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## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
### SECTION B—PHYSICS

THE annual meeting of Section B, Physics, of the American Association for the Advancement of Science, was held in Fayerweather Hall of Columbia University, in New York City, on December 27, 28 and 29, 1906. The annual meeting of the American Physical Society occurred at the same time and place; each society nominally held a separate meeting for the transaction of business, but all of the sessions for the reading of papers were joint sessions.

The presiding officers were Professor W. C. Sabine, of Harvard University, vice-president and chairman of Section B, and Professor Carl Barus, of Brown University, president of the American Physical Society. The other officers of Section B who were present were the retiring vice-president, Henry Crew; the secretary, D. C. Miller; member of the council, E. F. Nichols; member of the general committee, William Hallock; members of the sectional committee, Henry Crew, W. C. Sabine, D. C. Miller, E. B. Rosa (elected at this meeting to serve for five years), G. F. Hull, E. L. Nichols; press secretary, W. S. Day.

For the next meeting, to be held in Chicago, in convocation week of 1907–8, the officers, so far as now determined, are:

*Vice-president and Chairman of Section B*—Dayton C. Miller.

*Retiring Vice-president*—W. C. Sabine.

*Members of the Sectional Committee*—W. C. Sabine, Dayton C. Miller, A. D. Cole, G. F. Hull, F. E. Nipher, E. L. Nichols, A. Trowbridge, E. B. Rosa.

*Secretary of Section B*—A. D. Cole, Ohio State University, Columbus, Ohio.

On December 28, the retiring vice-president, Professor Henry Crew, of Northwestern University, gave a most interesting and important address on 'Fact and Theory in Spectroscopy'; this address was printed in full in SCIENCE for January 4, 1907.

Probably the sessions of Section B have never before been attended by so large a number of representative physicists; at some of the meetings more than one hundred and fifty persons were present. The papers were many (nearly fifty in number) and were, upon the whole, of a very high order of merit. The meeting was universally pronounced a most successful one.

There was no distinction between the programs of the Physical Society and of Section B; the abstracts and titles of the papers of both societies are given below.

*Effect of a Magnetic Field upon the Ionization in a Closed Vessel:* W. W. STRONG, Johns Hopkins University.

According to present views, atoms contain charged particles which are in rotation. In magnetic substances such as iron or oxygen more of these charged particles rotate in one direction than in another, and these orbits of rotation lie in the same or in parallel planes. In a magnetic field atoms would turn so that their planes would be perpendicular to the field. The effect of the field would then be to decrease the velocity of these charged particles, but not to change their radius of rotation. This would make the atom more stable. One could expect that the natural ionization in a closed vessel would be decreased by the application of a strong magnetic field. This was the effect looked for.

The electroscope consisted of a sheet-iron box of some three litres volume containing air at atmospheric pressure. The charged electrode consisted of a wire bent into the arc of a circle at one end. The gold leaf was attached to a rod at a point slightly different from the center of the electrode arc. The length of the gold leaf being slightly less than the radius of this arc, at different positions its end would be at different distances from the charged electrode. By this means the gold leaf could be made very sensitive to changes of voltage of the charged electrode. The gold leaf was earthed.

By using a large electromagnet the rate of leak was found to be changed as much as thirty parts in a hundred at times although this change was not found to be constant. The greatest effect was found when the field was turned on for the first time. An example of the readings are as follows, they being made consecutively:

| Time. | Leak in Scale Divisions of Micrometer Microscope. | Rate of Leak in Scale Divisions per Second |
|---|---|---|
| Field on, 663 secs. | .737 | .00111 |
| Field off, 613 secs. | .876 | .00143 |
| Field on, 515 secs. | .540 | .00105 |
| Field off, 520 secs. | .835 | .00161 |

The writer can not attribute this change as due to any other effect than that of a magnetic field on the natural ionization. It may be possible, however, that there is some other explanation.

*Projections of the Globe Appropriate for Laboratory Methods of Studying the General Circulation of the Atmosphere:* CLEVELAND ABBE, United States Weather Bureau.

The general circulation of the atmosphere is controlled by the general distribution of land and water, and by the insolation, with its resultant temperature, evaporation and clouds. In the analytical treatment of this problem, beginning with d'Alembert, Ferrel and Erman, as well as in the more elegant works of Helmholtz, Oberbeck and Margules, it has always been considered necessary to simplify the problem by assuming a uniform surface and uniform coefficient of resistance for the whole globe, as also a uniform condition of dry air. In this shape the problem is already very complicated, and it is likely that the profound meteorological problem of the deduction of the actual winds from the laws of mechanics, will for a long time be too difficult for pure analysis; but on many occasions I have stated my belief that a solution may be arrived at in an experimental way.

We may represent any portion of the globe, with its atmosphere, by a horizontal plane surface, covered with some heavy gas or liquid, such as a thin layer of carbonic-acid gas, or alcohol, or water, which is to be set in steady rotation, and may be warmed from below in such a way as to approximately imitate the actual isotherms of the lower atmosphere. Special areas of high and low temperature can easily be imitated by electrical resistance coils. These rotating areas are to be covered by plates of glass, rotating with them.

Various theorems relative to the similarity of such a model to the atmosphere of the earth were first published by Helmholtz in 1873, 'On a Theorem Relative to Movements that are Geometrically Similar in Fluid Bodies,' and these ideas were further applied by him in memoirs on atmospheric motions, in 1888 and 1889; and further developments have lately been given by Lord Rayleigh. But in applying these ideas to our two polar projections we stumble upon a great difficulty, namely, that the maps are not true representations of the spherical surface of the earth.

In the present case we should like to preserve the equality of surface areas; and to preserve equality of distances, since we have to compare velocities; and above all, we should like to preserve the equality of the moments of inertia. That which best satisfies all desiderata seems to be Airy's 'projection by balance of errors,' published by him in 1861. The combination of Airy's development with Helmholtz's method of mechanical similarity should enable us to interpret our laboratory experiments.

I consider it extremely desirable that these experiments should be made on a large scale, with due regard to all numerical, statistical and mechanical details, in some laboratory where the study of meteorology is prosecuted as a branch of mathematical physics.

*Some New and Useful Data in Reference to the Moisture of the Air:* Henry Emerson Wetherill, Philadelphia.

This paper gave an outline of researches upon the relative humidity of the air, as determined with a new cobalt chloride scale and test paper, and referred to the use of a special instrument for measuring the moisture of the body in different diseases.

References were made to new psychrometers for correcting hygroscopes and to studies of the measurement of the perspiration, in malarial and other fevers, as carried out in the Philippines, Panama and elsewhere; and also to a cobalt hygroscope depending upon the change of weight of the test papers with humidity. The weighings of this change suggested the production of an instrument that might be called the hygrobaro, and one that would be of service to the weather bureau.

*The Compensated Two-circuit Electrodynamometer for Alternating Current Measurements of Precision:* EDWARD B. ROSA, Bureau of Standards.

If an electric current pass in series through a shunt $S$ and the fixed coil $F$ of an electrodynamometer, and a small derived current, taken from the potential points $ab$ of the shunt flow in series through the resistance $R$ and the moving coil, a deflection will occur proportional to the square of the current and inversely as the resistance, $R$. The current may be either direct or alternating. Hence if a known direct current, measured by means of a potentiometer, standard cell and standard resistance, be used first to get the constant of the dynamometer, the value of an alternating current can then be obtained. It is shown in the paper mathematically that any self-inductance in the shunt $S$ or the fixed coil $F$ does *not* produce an error in the alternating current measurement, but that the self-inductance of the moving coil and any Foucault currents in the fixed coil or in any neighboring conductor or metallic parts *do* cause an error. It is shown how to detect such an error and to compensate for it, so that the deflected readings of the instrument are the same as though these sources of error were absent. The mathematical theory is verified by experiment, and alternating currents up to 500 amperes are thus measured with precision. The compensation holds good at different frequencies, and the error of a Kelvin balance, due to frequency, is *measured.*

*The Power Factor and Temperature Coefficient of Mica Condensers:* E. B. ROSA and F. W. GROVER, Bureau of Standards.

Absorption and leakage in a condenser are a cause of expenditure of energy when the condenser is placed on an alternating-current circuit. This energy is, of course, smaller for good condensers than for poor ones, and for very good condensers is extremely small, so small that the heat resulting is inappreciable unless the voltage is higher than can safely be applied to the condenser. In the comparison of condensers by means of an alternating current bridge, it is shown in the paper how the phase angle of the currents through the two condensers can be compared, the difference indicating which is the better condenser. In an air condenser the current is 90° in phase ahead of the electromotive force acting on the condenser, and if a mica condenser is compared with an air condenser and shows a difference in phase of 10′, the angle for the mica condenser is 89°50′. The power factor is then cos 89°50′ = .0029. If the power factors of standard mica condensers are determined, other condensers may be compared with them and their differences (+ or —) being directly measured, giving the power factors of the condensers under test. This is the best single test of the quality of a condenser, and capacities measured in this way are not subject to the error due to the leakage to which direct-current measurements are subject.

The temperature coefficient of a mica condenser will be affected by the paraffine in which it is embedded. Some grades of paraffine melt at a relatively low temperature and soften and expand rapidly at still lower temperatures. The temperature coefficient of the condenser will be small and nearly constant up to a certain temperature and then rather suddenly increase greatly. The temperature at which this sudden increase occurs is sometimes low enough to occur in summer weather without any additional heating. A good mica condenser should be embedded in high-grade paraffine, so that its temperature coefficient may remain small through all ordinary ranges of laboratory temperatures.

There is a great difference among condensers as to power factor and temperature coefficient, and a condenser should never be purchased without a knowledge of these constants as well as a knowledge of its capacity.

*The Diffraction of Electric Waves of Short Wave-length:* A. D. COLE, Ohio State University.

Peculiarities observed in a quantitative study of the reflection of electric waves seemed to be due to diffraction and led to this study. These peculiarities were: (1) A sudden increase in the amount of energy passing through a slit of increasing width when it becomes more than a quarter wave wide, (2) the amount of energy reflected from a narrow mirror was found to be greater than that passing through a slit of the same width provided each is but a small fraction of a wave-length wide, (3) irregularities noticed when screens were introduced to cut off direct radiation.

The earlier investigations of Trouton, Zehnder and Righi were carried out with apparatus which did not give quantitative results. A modified form of Klemenčič thermo-receiver made it possible to study the distribution of refracted energy quantitatively. A Righi exciter, actuated by an induction coil and Wehnelt interrupter, was used for generating the waves.

The lateral distribution was studied and the result exhibited by curves for the following cases: (1) A slit about three fourths of a wave-length wide showed a broad spreading of energy, with a central 'bright band' having a dark band and weaker bright band at each side. Their locations agreed with the optical formula, $\lambda = a \sin \theta$. (2) A wider slit showed interference bands nearer together. (3) Case of energy distribution behind a thin metallic edge placed on the axis of a plane wave front. (4) Similar with the edge displaced laterally.

Trouton's discovery that the system of nodes and loops formed by reflection at perpendicular incidence from a small plane mirror is shifted outward if the mirror is made with dimensions of a wave-length or less was verified and the amount of the shifting measured for several cases.

The study of diffraction is being continued.

*Final Report on Ether-drift Experiments:* EDWARD W. MORLEY and DAYTON C. MILLER.

At the Philadelphia meeting an account was given of experiments to detect ether drift. These observations gave no indications of a drift of the ether. It has been suggested that the negative results are due to the influence of the heavy stone walls of the building within which the apparatus was mounted. The interferometer has, therefore, been mounted on high ground near Cleveland, and covered in such a manner that there is nothing but glass in the direction of the expected drift. It was much more difficult to make observations in this location than in the building; satisfactory observations could only be made on a cloudy evening following a cloudy day, when the temperature changed very slowly. The temperature effects could never be entirely eliminated. The conclusion from many observations is that there was no indication of a drift of the ether through the interferometer. The expected drift would produce a displacement of the interference fringes of 1.53 wave-lengths; the above result is probably certain to one eightieth part of the whole.

*The Optical Analogue of Certain Electrical Experiments:* WILLIAM B. CARTMEL, Harvard University.

The recent experiments of Messrs. Blake and Fountain show that the amount of electric radiation transmitted by sheets of glass, may be increased by covering the glass with regularly spaced strips of tinfoil, and this led the present writer to investigate the possibility of making a thin film of transparent substance more transparent by covering it with a much thinner film of metal.

A film of dye was deposited upon one half of a plate of glass, and silver was deposited on half the glass but in a direction at right angles to the dye film. One could thus compare silvered dye with silvered glass. The film of silver was so thin that it was impossible to see any difference between the part of the glass that was silvered and the part that was not, but where the glass was covered with both silver and dye, less light was transmitted than when the glass was covered with dye alone. Similar effects were obtained with combined films of silver and selenium.

The explanation is that the phase change at the top surface of the silvered dye film is different from that at the top surface of the bare dye film. The rays reflected from the back surface of the dye will therefore interfere in a different way with the ray reflected from the top surface, in the two cases, and for certain thicknesses of the dye film, the intensity of the light reflected from the film will be diminished by silvering, and there will be a correspondingly increased transmission.

*A Preliminary Communication concerning a New Fundamental Principle of the Kinetic Theory of Gases:* LUIGI D'AURIA, Philadelphia.

In this paper the author proves that the square of the speed of an elastic sphere forced to oscillate between two elastic plates perpendicular to the direction of its motion while one of the plates approaches the other with speed which is very small compared with that of the sphere, varies inversely with the length of its free path. The author observes that in a medium composed of numerous elastic spheres moving in all directions in a bounded space, each sphere can be considered as if moving with the mean square speed in a path equal to the mean free path of all the spheres; and, therefore, in accordance with his new theorem, in such a medium the mean square of the speed would vary inversely with the mean free path.

Combining this result with the expression for the mean free path, which, according to Clausius, varies inversely with the density of the medium and the square of the diameter of one of the spheres, and observing that the pressure of the medium upon unit area varies with its density and the mean square of the speed of the spheres, the author arrives at the equation $pv^2 = \text{constant}$, independent of thermodynamic considerations, in which $p$ is the pressure per unit area and $v$ the volume of unit quantity of the medium. Thus in a medium composed of elastic spheres in motion in a bounded space, the pressure per unit area of the bounding surface would vary inversely with the square of the volume.

If the above medium represents a gas, we must have also $pv^\gamma = \text{constant}$, in which $\gamma$ is the ratio of the specific heats, and therefore, $\gamma = 2$. According to Clausius and Maxwell, for such a gas the ratio of the specific heats would be 5/3, and this is too small to account for the ratio of the specific heats of mercury vapor found by Kundt and Warburg which ranges from 1.631 to 1.695, since the theory requires that this ratio should be considerably less than the theoretical value.

The result $\gamma = 2$ leads to the new fundamental equation $pv = E$ in which $E$ represents the energy of agitation of the gas, and the author shows that this equation accords with the principle of the conservation of energy, and that, therefore, the equation $pv = 2/3E$, which results from the investigations of Clausius and Maxwell, can not be correct.

*On the Variation of the Heat of Mixture with Concentration and Temperature:* B. M. CLARK.

When two liquids are mixed, there is in general either an absorption or a generation of heat, the amount of heat depending upon the relation of the liquids present, and upon the temperature at which mixture occurs.

The variation of the heat of mixture with temperature—for any one definite concentration—bears theoretically a simple relation to the specific heats of the components of the mixture and the specific heat of the resultant mixture, and the present experiments were begun with a view to determining experimentally the numerical value of this relation in the case of some of the simpler solutions.

Observations were made on the following liquids:

Glycerin—Water,
Glycerin—Ethylalcohol,
Glycerin—Methylalcohol,
Phenol—Water,
Isobutylic Alcohol—Water,
Anilin—Xylol,
Anilin—Toluol.

The values obtained for the heat of solution at various temperatures show that for the liquids tested the thermodynamic relation

$$\partial Q/\partial t = K - K',$$

holds within the limits of experimental error. The value $\partial Q/\partial t$ known as the temperature coefficient of the heat of mixtures varies in some mixtures with the temperature.

Anilin xylol, anilin-toluol gave evidence of a temperature coefficient equal to zero, *i. e.*,

$$\partial Q/\partial t = 0.$$

Numerical values and curves will be given in a paper to appear shortly.

*A Color Mixer:* ALBERT B. PORTER, Chicago.

The simplest means of mixing and matching colors is undoubtedly Maxwell's color-top. It is, however, defective in that one can not continuously vary the positions of the slotted discs while seeking a color-match, but must usually stop the top many times, readjust the discs, and again set up the rotation, before a satisfactory match is secured.

In the present instrument the slotted discs remain stationary while their image is rapidly rotated. This is effected by viewing the discs through a right-angled prism which rotated with its hypothenuse parallel to the axis of rotation and to the line of sight. As the slotted discs remain stationary, their angular exposure can be easily and continuously varied until the best possible color-match is secured.

*On the Nature of Optical Images:* ALBERT B. PORTER, Chicago.

A consideration of the method by which light is propagated is sufficient to show that an ordinary optical image is merely a particular case of an interference pattern. This may be easily shown experimentally by using as an object a coarse, black-line grating illuminated by a parallel beam of monochromatic light passing through the grating and then through a convex lens. On the far side of the lens a system of sharply defined interference fringes is formed which can be seen with an eye-piece, or, intercepted on a screen, at any point over a considerable range along the axis. Somewhere in this system of fringes is the geometrical image of the grating, but it is visually quite indistinguishable from other sections of the fringe system. If the angle of incidence of the light falling on the grating is changed, the whole fringe system shifts to one side or the other except in the focal plane, where it remains stationary. This shows that the focal plane of the lens is merely the plane in which the interference fringes formed by light of all incidences coincide, and that the so-called geometrical image is really a superposition of coincident interference patterns; while the usual absence of a sharp image outside the focal plane is due to the more or less uniform illumination caused by the overlapping of fringe systems formed by light coming from various points in the source. When the grating is illuminated by a parallel beam of white light the effects are similar, except that outside the focal plane the interference fringes are colored. This shows that the focal plane is also the plane of achromatic interference, *i. e.,* the plane in which the fringes due to light of various wave-lengths coincide.

*On the Conductivity of the Air caused by Certain Compounds during Temperature-Change:* Fanny Cook Gates.

Investigations on the conductivity of the air, caused by the presence of the sulphate of quinine under certain conditions, indicate that it accompanies hydration and dehydration, although phosphorescent effects to which it may be directly due, appear at the same time. The phenomenon is most easily observed during the cooling of the quinine from something over 100° C. to room temperature.

Heretofore, the only other substance known to produce a similar effect is cinchonine, which like quinine, hydrates and phosphoresces upon cooling. Both substances are so complex in structure that the exact chemical changes to which they are subject are studied with difficulty.

During the investigations described in the present paper, a large number of substances were heated to about 150° C., and the conductivity of the surrounding gas was tested while they cooled. Of all the substances tested, none was found to give so large an effect as that which results from the sulphate of quinine, but a very definite and marked conductivity was found to accompany the cooling of anthracene, and to a less degree that of grape-sugar and æsculin.

*The Transmission of Röntgen Rays through Metallic Sheets:* J. M. Adams.

For some years after Röntgen's discovery of the X-rays, it was a matter of doubt whether the absorption of the rays in metallic sheets was accompanied by the development of heat. To investigate this question by means of an instrument different from those already used for this purpose, a radiomicrometer was constructed. The metals forming the thermal couple were constantan and copper. At one of the junctions was placed a small disk of thin platinum to receive the rays, the other junction being shielded from them. The sensitiveness of this radiomicrometer was such that a radiation of $5.6 \times 10^{-8}$ gm. cal. per sec. per sq. cm. of its sensitive surface produced a deflection of one scale division.

Evidence of heat developed in the platinum by the absorption of Röntgen rays in it was readily obtained. The necessity of making correction for the incomplete absorption of the rays in the platinum of the instrument, together with the well-known fact that the character of Röntgen rays is changed by passage through substances, made it seem desirable to investigate the phenomena of the transmission of the rays through metallic sheets more fully than has been done heretofore.

The general law of the absorption of the rays in a metal, *viz.,* that each successive equal increment of thickness is less effective as an absorbing medium than the one preceding it, was confirmed by experiments with the radiomicrometer.

The dependence of the absorbing power of a given metallic sheet upon the intensity of the rays incident upon it was examined for sheets of silver, platinum, copper, tin, and aluminium, and in every case it was found that the effectiveness of a sheet as an absorbing medium is independent of the intensity of the incident rays.

It was found that the effect of the *surfaces* of metallic sheets upon transmission is small in the case of copper and of aluminium. To show this, a laminated plate of the metal in question was prepared, equal in total thickness to another solid plate of the metal. These two plates were interposed in turn in the path of the rays, and produced equal reductions of the deflection of the radiomicrometer.

The transmission of a beam of Röntgen rays through a metallic sheet has generally been supposed to render the beam more penetrating toward a second sheet of the same or of any other metal than the original beam was.

Evidence of transformation of one sort of ray into another, in transmission through a metallic sheet, was sought, with a negative result.

*The Mutual Inductance of a Circle and a Coaxial Helix. The Lorenz Experiment and the Ayrton-Jones Absolute Electrodynamometer:* E. B. Rosa.

The constant of the Lorenz apparatus for the absolute measurement of resistance and of the Ayrton-Jones electrodynamometer for the absolute measurement of current require the calculation of the mutual inductance of a circle and a coaxial helix, the circle in the first case being the edge of the rotating disc and in the second case one end of the suspended coil, the helix being the fixed coil carrying the primary current.

Jones obtained an expression for the mutual inductance in question which is a very tedious and difficult one to use in numerical calculations. Lorenz's expression is an algebraic series less difficult but also less accurate than Jones's. Using an expansion in zonal harmonies, I have obtained an impression in the form of an algebraic series, similar to Lorenz's but more accurate, which is far more convenient to use than Jones's and agreeing with the latter to less than one part in a million (in a particular numerical test) thus being amply accurate for the most refined experimental work. This expression is obtained on the assumption that the current is distributed over the solenoid in a uniform current sheet, whereas Jones's expression assumed the current flowing in a helix. Their agreement is a confirmation of the theorem that a spiral distribution of current is equivalent to a current sheet.

*Mutual Inductances for Laboratory Use:* E. B. Rosa.

The most accurate as well as the most convenient method of calibrating a ballistic galvanometer is by means of a mutual inductance, through the primary of which a measured current flows. Some laboratories use a standard solenoid with a secondary wound within or without, calculating the mutual inductance of the primary and secondary coils from their dimensions. Such a solenoid made large enough and carefully enough to give the mutual inductance with fair precision is both bulky and expensive, and not very portable. Being of considerable length, its magnetic field often extends to a considerable distance and may disturb other work. On the other hand, suitable primary and secondary coils may be wound on a thoroughly seasoned wood spool (or a marble spool) only 10 to 12 cm. in diameter and afford, when calibrated, an accurate and convenient mutual inductance for the calibration of galvanometers that is cheap, portable and reliable. Such inductances are so inexpensive and occupy so little space that one can be left with its secondary in circuit with the galvanometer, ready to be used for calibrating the latter at any time. They can be made in the laboratory at trifling cost and can be sent by mail or express to the Bureau of Standards and calibrated at very slight expense. Specifications for such coils will shortly be published by the bureau.

*The Mutual Inductance of Two Coaxial Coils:* E. B. Rosa.

Absolute measurements of resistance have been made by Rowland, Glazebrook and others, using two coaxial coils the mutual inductance of which was computed from their dimensions. By the methods employed by Kohlrausch and Rayleigh the mean radius of such coils can be obtained with great precision by comparing them with larger coils wound with a single layer of wire, the mean radius of which may be determined with sufficient accuracy by direct measurement. The formulæ employed by Rowland and Glazebrook in calculating the mutual inductances of their coils are both approximate, and do not agree with one another closely unless the coils have very small sections or are rather far apart. Weinstein and Stefan both gave formulæ for use in calculating the mutual inductance of such coils, but they do not agree with one another as accurately as is desirable for precision work. I have revised and corrected Weinstein's formula and derived a new formula starting where Stefan began, these two formulæ agreeing very closely and proving more accurate than any of the others. These formulæ are sufficiently accurate for the most refined work in the absolute measurement of resistance.

*Remarkable Optical Properties of Carborundum:* Lewis E. Jewell.

Some transparent blue plates of carborundum, found in 1904, gave by preliminary measures with a microscope a very high value for the refractive index.

Later, in material received from the Carborundum Company of Niagara Falls, were found some transparent and colorless plates, some of which were fairly thick. The polarization of the plates was studied with the polariscope and one specimen of twinned crystals produced a well-defined, transparent, colorless prism where the plates were joined.

Measurements with the spectrometer were made and the refraction proved to be greater than that of the diamond, and the dispersion more than twice as great.

Spectrograms were obtained of the light transmitted through the plates and a thickness of one thirtieth of a millimeter absorbed practically all light having a wavelength less than 4,000 Ångström units.

Interference bands in the spectrum of light transmitted through their parallel plates gave greater values of the dispersion than the measurements with the spectrometer. Spectrograms have also been obtained of the light reflected from the surfaces of the crystals and the reflective power, which is extremely high, differs very little in the visible and ultra-violet portions of the spectrum until a wavelength of about 2,400 is reached, beyond which there seems to be an absorption band.

Very remarkable markings have been found upon some plates, the most remarkable of which take the form of spirals, some of which are hexagonal and others triangular, changing to hexagonal farther out. Most of the spirals are, however, circular; some of them are so close together and so regular as to form brilliant spectra, even to the sixth or eighth order; the lines in some cases are as close together as thirty or fifty thousand to the inch. Many of these markings are extremely beautiful.

Sometimes there are two outer coatings

to the plates, the outer an oxidation product giving the brilliant surface colors which are due to a thin film. Sometimes there is another layer with an exceptionally brilliant silver-like surface.

*The Absorption of Some Solids for Light of Short Wave-length:* THEODORE LYMAN.

The grating spectroscope which the author has used in his measurement of the hydrogen spectrum between 1,650 and 1,250 Ångström units, though well adapted for the determination of wavelengths, is not especially fitted for rapid work in other branches of the subject. A prism spectroscope would be preferable for many purposes on account of its short light path and the superior intensity of its spectrum.

The first purpose, therefore, of the present research was a purely practical one, namely, to find some substance from which the prism and lenses of such an instrument might be constructed. White fluorite is the only known substance fitted for the purpose, and it was hoped that a less costly substitute might be discovered.

In order to test rapidly the transparency of a great number of substances an instrument of special type was constructed. In it the light from a discharge tube fell upon a concave mirror and was thrown by it through a fluorite prism on to a screen coated with willimite. The whole apparatus was enclosed in an air-tight case which could be exhausted and filled with hydrogen. The specimens to be examined were introduced into this case in such a manner that eight of them could be interposed in succession between the mirror and source of light without opening the apparatus. The extent and intensity of the spectrum on the fluorescent screen was observed through a glass window.

The substances examined were: Colored fluorites, quartz, topaz, gypsum, celestite, rock salt; barite alum, colemanite, sugar (rock candy), borax adularia, calcite, chrysoberyl, sanidin, anagonite, and apophyllite. The results are:

I. No substance shows so great transparency as white fluorite.

II. The transparency of colored fluorites varies through a considerable range, but some light green specimens are nearly as good as the white variety.

III. Colored fluorites may be deprived of their color by heating. The process does not materially alter their transparency.

IV. Quartz in thicknesses of about 1 mm. is transparent to $\lambda$ 1,500. The absorption increases with such rapidity with the thickness that prisms and lenses would cut the spectrum off at about $\lambda$ 1,750 for all practical purposes.

V. Of the remaining substances Ceylon topaz is the best, being transparent to $\lambda$ 1,560.

VI. Rock salt is transparent to $\lambda$ 1,750 only.

*Geometrical Theory of Radiating Surfaces with Discussion of Light Tubes:* EDWARD P. HYDE.

Theoretical photometry assumes two general laws of radiation. (1) The law of variation of the intensity of illumination of a surface in face in inverse proportion to the square of the distance of the surface from the luminous source is merely a statement of a geometrical property, if the rectilinear propagation of light is assumed. (2) Lambert's law of variation of the intensity of a luminous surface in direct proportion to the cosine of the angle of emission is an empirical law based primarily on the observation that a uniformly bright sphere, when viewed at a distance, appears as a uniformly bright disk. It would seem to follow from Kirchhoff's law that Lambert's cosine law can be true only for a black body, but no satisfactory experiments have been made, so far as the writer knows, to test the law empirically in its application to glowing surfaces.

These two laws, the inverse-square law and the cosine law, are applicable to the infinitesimal elements of a radiating surface, and large errors may result if they are assumed to apply to an extended source as a whole. Particularly is this so in the case of the inverse-square law, which underlies the great majority of photometric measurements.

In each of the above two cases the expression is deduced for the illumination at different distances in a single plane or along a single line symmetrical with respect to the radiating surface. In the case of a uniformly bright strip of infinite length but of finite width it is not difficult to derive the expression which will give the illumination at any point in space. Instead of illumination, however, the more general term *specific luminous flux* is substituted. At every point in space there is some definite direction in which the flux of luminous energy is a maximum. The quantity of luminous energy which in one second flows normally across a surface of unit area placed perpendicular to the direction of maximum flux is defined as the *specific luminous flux* at the point. It is a vector quantity, and the component in any direction equals numerically the difference in illumination on the two sides of an infinitely thin material screen placed perpendicular to the direction.

Two examples are given of the errors incident to assuming for a finite surface the inverse square law, which only applies to the elements of the surface; the above case of an infinite strip is used to show the errors incident to assuming for the strip as a whole the cosine law, which is true only for the elements of surface of the strip. The value of $\phi_0$ at different distances in a direction normal to the strip at its middle point, and in a direction making an angle of 45° with the normal at the middle point, are calculated. For any definite distance the former multiplied by cos 45° would equal the latter if the cosine law, which has been assumed for the elements of surface, applied to the surface as a whole. The difference between the two values gives the errors for the distance used, and by plotting the errors for different distances a curve of deviation from the cosine law is obtained.

*On the Magnetic Properties of Heusler's Alloys:* J. C. McLennan.

In this paper the author describes some experiments made during the past year by Messrs. Dawes, McTaggart and Robertson, and Mr. L. B. Johnston, on the magnetostriction and permeability of Heusler's alloys of varying composition.

From measurements on both phenomena the alloys are shown to be in an exceedingly unstable condition when freshly made, and from observed changes in their magnetic behavior the conclusion is drawn that profound modifications are made in their structure through the lapse of time as well as by their being subjected to changes in temperature and to repeated magnetizations and demagnetizations.

In connection with the phenomenon of magnetostriction the gradual shortening observed by Austin with rods of the alloys subjected to long-continued high magnetic fields is shown to disappear when the rods have reached a stable condition after being repeatedly magnetized.

In a series of rods containing the same amount of manganese with varying amounts of aluminium the greatest elongation was observed with rods in which the manganese and aluminium were present in the ratio of their atomic weights.

The paper concludes by emphasizing the suggestion made by Hill that possibly the magnetic properties of these alloys at room temperatures are largely determined by the temperatures from which they have been cooled, and that by suitably heating samples of the alloys to different temperatures and then chilling them their magnetic properties at these temperatures may be ascertained, just as the structures of other alloys at different temperatures have been investigated in this way by Neville and Heycock.

*On the Magnetic Susceptibilities of Mixtures of Salt Solutions:* J. C. McLENNAN and C. S. WRIGHT.

In this paper the authors give some measurements on the magnetic susceptibilities of solutions of manganese, aluminium, and copper sulphates in water, and several mixtures of these solutions made with the object of obtaining information which might be of service in explaining the behavior of the magnetic alloys, recently discovered by Heusler. The method followed in measuring the susceptibilities is that suggested by Kelvin, in which a glass cell of the solution investigated is placed in a strong magnetic field and the susceptibility deduced from the pull exerted on the solution by the field.

The magnetic susceptibility of water was found to be $-7.33 \times 10^{-7}$. Measurements on a series of salt solutions gave the following molecular susceptibilities:

| | | $M_s$ |
|---|---|---|
| Manganese sulphate | $MnSO_4$ | +.01491 |
| Copper sulphate | $CuSO_4$ | +.00153 |
| Aluminium sulphate | $Al_2(SO_4)_3$ | —.00018 |
| Aluminium nitrate | $Al_2(NO_3)_6$ | +.00002 |
| Aluminium chloride | $Al_2(Cl)_6$ | —.00005 |

A set of measurements on solutions of manganese sulphate of different concentrations showed that the molecular susceptibility of the salt was independent of the concentration.

*On Magnetic Shielding:* A. P. WILLS.

Assuming the results of a previous paper, giving the 'shielding ratio' for a set of three concentric spherical iron shells and for a similar set of cylindrical shells, the following problem was discussed: Given the innermost and outermost radii of the system in each case, what values should the remaining four radii have in order that the shielding shall be a maximum? Starting with the expression giving the 'shielding ratio' (the ratio of field impressed to field within innermost shell), derived in the paper referred to above, the conditions for a maximum of the expression, under the conditions imposed, are examined; and it is found that approximately the best conditions are obtained when the radii of the shells are in geometrical progression. This holds for both spherical and cylindrical systems.

*Models Illustrating the Motion of a Violin String:* HARVEY N. DAVIS.

The function $u(x, t)$ which gives the displacement, at the time $t$, of a point $x$ units from one end of a violin string, can be represented graphically by a surface with the $x$, $t$ plane as a base-plane. If the units were properly chosen, this graph would be the surface which the string would generate if, while it vibrated, it were also carried along in a direction perpendicular to the plane of its vibration; and in any case, a section of such a surface parallel to the $x$ axis represents, usually on a magnified scale, the configuration of the string at some corresponding time, $t = t_0$, while one parallel to the $t$ axis represents the displacement of a corresponding point, $x = x_0$, as a function of the time.

Five surfaces of this kind, modeled in three dimensions, were shown, representing, one the general Helmholtzian solution and the other the motion of a string bowed at points 1/5, 2/5, 2/7 and 3/8 of its length from one end. These particular cases were chosen because, besides being typical, they have some interest in connection with Young's and Krigar-Menzal's observations on the absence or dominance of certain overtones when a string is bowed at or near one of their nodes.

*The Motion of a Violin String under Light Bowing:* Harvey N. Davis.

This paper discusses the influence which the pressure of the bow upon the string has on the resulting vibration form. For each bowing speed there is, for comparatively great pressure, a considerable range within which the only effect of a change in the pressure is a slight corresponding change in the position of equilibrium about which the string vibrates, the vibration form being always that described by Helmholtz and others, and the amplitude remaining the same. For smaller pressures both the amplitude and the vibration form change with the pressure. In particular, if the pressure is below a certain critical value, determined partly by the materials and condition of the apparatus and partly by the bowing speed, no vibrations can be maintained. For pressures slightly greater than this critical pressure there are no overtones, the time graph of the displacement of the point under the bow being the sine curve tangent at its point of greatest slope to a line representing the speed of the bow. As the pressure is increased beyond this value, the bowing speed remaining constant, the mode of vibration goes over continuously into the Helmholtzian form.

*On Distributions of Nuclei and Ions in Dust-free Air:* Carl Barus.

I have recently found it desirable to gather my data together for comparison. There is, in fact, a serious discrepancy between Mr. C. T. R. Wilson's results and mine when reduced to the same scale. Mr. Wilson's supersaturations for negative ions and cloud are distinctly higher, which certainly can not mean that my fog chamber is in these regions inferior to his own. Thus in moderately ionized dust-free air my condensations begin at a drop of about 18.5 cm. from 76 cm. as compared with 20.5 in Wilson's apparatus; similarly my fogs begin at the drop 20.3, Wilson's at 27.7. Furthermore, at low ionization even the vapor nuclei of dust-free wet air become efficient in the presence of ions. It seems impossible, therefore, that any positive ions should fail of capture. The question is to be asked why I catch the negative ions, etc., at an apparently much lower supersaturation than C. T. R. Wilson. I have entertained doubts whether the inertia of the piston in his apparatus is initially quite negligible; whether in any apparatus the computed adiabatic temperatures were actually reached. Nobody has proved it, and the case is worse for tubes. Moreover, in every apparatus there must be a limit at which the smaller nuclei of a graded system can no longer be caught in the presence of the larger nuclei. But I do not believe that the real discrepancy will be found in any of these misgivings. It seems to me to be inherent in this; in Wilson's apparatus the results are given from the observed volume ratio $v_1/v$ of adiabatic expansion; in my method the results follow from the observed pressure ratio $p/p_1$. It seems questionable whether the customary constants by which one passes from one group of data to the other are really applicable, to wet air at very low temperatures. Moreover, when the exhaust cock in my apparatus is opened for

$t = 0$ .25 .5 1 2.5 5 $\infty$ sec.

The isothermal pressures of the fog chamber (cæt. par.) read

$\overline{p}_2 =$ (57.8) 53.2 52.7 52.0 51.5 50.9 50.4 cm., so that in the first quarter second of opening the final isothermal pressure $p_3$ (chambers communicating) is already reached to more than 60 per cent., and my smallest fog chamber holds over 6 liters. One naturally asks whether the importance of this in its bearing on the measurements of the ratio of specific heats $k/c$, has ever been adequately appreciated.

*Fluorescence Absorption:* E. L. NICHOLS and ERNEST MERRITT, Cornell University.

*Energy Necessary to Ionize a Molecule by Impact of Negative Electrons:* BERGEN DAVIS, Columbia University.

*The Transformation into an Electric Current of Radiation Incident on a Moving Surface:* BERGEN DAVIS, Columbia University.

*The Standard Cell:* F. A. WOLFF and C. E. WATERS, Bureau of Standards.

*The Equilibrium of Mercurous Sulphate and Mercury and Cadmium Sulphate:* F. A. WOLFF and C. E. WATERS, Bureau of Standards.

*The Distribution of Energy emitted by a Righi Vibrator:* C. R. FOUNTAIN.

*The Constants in Gas-viscosity:* WILLARD J. FISHER, Cornell University.

*Production of Radium by Actinium:* BERTRAM B. BOLTWOOD.

*Production of Radium from Actinium:* E. RUTHERFORD.

*The Influence of Electrical Fields upon Spectral Lines:* G. F. HULL, Dartmouth College.

*Helion, a New Incandescent Lamp Filament:* H. C. PARKER and W. G. CLARK.

*The Magnetic Rotation of Sodium Vapor at the D lines:* R. W. WOOD.

*Flourescence Spectra of Mercury Vapor:* R. W. WOOD.

*Hydraulic Analogy of the Welsbach Mantle and other Radiators:* R. W. WOOD.

*The Shielding of a Highly Sensitive Galvanometer:* E. F. NICHOLS and S. R. WILLIAMS.

*On the Temperature of the Mercury Arc:* CHARLES T. KNIPP.

*A Study of the Reversible Pendulum:* JOHN C. SHEDD and JAMES A. BIRCHBY.

*Wave-metrical Measurements with Wireless Telegraph Circuits:* G. W. PIERCE.

*The Electrical Properties of Carborundum:* G. W. PIERCE.

DAYTON C. MILLER,
*Secretary of Section B*

## *SCIENTIFIC BOOKS*

*Qualitative Analysis as a Laboratory Basis for the Study of General Inorganic Chemistry.* By WILLIAM CONGER MORGAN, Ph.D. (Yale), Assistant Professor of Chemistry in the University of California. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1906. Pp. xiv + 351.

That the last word as to the best method of teaching chemistry has not yet been spoken is evidenced by the number of new text-books in general and analytical chemistry. Such a multiplicity of new books may be from a financial standpoint unsatisfactory to authors and publishers, but it reveals an activity and healthy independence on the part of teachers of chemistry. Most if not all these books are written, not to sell, but to bring out the writer's views for his own classes.

The latest book on qualitative analysis is that by Dr. Morgan, and is to some extent along new lines. Most teachers of chemistry in colleges are confronted with a difficulty arising from the chemistry of fitting schools. Comparatively few students present themselves for entrance to college well grounded in general chemistry, especially as viewed from the modern physical chemical standpoint, and yet these men are too advanced to be put in a class which is open to beginners. They have