miller, President of the Society, and Professor K. T. Compton, Vice-President. The attendance was about one hundred and fifty.

On Tuesday afternoon at four o'clock, Professor Dayton C. Miller delivered the presidential address on "The Michelson-Morley Ether-drift Experiment—Its History and Significance," in the Assembly Room of the Junior College. This address was a general session of the A.A.A.S.

The annual joint session with Section B was held on Wednesday morning, with Professor H. M. Randall, Chairman of Section B, presiding. The retiring Vice-President, Professor K. T. Compton, opened the joint meeting with an address entitled "Dielectric Constants and Molecular Structure." This was followed by a symposium on "Relativity," consisting of three addresses as follows: "The Effect of the Earth's Rotation on the Velocity of Light," by H. G. Gale, University of Chicago; "Astronomical Evidence for Gravitational Displacement of Spectrum Lines," by Charles E. St. John, Mt. Wilson Observatory; "Experimental Science and World Geometry," by A. C. Lunn, University of Chicago. In the absence of Professor Gale, owing to illness, his paper was read by Dr. W. W. Watson.

On Tuesday evening, December 29, 1925, there was a dinner for the members of the Society and of Section B and their friends at the Hotel Baltimore, attended by ninety-eight persons.

Annual Business Meeting.—The regular annual business meeting of the American Physical Society was held on Tuesday morning, December

29, 1925, at eleven o'clock. A canvass of the ballots for officers resulted in the elections for the year 1926 as follows:

For President;	Dayton C. Miller
For Vice-President;	K. T. Compton
For Secretary;	Harold W. Webb
For Treasurer;	George B. Pegram
For Members of the Council, Four-year term;	A. H. Compton E. P. Lewis
For Managing Editor of the Physical Review, Three-year term;	John T. Tate
For Members of the Board of Editors of the Physical Review, Three-year term;	J. A. Gray G. E. M. Jauncey J. H. Van Vleck

The Secretary reported that during the year there had been 171 elections to membership, and that the resignations of 54 had been received. The deaths of 5 members were reported during the year. The total membership was 523 Fellows, and 1237 Members, making a total of 1760.

The Treasurer presented his financial report for the year 1925. The Managing Editor of the Physical Review presented the financial report for the year 1925, together with a report showing the progress of the Review during the years 1923, 1924 and 1925.

On motion of Professor R. A. Millikan, the following resolution was unanimously passed:

"*Resolved* that the Physical Society express its appreciation to the retiring Editor of the Physical Review for the following specific reasons:

1. He has introduced an abstracting system which had proved a distinct contribution to bibliographic method and has made the Physical Review in this respect a model already followed by many journals.

2. He has greatly improved the quality of the papers appearing in the Review, by an immense amount of detailed editorial work, and by insisting that contributors present their results with brevity and elegance.

3. He has given a demonstration of value to other sciences in that a journal, which a few years ago seemed unable to run without a subsidy, has been made to do so by attention to brevity and other elements of quality. By these services Dr. Fulcher has made an outstanding contribution to scientific progress."

Meeting of the Council.—At the Meeting of the Council held on December 28, 1925, three persons were elected to Fellowship, one was transferred from Membership to Fellowship, and twenty-six were elected to

Membership. *Elected to Fellowship:* William Bowie, Otto Laporte, H. Nagaoka. *Transferred from Membership to Fellowship:* Kanji Honda. *Elected to Membership:* Penrose S. Albright, Edward V. Appleton, Z. T. Chang, James L. Dunham, H. F. Fruth, R. J. Havighurst, Leland D. Hemenway, Victor Henri, Edward L. Hill, H. J. C. Ireton, Z. N. Loh, Daniel P. Mahoney, Roy H. Mortimer, Suminosuke Ono, Robert H. Oster, Neil B. Reynolds, Carl S. Roys, Richard Rudy, Matthew H. Schrenk, Surain Singh, Hildegarde Strücklen, Clyde H. Tarney, Henry W. Taylor, Tillman G. Titus, Louis J. Waldbauer, Robert G. Wulff.

The regular program of the American Physical Society consisted of 53 papers, Numbers 11, 14, 16, 19, 23, 25, 26, 37, 38, 41, 44, 47, 51 and 52 being read by title. The abstracts of these papers are given in the following pages. An **Author Index** will be found at the end.

HAROLD W. WEBB,
Secretary.

ABSTRACTS OF PAPERS

1. A correspondence theorem for the Compton effect. G. BREIT, Carnegie Institution of Washington.—As has been discovered by Bohr, the frequency emitted by a hydrogen atom as it falls from one of its quantized states to another may be expressed as a properly taken average of the frequency of the electron in its orbit (or of an overtone of that frequency) between the initial and the final state. In the present paper it is shown that the same is true for the Compton effect. The frequency actually scattered is a properly taken average of the frequency which would be scattered on the classical theory as the electron is accelerated from its state of rest to its final recoil condition. Similarly, the intensity scattered in various directions may be represented as a proper average of the intensities scattered on the classical theory. This point of view eliminates the difficulty of a constant correction-factor which has been encountered by Compton and Woo in their explanation of intensity relations.

2. Experimental values on the ratio of the modified to the total scattering of x-rays. O. K. DE FOE, Washington University.—Using the null method described at the Chicago meeting of the Physical Society for measuring the ratio of the modified scattering coefficient s_2, to the total scattering coefficient (s_1+s_2), a determination has been made for copper and carbon. The wave-lengths used ranged from .2A to .7A while the scattering angle was varied from 60° to 120°. The experimental values of $s_2/(s_1+s_2)$ appear to be always less than the values of this ratio as calculated from Jauncey's theory (Phys. Rev., **25**, 314 and 723, 1925), thus agreeing with the result reported by Woo at the Chicago meeting. Further experiments are in progress for the scattering from other substances. It may further be remarked that the rate of decrease of the experimental values of the ratio of $s_2/(s_1+s_2)$ is greater than the rate of change in the theoretical ratio. A possible interpretation of this is that the probability of scattering by an electron depends upon whether or not the difference in energy between the primary and scattered quanta is sufficient to eject the electron from the atom.

3. An experimental test of the Raman and Ramanathan theory of the diffraction of x-rays by liquids. E. H. COLLINS, University of Iowa.—The liquids, ether, water and glycerine were inclosed in small, thin walled glass cylinders at the center of the x-ray spectrometer and the diffraction curve—intensity of diffracted x-rays plotted against angle from incident beam—was determined by means of an ionization chamber and electrometer and compared with theoretical curves plotted from a formula given by Raman and Ramanathan. Raman and Ramanathan suggest that ether, because of its high compressibility, should give a broad peak in the diffraction curve. The experimental curve is found to have a broad peak. However, the theoretical curve plotted from their formula is found to be sharp due to the fact that the mean molecular distance is found experimentally to be large. The curves for water and glycerine show closer agreement but there is no evidence of the uniqueness of the theory.

4. Photometric measurement of x-ray plates showing the L absorption of tungsten. C. B. Crofutt, University of Arkansas.—In previous work (Phys. Rev. **24,** 9, 1924) both the absorption and emission spectra of tungsten were photographed simultaneously on the same plate. It has since seemed advisable to make a photometric analysis of the plates showing the absorption bands. The present paper contains an account of this work and includes the photometric curves obtained in the region of the three L absorption bands. The results are in agreement with the previous results. This work was done at the University of Iowa.

5. The intensity of reflection of x-rays by powdered sodium chloride. R. J. Havighurst, National Research Fellow, Harvard University.—The relative intensities of reflection of the Mo $K\alpha$ doublet from most of the planes between (111) and (8,6,2-10, 2,0) of powdered NaCl have been measured with an ionization spectrometer, using the focusing method of W. H. Bragg, Brentano, Owen and Preston. The powder was pressed into the form of a thin briquet, and adjusted on the crystal table so that the relation $a/b = \sin \alpha / \sin \beta$ was always satisfied, where a and b are the distances from center of crystal table to focal spot and ionization chamber slit respectively; α is the angle between the primary beam and the surface of the briquet and $\beta = 2\theta - \alpha$, where 2θ is the total deviation. The NaCl particles had an average diameter of 8×10^{-5} cm, so small that the effect of extinction (Darwin, Phil. Mag. **43,** 800, 1922) is negligible. The experimental values of the relative intensities were substituted in the equation given by Darwin and A. H. Compton for intensity of reflection and values of $f^2 e^{-b \sin^2\theta/\lambda^2}$ as a function of the distance between planes and of the electron distribution in the atoms, obtained for different values of θ. These values are in fair agreement with those of W. L. Bragg, James and Bosanquet (Phil. Mag. **42,** 1, 1921) obtained from single crystals of rock-salt, after the application to the latter of a correction for secondary extinction.

6. Secondary electrons from iron; critical potentials. H. E. Farnsworth, University of Maine.—The magnitude of the secondary electron current from Fe was measured as a function of the primary accelerating potential, 0 to 300 volts. Limiting curves were obtained for two different specimens of Fe after red-heat treatment and for a film of Fe deposited by evaporation. Three different forms of apparatus were used. In all cases the curves show sharp maxima at 1.2 and 7.0 volts with minima at 3.7 and 9.0 volts, and a less sharp maxima and minima at 10.0 and 12.0 volts, respectively. A steady upward trend of the curve begins at 12.0 volts, which is interpreted as an ionization potential. Potentials corresponding to the position of the maxima are interpreted as resonance potentials. Attempts to locate higher critical potentials than the above showed that the positions of slight changes in slope of the curve varied with uncontrollable conditions and with form of apparatus used. These slight changes are taken to have no real significance. Disagreement between these results and those of other observers is mentioned. While previous results for Cu indicate that a layer deposited by evaporation is amorphous, the present results indicate that a similarly formed layer of Fe is crystalline. These experiments were performed at University of Wisconsin last summer.

7. Voltage-intensity relations of mercury lines below ionization. D. R. White and Harold W. Webb, Columbia University.—Using a special four-electrode tube (hot cathode and three grids) voltage-intensity curves have been obtained in mercury vapor for about twenty lines in the wave-length interval 2500-5800A. The voltage-intensity relationship for each line appears to be primarily a function of the outer energy level involved. This is very clearly shown by two pairs of lines 4358 ($2p_2-1s$), 5461 ($2p_1-1s$) and 2893 ($2p_2-2s$), 3341 ($2p_1-2s$), each pair of which gave voltage-intensity curves practically identical in form. The groups of lines starting at the $3D$, $3d$ and $4D$, $4d$ levels show similarities, though not as marked. Abrupt changes of slope are to be observed in the curves which seemingly correspond to certain critical potentials. The voltages at which the lines first appear agree with theory, as in previous work by Eldridge and by Hertz.

8. Fine structure of the Balmer lines. William V. Houston, National Research Fellow, California Institute of Technology.—A Fabry-Perot interferometer can be used to measure these doublets without the usual errors due to overlapping of the components, if the plate separation is so adjusted that the weaker component comes in the middle of the space between adjacent orders of the stronger component. In this way Hα is found to have a wave-number separation of about .31, while Hβ has a separation of about .33. The resolution is such that the difference between these two can be seen by a casual examination of the plates. This is explicable on the theory of Sommerfeld, if it is assumed that the field within the tube is sufficient to suspend the principle of choice and to cause the appearance of those lines corresponding to a change of zero in the azimuthal quantum number. If this is true, the short wave-length component of Hα should be a doublet with a separation of about .05A. While this has not yet been resolved, the line on many plates looks like a close doublet, and further examination will be made with a microphotometer.

9. Duration of radiation excited in hydrogen by 10.2-volt electron impacts. F. G. Slack and Harold W. Webb.—Using the method already described (Phys. Rev. **24,** 113, 1924) in which high frequency voltages are applied in phase to the grids of the excitation and photo-electric systems of a four-electrode tube, the life of the $2P$ state in hydrogen, excited by 10.2-volt electron impacts was measured. Excitation was produced only in the positive half-cycle and the peak voltage was too low to permit other than the 10.2 radiation. It is improbable that absorption and re-radiation played any part due to the limited amount of dissociated hydrogen. The experimental curve agrees well with that calculated on the assumption that starting at the instant of impact the radiation falls off exponentially. The exponential constant found was $.83\times10^8$ sec.$^{-1}$ Unless the form of these curves is the result of a lag in the photo-electric effect, as seems improbable, the average time τ for an atom lifted to the $2P$ state by electron impact to return to its normal state by the process of emitting $\lambda1215.6$ is 1.2×10^{-8} seconds. If the photo-electric lag is effective this is the maximum value of τ. The same results were found for tubes of different dimensions and for pressures from .075 mm to .25 mm.

10. The time interval between the appearance of certain spectrum lines in the visible region. J. W. Beams, National Research Fellow, University of Virginia.—The experimental method consisted essentially in a comparison of the time interval elapsing between the appearance of two spectrum lines with the time required for light to travel a measured distance. The spectra of cadmium, zinc and magnesium in the spark in air and the spectrum of hydrogen in condensed discharges at various pressures were studied. The time intervals measured are as follows: In the spectrum of cadmium from the spark doublet 5378,38 to the line 4800 the time interval was 12×10^{-8} sec.; from 4800 to 5086, 1.3×10^{-8} sec.; and from 5086 to 4678, 0.7×10^{-8} sec. In the spectrum of zinc from the spark doublet 4924, 12 to the line 4680 it was 15×10^{-8} sec.; from 4680 to 4722, 2×10^{-8} sec.; and from 4722 to 4811, 1.3×10^{-8} sec. In the spectrum of magnesium, from the spark doublet 4481 to the triplet 5184, 73, 67 it was 8.2×10^{-8} sec. From 4481 of Mg to 5378, 37 of Cd it was 7.5×10^{-8} sec., and from 5378, 37 of Cd to 4924, 12 of Zn, 9.6×10^{-8} sec. In the spectrum of hydrogen, Hβ appeared first, Hγ second and Hα third.

11. The time interval between excitation and emission for fluorescein. L. G. HOXTON and J. W. BEAMS, National Research Fellow, University of Virginia.—Solutions of fluorescein at concentrations of 2.5×10^{-5} gm per cc were investigated. The exciting light was limited to the spark lines 4481 of magnesium. It was found that the time elapsing between the beginning of incidence and the beginning of fluorescent emission was $(3.2\pm0.3)\times10^{-8}$ sec. for the aqueous solution and $(3.7\pm0.4)\times10^{-8}$ sec. for the alcoholic solution. In the experimental method about half of the beam of exciting light was intercepted by the solution, the other half passing on and returning, after reflections, by a path whose length could be varied, to a point close enough to the point of division to be seen in the same field as the fluorescent light through an optical system (a modification of the arrangement of Abraham and Lemoine) which was, in effect, a shutter electrically operated by the spark discharge. Its time of closing was advanced until the fluorescent light just disappeared from view; then the light path was lengthened until the returning light did likewise. The time interval sought was thus made equal to that required for light to travel a measured distance.

12. Band series in infra-red absorption spectra of organic compounds. JOSEPH W. ELLIS, University of California, Southern Branch.—A series of outstanding absorption bands below 3μ, already attributed to a carbon-hydrogen bond, is shown to fit accurately the non-linear equation, $\nu_n\times10^{-12}=47.37n-0.783n^2$, (1), where ν_n is the frequency and $n=3, 4, 5$, etc. Numerous secondary absorption maxima in the spectra of both the open chain and closed ring types of compounds, containing only carbon and hydrogen atoms, fit the linear equation, $\nu_m'\times10^{-12}=10.71m$, (2), where $m=10, 11, 12$, etc. They are attributed to a carbon-carbon linkage. All other short wave-length bands can be accounted for by simple additive combinations of low frequency members of series (1) and (2), $\nu_c=\nu_n+\nu_m'$. Other members of these three series are identified in longer wave-length spectra obtained by Coblentz and other investigators.

13. The quantum analysis of the rotational energy of certain molecules. RAYMOND T. BIRGE, University of California.—The formulas recently derived for the constants of the molecular law of force enable one to calculate, from data on a set of *vibrational* states, the higher order terms of the *rotational* energy function. This must be assumed an even-powered function of the nuclear momentum m. The rotational energy data may thus be reduced to a theoretically linear equation whose two constants give the most probable values of the moment of inertia I_0 and electronic momentum ϵ. This method was suggested to the writer by E. C. Kemble. The results in the case of CuH give evidence in favor of half-integers for the *resultant* momentum of the molecule, and for the initial excited state alone, require a small value of ϵ (0.0059), which *increases* with m. The variation in ϵ is due presumably to the warping of the electron orbits, caused by the nuclear rotation. This new method uses all of the data, in determining I_0 and ϵ, and to this fact is due its great accuracy. Separate papers give the results in the case of the Swan bands and the AlO bands. In *all* cases the resultant electronic momentum and nuclear momentum are parallel and in the same sense.

14. Molecular constants determined from the Swan bands. J. D. SHEA and R. T. BIRGE, University of California.—Using the method recently developed for obtaining accurate values of the moment of inertia I_0 and electronic momentum ϵ of certain types of molecules, the following results have been obtained for the rotational energy F (in wave-numbers) of the non-vibrating molecule. For the initial state $F=1.7541m^2-6.911\times10^{-6}m^4+1.22\times10^{-11}m^6$, where $m=k-\epsilon=k-(0.0989+1.746\times10^{-5}k^2)$. k is a half-integer and represents the *resultant* molecular momentum. Hence $I_0=15.792\times10^{-40}$.

For the final state $F=1.6295m^2-6.594\times10^{-6}m^4+1.73\times10^{-11}m^6$, where $m=k-(0.0741+0.964\times10^{-5}k^2)$. Hence $I_0=17.000\times10^{-40}$. These constants have been obtained from the middle component of the triplets of the Swan bands. The values of I_0 and ϵ are surprisingly similar to those for the second positive group of nitrogen (known to be due to N_2) and since the HC·CH molecule has the same number of electrons and nearly the same mass as N_2, this *may* be the emitter of the Swan bands, if such a molecule can vibrate and rotate like a dipole. The above values of I_0 should be accurate to 0.10 percent, and replace the previous approximate values (Phys. Rev. **25**, 716, 1925).

15. The combination relation in the λ3064 OH band. WILLIAM W. WATSON, University of Chicago.—The P,Q,R combination which holds for any normal band is not satisfied in the MgH and OH bands, the defect being as great as 34 cm^{-1} at $m=22$ in the 3064 OH band. New measurements have been made on this band, and satellites of the Q lines have been located which, when combined with the main P and R lines, give the required combination. As predicted by Dieke, these satellites are found to be farther from the main lines than those reported by Fortrat. The possible rotational energy levels are considered.

16. Spectroscopic investigation of acetylene, methane and ethylene. FRANK C. MCDONALD, University of Chicago, (introduced by Harvey B. Lemon).—Although an attempt to obtain emission spectra from acetylene, methane and ethylene (in tubes of the Wood type, in tubes using an oxy-cathode, and in mixtures with helium subjected to a wide variety of pressures and methods of excitation) have failed to reveal any bands definitely ascribed to these complete molecules, a new band spectrum has been observed when methane, in a Wood tube, at a pressure of about 2 mm, is excited by a violent disruptive discharge. This spectrum consists of three bands degraded to the red, with heads at 2263, 2367, and 2395A. Their location where the dispersion of the quartz spectrograph is large and their open character make possible a study of their fine structure, which is now in progress and which it is hoped will reveal their relation to other hydrocarbon spectra. Methane and ethylene in tubes 150 cm long with quartz ends, at pressures up to 90 cm show no absorption, while the absorption of acetylene begins at shorter wave-lengths than that reported by Henri.

17. "True half breadth" of absorption lines. THOMAS M. DAHM, University of Idaho.—True half breadth is discussed by Harrison and Slater. (Phys. Rev. **26**, 176, 1925, and **25**, 783, 1925.) While the shape of the T (transmittancy) curve varies with x, the shape of the $\log_e\log_e(1/T)$ curve is independent of x. For infinitesimal x, $\log_e\log_e(1/T)=\log_e(1-T)=\log_e$ (absorption). Hence "true half breadth" may be obtained by measuring the length of horizontal line drawn at distance $\log_e 2$ below crest of $\log_e\log_e(1/T)$ curve, provided there is no general absorption. If k_0, k_1 and k_2 are absorption coefficients at λ_0, λ_1 and λ_2, where $\lambda_2-\lambda_0=2(\lambda_1-\lambda_0)$, $k_0(4k_2-k_1)-3k_1k_2=0$, with no general absorption, assuming Slater's Eq. (9). $K_0(4K_2-K_1)-3K_1K_2=\Delta$, if there is constant general absorption. Reducing each experimentally determined K by amount $K^1=\Delta/(3K_0-4K_1+K_2)$ corrects for general absorption. A new curve of $\log_e\log_e(1/T)$, or of $\log_e k$ which has the same shape, may be plotted and the "half breadth" found graphically, as above. k^1 need not be found by trial as in Slater's method, and C_1C_2 is determined directly from the curve. If general absorption is variable, of amount k^1, k^1+a, k^1+2a, at λ_0, λ_1, λ_2, $k^1=\Delta-a(7K_0-6K_1-3K_2+6a)/(3K_0-4K_1+K_2+2a)$, a being determined by trial, provided it is small enough not to displace λ_0 too much.

18. The absorption spectra of the vapors of aluminum, gallium, indium and thallium in the ultra-violet. JOHN G. FRAYNE, Antioch College, and ALPHEUS W. SMITH, Ohio State University.—(1) *Absorption in heated vapors.* The metals were vaporized in a graphite tube 15 cm long heated with an oxy-acetylene torch to 2000°C. A tungsten under-water spark provided a continuous spectrum. *Aluminum.* At about 1200°C the first seven pairs of the first subordinate series were absorbed. The relative intensities disagree with the Bohr theory. No absorption was observed for the second subordinate series. *Gallium.* At a temperature of about 1500°C, 17 prominent lines appeared, including the first four pairs of the first and second subordinate series and the 5th term of the $2p_1-ms$ series. *Indium.* At about 1200°C 18 lines appeared, including the first three pairs of the first subordinate series, the first 5 pairs of the second subordinate series and the 4th term of the $2p_1-md$ series. *Thallium.* At 400°C 4 lines of the $2p_2-ms$ and 4 of the $2p_2-md$ series appeared, widening into bands with increasing temperature. At 800°C lines from the $2p_1$ level appeared as fine absorption lines. (2) *Absorption in the arc.* A bead of the metal was placed in the crater. *Aluminum.* In a 15 amp. arc the lines of the $2p_2-md$ and $2p_1-md$ series, $m=5$ to 11 were completely absorbed. *Indium.* The lines $2p_2-2s$, $2p_2-3d$, $2p_1-2s$ and $2p_1-3d$ were completely absorbed.

19. Interference in a spectrometer with white light and wide slit. H. M. Reese and L. E. Pinney, University of Missouri.—The ring-pattern from a Fabry-Perot interferometer is focussed upon the slit of a non-astigmatic concave grating spectrometer. With illumination in white light, a series of curved interference fringes is found, as expected, in the focal surface of the spectrometer. It was observed, however, that although the fringes disappear when the slit is widened a little, they reappear if the widening is continued. For slit-widths ranging from zero to 1.5 or 2 mm, 9 or 10 disappearances and reappearances of the fringes can be observed in the green region, and more at shorter wave-lengths. A theory of the phenomenon, involving some approximations, is presented and shown to be in quantitative agreement with the observations.

20. Optical constants of single crystal bismuth. L. H. Rowse, University of Iowa, (introduced by E. P. T. Tyndall).—The index of refraction and extinction modulus for light traveling parallel to the optic axis were determined by measuring the ellipticity produced by reflection from the cleavage surface of single crystal bismuth. A Stokes analyser was used and readings were taken in the visible spectrum only. The index of refraction rises from 1.05 at 470 $m\mu$ to 1.55 at 670 $m\mu$, while the extinction modulus rises from 2.7 at 470 $m\mu$ to 3.6 at 670 $m\mu$. The computed reflectivity lies between 65 and 70 percent. The results are compared with those of other observers made on polished surfaces.

21. Optical constants of molybdenite in the ultra-violet. Alfred W. Meyer, University of Iowa, (introduced by E. P. T. Tyndall).—The index of refraction and extinction index for light transmitted parallel to the optic axis in crystals of molybdenite were determined by measurements of the ellipticity produced by reflection at a cleavage surface. Minor's method was used. The index of refraction rises to a maximum of 7.8 at 480 $m\mu$ and falls to 2.7 at 330 $m\mu$. The extinction index rises steadily from 0.35 at 500 $m\mu$ to 1.0 at 360 $m\mu$ and remains constant to 330 $m\mu$. The reflectivity is computed and compared with results of other observers.

22. Luminescence of Grignard compounds in magnetic and electric fields. R. T. Dufford, Dorothy Nightingale, and L. W. Gaddum, University of Missouri.—The writers in co-operation with several other workers, have investigated the effects of electric and magnetic fields on the luminescence of organo-magnesium halides in ether solutions. In magnetic fields of the order of 15,000 gauss, the luminescence due to oxidation in air or oxygen is found to be notably brighter in the more intense part of the field. Polarization of the light appears to be nearly if not completely absent. It is impossible to apply large electric fields, on account of the abnormally large conductivity of such solutions. With voltages up to 1500, it is found that the compounds that give luminescence on oxidation with O_2 give light at the anode, but the brightness is not in the same order as with O_2. Polarization appears to be absent here also.

23. On the spectroscopic examination of the striated discharge in mixed gases. David A. Keys and M. Home, McGill University.—Continuation of the work on the striated discharge in hydrogen (Trans. Roy. Soc. Canada, **19**, 143, 1925) using the same apparatus but mixtures of (1) hydrogen with helium and (2) hydrogen with nitrogen gave the following results. In the mixture of helium and hydrogen, the Hα line is hardly visible in the negative glow but strong in the striation. The Hβ line, however, is easily visible in the negative glow, i.e., its intensity is stronger than Hα, but in the striation it is weaker than Hα. With a mixture of nitrogen and hydrogen, the Hα and Hβ lines are strong in the negative glow but not detectable in the striation. This is the reverse of what was found in helium and hydrogen. When only hydrogen is used, the Hα and Hβ lines are stronger in the negative glow than in a striation.

24. Resonance potentials in gallium and indium vapors. C. W. Jarvis, Ohio Wesleyan University, (introduced by Alpheus W. Smith).—The critical potentials of gallium and indium were investigated by the methods of inelastic impact. The tube containing the vapors was the differential type used by Hertz but so arranged that by making the proper electrical connections it could be used as a simple three-electrode tube. The three following methods were employed to detect direct ionization: (1) the change of the negative space charge, (2) the Lenard method, (3) the modification of the gap resistance. The results obtained for gallium are: (1) 3.06 ± .05 volts. This resonance potential corresponds to λ4033 A and the transition $2p_2-2s$. (2) 4.22 ± .05 volts which corresponds to λ2874 A and the transition $2p_2-3d_2$. In gallium there was evidence of weak ionization at about 6 volts and a stronger second ionization at about 13 volts. Two resonance potentials were also observed for indium. They are as follows: (1) 3.03 ± .05 volts corresponding to λ4102 A and the transition $2p_2-2s$. (2) 4.07 ±05 volts corresponding to λ3039 A and the transition $2\ p_2-3d_2$. In indium as in the case of gallium there was evidence of weak ionization at about 6 volts and a stronger second ionization at about 14 volts. The failure to get satisfactory ionization for these metals at the voltage corresponding to the first ionization potential is attributed to the small vapor pressure at the temperature used in these experiments, namely 500° to 600° C.

25. Low voltage arcs in iodine. H. F. Fruth and O. S. Duffendack, University of Michigan.—Low voltage arcs in monatomic and molecular iodine were investigated together with their spectra. From a study of the current-voltage characteristics it was concluded that 6.5 volts is the minimum radiating potential of the atom, 8.0 the ionizing potential of the atom, and 9.5 the ionizing potential of the molecule. Non-oscillating abnormal low voltage arcs were maintained down to 4.9 volts and oscillations were observed around 12 volts. With arc currents of about 2 amperes the filament current could be cut off and the arc sustained indefinitely at 30 volts or above. The spectrum of the 4.9 volt arc contained only 3 lines, ($\lambda\lambda$2062, 2535, 3135) the continuous band 3460, and several groups of bands. At slightly higher voltages arc lines appear and at 8 volts the strongest spark lines begin. These lines are succeeded by new ones at higher voltages making it seem probable that the stripping of the atom is in progress. Peculiar behavior of the lines 2535 and 3135A was observed. Three continuous bands (at 4080, 4300, 4800A) are present in molecular but disappear in atomic iodine. A band system lying between 2224 and 2050A was observed, and two groups of four bands each were found at 2880, 2833, 2776, 2716A and 2480, 2379, 2290, and 2243A.

26. The magnetic properties of atomic rays of the alkali metals. John B. Taylor, University of Illinois, (introduced by Jacob Kunz).—The direct experiments of Gerlach and Stern on space quantization with atomic rays of silver, have been repeated in a simplified apparatus. A broadening of the atom stream was found, rather than the actual splitting which Gerlach and Stern were able to detect. The splitting would probably be obtained with narrower slits. Work is now in progress on the alkali metals.

In order to insure deposition of the alkali metal to form an image of the slit, it is necessary to cool the plate with liquid air. Preliminary results on sodium indicate a broadening of the image by a magnetic field as in the case of silver, but the effect obtained so far is too small to establish the conclusion beyond doubt.

27. Conductivity of activated nitrogen. PHILIP A. CONSTANTINIDES, University of Chicago, (introduced by H. B. Lemon).—The conductivity in activated nitrogen produced by an electrodless discharge has been directly measured. Nitrogen gas moving with a uniform velocity has been activated in a bulb, and then passed in an ion chamber consisting of a metal tube charged to suitable potentials with respect to an electrode along its axis connected to an electrometer. The ion current when plotted as a function of the cylinder potential follows Ohm's law to the neighborhood of saturation potential. By increasing the potential beyond the saturation potential an increase of ion current is observed in the vicinity of the ionization potential of N_2.

28. Theory of the cathode of an arc. J. J. SLEPIAN, Westinghouse Research Laboratory, East Pittsburgh.—It is generally believed that thermionic emission at the cathode is essential for the maintenance of an arc, although a number of serious objections have been raised against this view. K. T. Compton has explained the conductivity of the positive column in an arc by thermal ionization of the gas. The author shows that this hypothesis of thermal ionization of the gas may also explain the passage of current to the cathode so that liberation of electrons from the cathode is not necessary, the current being carried to the cathode by positive ions. Quantitative calculations by equations of Saha and Langmuir give reasonable values for the temperature of the gas.

29. The positive ion emission from a mixture containing Fe, Al and Cs, and the work function φ_+ for Cs from this mixture. C. H. KUNSMAN, Fixed Nitrogen Research Laboratory, U. S. Department of Agriculture.—A mixture consisting of magnetite to which about 1% of Al-oxide and about ½% Cs in the form of caesium nitrate was fused in a resistance furnace, where the material itself was the resistor. This mixture furnished a very definite source of positive ions when used as a hot anode in a vacuum. The magnitude of the ion current depended upon the previous gas treatment and state of reduction of the material. After a thorough degassing and glowing in a vacuum, the positive ion current was sufficiently constant at a given temperature so that a very definite and reproducible value of the work function, $\varphi_+ = 2.37$ volts, was obtained by means of Richardson's equation $I_+ = AT^{\frac{1}{2}}\epsilon^{-\varphi e/kT}$ for temperatures from 962° to 1185°K. That this emission was largely positively charged ions of Cs was determined by the electron emission characteristics of a tungsten filament, placed so as to collect some of the positively charged particles. The reduced mixture of the oxides of Fe, Al and Cs is a good catalyst for the synthesis of ammonia from N_2 and H_2.

30. Departures from Ohm's law and theories of metallic conduction. K. T. COMPTON, Princeton University.—Four years ago Bridgman reported departures from Ohm's law of the order of one percent for current densities of the order of 10^6 amp. per cm^2 in gold and silver. It is shown that such departures render untenable Thomson's "second" (or doublet) theory of conduction, but are of the order to be expected on the classical free electron theory. The classical electron theory expression for conductivity is used, except that account is taken of the fact that the electrons are not in thermal equilibrium with the atoms but have greater energies on account of the field. These energies are calculated after the manner of "terminal" energies. The electronic free path can be calculated from the experimental data by

$$l = (\alpha T/Ee)[(9.072m/M)(\sigma - \sigma')/\sigma]^{\frac{1}{2}}$$

where σ and σ' are the conductivities at low current density and with potential gradient E, respectively, m and M are electronic and atomic masses and αT is the mean kinetic energy of the atoms. The free path l comes out $2.85(10)^{-8}$ cm for gold, a value consistent with other indications. Critical experimental tests of the theory are suggested by the equations.

31. The resistivity of liquid alloys. C. V. KENT, Kansas University.—The expression $\rho = 2mW/Ne^2$ for the resistivity ρ of a metal (W being the free electron impact frequency and N the free electron density) in the simple electron theory, is consistent with electrical and optical data for molten metals and alloys (C. V. KENT, Phys. Rev. **14,** 459, 1919, and **23,** 479, 1923). W and N seem to be linear functions of the atomic or molecular percent of one component in the alloy, or of one component in the component-compound alloy when such compound (or aggregate) is indicated by the melting point diagrams. The atomic concentration-resistivity graph should then be one or more sections of rectangular hyperbolae. This conclusion has been tested from the data of others and for some obtained by Mr. Geo. Emery and the writer, and is apparently confirmed. Furthermore the free electron concentration is independent of the temperature, the entire temperature change in resistivity being due to the variation in the free electron impact frequency with the temperature. The data available are generally insufficient and further experimental work is in progress. There is some evidence that the resistivity curves of some solid alloys obey the same laws.

32. The location of the electromotive forces in galvanic cells and thermocouples. W. H. RODEBUSH, University of Illinois.—Electromotive forces may be classified as (1) electromagnetic, (2) electrostatic, (3) electrokinetic. In the galvanic cell the conclusion is drawn that the principal e.m.f. resides at the junction of electrode and solution. There is neither an e.m.f. nor a difference of potential of appreciable magnitude at the metallic junctions. In the thermocouple the e.m.fs. are electrokinetic. The second law of thermodynamics does not indicate the location of these e.m.fs. but the first law requires them to be associated with heat effects. In a thermocouple with infinitesimal temperature difference between junctions these e.m.fs. are to be referred to the junctions. This conclusion can be extended to cases where a finite temperature difference exists.

33. Experiments with standing electromagnetic waves produced by means of a short wave electron tube oscillator. ALEXANDER MARCUS, College of the City of New York.—For laboratory experiments with electric waves about two meters in length, the following type of short-wave generator has been found convenient. A linear oscillator adjustable to a length of about one meter is energized by means of an oscillating circuit consisting of a single turn of wire about four inches in diameter, with its ends connected to the grid and plate respectively of an ordinary electron tube like the 201A type. The wire is broken at its midpoint and a variable condenser having a maximum capacity of 0.0001 mf is inserted for the purpose of facilitating the tuning of the closed driving circuit to the fundamental wave-length of the linear oscillator. The latter has a hot-wire meter at its center to indicate the production of a current antinode at resonance. The polarized waves radiated by the linear oscillator may be conveniently detected by means of a similar linear oscillator with a thermal galvanometer inserted at its middle point. With the help of a grid of several parallel wires it is easy to produce standing waves having prominent nodes and loops in a room of ordinary size. A pair of Lecher wires loosely coupled to the driving circuit affords a check method of measuring the wave-length.

34. Application of a vacuum tube multimeter to electrical measurements at radio frequencies. S. LEROY BROWN and M. Y. COLBY, University of Texas.—The usual low frequency voltmeter-ammeter methods of measurements can be extended to include audio and radio frequencies by the use of a vacuum tube meter utilizing two triodes. The grid potential of the first tube is lowered proportionally to the peak value of the applied voltage; this decreases the plate current of the first tube and the direct potential drop across a high resistance in its plate circuit is so applied in the grid circuit of the second tube that the result is an increase in the plate current of the second tube which is measured by a direct current micro-ammeter. This instrument is so constructed that its input impedance is very high, it is independent of the nature of circuit to which it is connected and its registration is independent of frequency up to a million cycles per second. The lowest measurable electromotive force is about .05 volts and, therefore, with a non-inductive resistance of 1000 ohms, a current of 50 micro-amperes can be measured. Other applications of the instrument are: testing of audio and radio transformers, measurement of induced electromotive force in loop aerials and the intensity of harmonics, and the detecting of bridge balance.

35. Accurate measurement of small capacities. WILLIAM SCHRIEVER, University of Oklahoma.—The capacity of an electrometer and its connections may be obtained by the usual condensers-in-parallel method but the results will not be accurate unless the capacity of the shielded connecting wire is taken into account. By connecting each of two cylindrical condensers (alike in every respect except length) to the electrometer system in exactly the same way, it is possible to eliminate the "end-effects" in the calculations. These "end-effects" include the errors due to the finite length of the condensers (formula for capacity of concentric cylinders per unit length assumes them to be of infinite length), the errors due to the presence of insulating material between the parts of each condenser, and the errors due to the capacity of the wire connecting the condensers to the electrometer system. A constant source of ionization is required.

36. Measurement of the high frequency resistance of coils. R. R. RAMSEY, Indiana University.—The high frequency resistance of a coil is measured by comparing the heat (I^2R losses) produced in the coil by a radio frequency current (10^6 cycles) to the heat produced by a d.c. current in a known resistance. A differential thermometer is made of two inverted Pyrex beakers cemented to glass plates. Through each glass plate two electrical connections and a glass tube are cemented. The glass tubes are connected to a U-tube half filled with water. The coil to be measured is placed in one beaker and the known d.c. resistance is placed in the other. The heat developed in the two coils as indicated by the water in the U-tube is made equal by varying the d.c. current. The high frequency resistance of the coil is found to be less than that found by measuring the resistance of the circuit by the usual method in which the resistance of the condenser is assumed to be negligibly small. With a constant frequency the difference increases with the inductance of the coil.

37. The variation of the resistance of condensers with dial setting at radio frequent cies. A. E. MAIBAUER and T. SMITH TAYLOR, Bakelite Corporation.—In the measuremen- of the power factor of insulating materials by the resistance variation method, or by the substitution method, it has been customary to consider the resistance of the standard condenser as negligible compared with that of the sample under test. The writers were aware of the fact that this assumption was not justified and have determined the values of the effective series resistance of two condensers used as standards in power factor measurements. Use was made of a standard condenser made from two adjustable parallel plates. This condenser having either nothing but air, or very small pieces of Pyrex glass or mica as dielectric had as small an effective resistance at 1,000,000 cycles as it was possible to obtain. Curves are given which show how the resistances of condensers vary with dial settings.

38. A new type of electromagnetic wave-meter. W. W. SALISBURY, University of Iowa, (introduced by C. J. Lapp).—A high degree of accuracy and sensitivity are obtained by using a combination of a two element vacuum tube and direct current galvanometer, which measures the voltage across the condenser in the resonant circuit instead of the current in the inductance as is the common practice. The small amount of energy necessary to operate this indicator makes possible a very sharp resonance peak. Its sensitivity allows it to be operated so far from the source of the waves that it does not effect the wave-length. A new method of locating nodes on Lecher's wires makes possible greater accuracy than has previously been obtained in such measurements. The wave-meter is calibrated, with the aid of these wires, for wave-lengths between 3 and 100 meters.

39. An electrical frequency meter of wide range. HOMER L. DODGE, University of Oklahoma.—The paper describes a direct-reading, electrical frequency meter of wide range made up of standard electrical laboratory equipment consisting principally of condensers and an a.c. milliammeter.

40. Dielectric constant of helium and oxygen in a magnetic field. B. B. WEATHERBY and A. WOLF, University of Pennsylvania.—The heterodyne beat method was used to detect a possible change in the dielectric constant of gases, due to space quantization in a magnetic field. A condenser, forming a part of one oscillating circuit of about 1,000,000 cycles frequency, was filled with the gas investigated and the magnetic field then applied. The results obtained show that for helium (20 cm pressure), air (76 cm) and oxygen (76 cm) at room temperature there is no change in the dielectric constant to 1 part in 500,000. The magnetic field was of the order of 8000-10,000 gausses, while the electric field was estimated at 5000-10,000 volts/cm. The tests were carried out with the direction of the electric field both parallel and normal to the direction of the magnetic field. This work was suggested by theoretical considerations in an article by Ruark and Breit (Phil. Mag. Feb. 1925).

41. Effect of deposition-temperature on the magnetic properties of evaporated nickel films. R. L. EDWARDS, University of Iowa.—Uniform nickel films of thickness $30m\mu$ to $300m\mu$ were produced by evaporation on an aluminum foil base. Deposition occurred at temperatures ranging up to 250°C with a vacuum in most cases better than .003 mm. The magnetic properties were quantitatively determined with fields up to 139 gauss. Films deposited on an unheated surface were found to be only slightly magnetic, but for such films, the coercive force was also very small. The effect of maintaining films at a relatively high temperature during deposition was to greatly increase the permeability for large fields, and to increase the coercivity in a still greater ratio—that is, to increase both dimensions of the hysteresis loops. Loops plotted on the same scale of magnetic induction and field strength varied in area more than ten-fold due to this cause. Areas more than eighteen times as great as for annealed bulk metal were obtained. Presumably the films were crystaline, and their formation on a heated surface would produce larger crystals, yet such films were harder physically as well as magnetically than those produced on unheated surfaces.

42. Thermo-electric power and the Hall coefficient. C. W. HEAPS, Rice Institute.—The simpler theories of free electrons in metals make the Hall coefficient depend only on electron concentration. The thermo-electric power of a couple depends on the ratio of electron concentrations in the two metals. A relation between Hall coefficient and thermo-electric power is thus to be expected. Experiments performed on Bi and Sb show a Hall coefficient decreasing as the magnetic field increases while the thermo-electric powers of these metals with respect to copper increase. For crystalline graphite, increasing the magnetic field increases the Hall coefficient and decreases the thermo-electric power. No other non-magnetic metals have been found to have a variable Hall coefficient or thermo-electric power (with the possible exception of Te) so the tentative rule may be stated: If the Hall coefficient of a non-magnetic metal varies with the field the thermo-electric power of that substance will be found to vary in a converse way with the field. Richardson has suggested that any cause producing a continuous alteration of electrical conductivity at a given temperature should produce a corresponding alteration of the thermo-electric power. A magnetic field acting on graphite does not appear to behave in accordance with this suggestion.

43. A "Node" at the source. G. W. STEWART, University of Iowa.—Current literature shows a fairly general misunderstanding concerning the nodal location of the vibrating source in the Kundt's tube and in the Melde transverse string and fork experiment. It is shown by theoretical deduction that this source is one-half wave-length from the nearest node, that it is located more correctly *at a node* than "near a node" or "practically at a node." Experimental justification is also cited. The motion of the source is the cause of the misunderstanding, but the source, a boundary between two media, has a displacement that is exceedingly small compared to a wave-length and reflects and permits stationary waves to form just as if it were stationary.

44. Measurement of air velocity by means of a Rayleigh disk. C. N. WALL, University of Illinois, (introduced by F. R. Watson).—A Rayleigh disk was suspended by means of a quartz fiber in a pipe through which flowed a uni-directional stream of air from a constant pressure tank. By independent measurements of the air velocity and the resulting torque exerted upon the Rayleigh disk an empirical relation between the two quantities was established. It was found that the torque exerted upon the disk by the air stream is proportional to the 1.7 power of the air velocity instead of to the square of the velocity as predicted by the classical theory.

45. The vapor pressure of solid potassium amalgams. FRANKLIN E. POINDEXTER, Washington University.—A Buckley ionization gauge was used to measure the vapor pressure of three potassium amalgams ranging in concentration from 5 : 1 to 15 : 1 mol ratio of Hg to K. The vapor pressure of each amalgam was measured at a number of temperatures which were determined by means of a platinum resistance thermometer. The pressures measured varied from approximately 10^{-6} mm to 10^{-3} mm over a maximum temperature range of from $-24°$C to 28°C. The log p vs $1/T$ graphs for the different amalgams were found to be approximately straight lines. The heats of reaction were calculated by means of the Van't Hoff reaction isochore, the pressures at different temperatures for these calculations being taken from the log p vs $1/T$ graphs. These heats were of the order of 25,500 cal. per gram molecule of amalgam. The corresponding heats of reaction for sodium amalgams, as reported at the Chicago meeting of the Physical Society, were found to be of the order of 14,500 cal.

46. The relative importance of the Bernouilli principle and of viscosity in aspirator action. E. L. HARRINGTON, University of Saskatchewan.—Although the Bernouilli principle is cited in most text books of physics as the complete explanation of aspirator action it is found from both theoretical considerations and experimental study that the viscosity of air is really by far the more important factor to be considered. Aspirators designed to more thoroughly utilize the latter are described and shown to be many times as efficient as those designed to utilize only the Bernouilli principle.

47. Measurements on the thermal expansion of fused silica. WILMER SOUDER and PETER HIDNERT, Bureau of Standards.—Expansion tests were made on transparent and non-transparent fused silica over various temperature ranges between $-125°$ and $+1000°$C. Seventeen samples of fused silica were examined on which a total of 48 expansion tests were made. A detailed description of the apparatus and the methods used in this research and a summary of available data obtained by previous observers on the thermal expansion of fused silica are given. A critical temperature or minimum length was found at about $-80°$C. Expansion occurred on heating fused silica above the critical temperature or on cooling below this temperature. Typical expansion curves are shown and discussed, and the authors' average expansion curve compared with the results of previous investigators. The following table gives average coefficients of expansion derived from the data on all samples for various temperature ranges.

Average Coefficients of Expansion per Degree Centigrade of Fused Silica.

20 to 60°C	: 0.40×10^{-6}.	20 to 600°C	: 0.53×10^{-6};
20 to 200	: .50;	20 to 750	: .50;
20 to 400	: .55;	20 to 1000	: .48.

48. Piezo-electric effect in sodium bromate. Joseph Valasek, University of Minnesota.—The general problem of deduction of physical properties of crystals from their structure and kinds of atoms is a difficult one for which there may be some possible simplifications. Certainly, however, the replacement of the ions in sodium chlorate and bromate by point charges, leaves much of their piezo-electric moment unaccounted for. Experimentally, it is found that the change in the lattice constant of sodium bromate with temperature, which is given by the coefficient of thermal expansion, is 0.0000286, while the temperature coefficient of the piezo-electric constant is roughly one hundred times as large. This is entirely out of proportion to the change one would expect from a simple expansion of all atomic distances. By using different temperatures one can obtain the same piezo-electric constant from the sodium chlorate and bromate. This requires only a reduction of the bromate lattice by 10 percent of the difference between the two, that is, the bromate must be about 100°C cooler than the chlorate. The data show that the use of point charges instead of the ions in the crystal lattice cannot give correct results, and show the magnitude of the discrepancy. Details will be published later.

49. Thermodynamics of thermionic phenomena. N. Rashevsky, Westinghouse Research Laboratory, East Pittsburgh, (introduced by Dayton Ulrey).—An attempt is made to reduce all thermodynamical treatments of thermionic phenomena to the most general and exact form. In connection with this the kind of assumptions and approximations underlying all the thermodynamical methods used at the present time are investigated. Special attention is given to the rôle of the positive ions in the solid as well as in the gaseous phase and their possible mutual interaction with the electrons. Using the outlines of this general method, results obtained in a previous paper (Zeits. f. Phys. **33**, 606, 1925) as to the influence of pressure and the rôle played by the chemical constant of the emitter are confirmed, and furthermore are shown to be independent of the special assumptions made in that paper. In connection with a recent paper by W. Schottky the question is discussed as to whether the law of emission is the same for all substances or whether it may be different for elements and compounds.

50. Simple demonstration of the constancy of mass. J. A. Eldridge, University of Iowa.—The content of the electromagnetic field equations is very nearly the same as that of restricted relativity. It is well known that many of the results of relativity were obtained much earlier by electromagnetic reasoning. The purpose of this paper is to show as simply as possible the variation of mass with speed and to make the mass concept more concrete. The relation between the charge and the Faraday tube of force is like that between a spider and its thread—the tube of force furnishes not only the accelerating force but also adds to the mass moved. The charge, if accelerated in the direction of its velocity, adds to itself a Faraday tube; a transverse (i.e. centripetal) acceleration means no accumulation of mass. These concepts give numerically the variation of mass with velocity and the difference between longitudinal and transverse mass. This picture of the diffuse stationary mass being absorbed by the denser moving mass is quite general and illustrates the general principle of conservation of mass.

51. An oscillographic study of atmospherics. ROY H. MORTIMORE, University of Iowa, (introduced by E. P. T. Tyndall).—The variations of potential accompanying lightning flashes induced current in a critically damped antenna. The potential across a series condenser in the antenna was amplified with a resistance coupled amplifier the output of which was connected to a Duddell oscillograph. The photographic records obtained show that the impulses are unidirectional, aperiodic, and vary in duration from 500 to 8000 micro-seconds.

52. The energy levels of the carbon monoxide molecule. RAYMOND T. BIRGE, University of California.—It is possible to arrange all of the fourth positive group of carbon, and also Lyman's "fifth positive group" and nearly all the remaining previously unassigned bands in one quantum system of some 150 bands, given by $\nu=64,721+(1499.28n'-17.24n'^2)-(2147.74n''-12.703n''^2)$, where n' varies from 0 to 14, and n'' from 0 to 22. The distribution of intensity is a typical one, similar to that for the aluminum bands. The expected portion of these bands has been found by Leifson in absorption in cold carbon monoxide, and this system therefore represents the fundamental "resonance" system of CO. The Angstrom CO bands have as a final state the initial state of this same system. Duncan has unknowingly measured the excitation potential of the first negative group of carbon (due to CO^+), from which one obtains 14.2 volts for the ionization potential of CO. Therefore the relative energy values of three electronic levels for CO, and three for CO^+ are now known, and also the excitation potential for the fourth group of carbon (8.0 volts, "resonance potential"), Angstrom CO bands (10.7 volts), comet-tail bands (16.7 volts), first negative carbon bands and the "combination bands" of CO^+ (19.8 volts).

53. The structure of molecules. RAYMOND T. BIRGE, University of California.—Recent developments in band spectra indicate that there are in diatomic molecules electronic energy levels which may be designated *s*, *p*, etc., and which have a multiplicity similar to that of a certain "corresponding" atom. New quantitative examples of this are given for CO, N_2 and NO. The results for CO (previous abstract), together with those for N_2, H_2 and He_2, indicate that these molecular levels are given also at least approximately by the *formulas of line spectra.* Hence the structure of the outer electrons of molecules must be very similar to that of the "corresponding" atom (CO and N_2 like Mg, CO^+ and N_2^+ like Mg^+, CN and BO like Na, NO like Al, etc.), as already suggested by Mulliken and Mecke. Moreover, in CO, CO^+, NO, CN and BO, the frequency of vibration of the dipole is less, and consequently the moment of inertia is greater, when the radiating electron is in a *p* level, than when in any *s* level. This seems to be evidence that the radiating electron moves in a protruding path, to give the valence properties, which also penetrates to varying degrees the region *between the two nuclei*, and so plays a definite role in determining the strength of the chemical bond.

AUTHORS INDEX