

MINUTES OF THE MEETING

OFFICERS OF THE OPTICAL SOCIETY

<i>President</i>	Irwin G. Priest
<i>Vice-President</i>	Loyd A. Jones
<i>Secretary</i>	Charles C. Bidwell
<i>Treasurer</i>	Adolph Lomb
<i>Editor-in-Chief</i>	Paul D. Foote
<i>Asst. Ed.-in-Chief</i>	F. K. Richtmyer
<i>Past President</i>	W. E. Forsythe

Elected Members of Council

L. R. Ingersoll	A. H. Pfund
P. E. Klopsteg	W. F. Meggers

SPECIAL COMMITTEES FOR THIS MEETING

Bureau of Standards Committee on General Arrangements for the Meeting (Representing the Director of the Bureau): Frederick J. Bates (Chairman); E. C. Crittenden, Geraldine K. Walker, G. H. Vaneman.

Joint Committee of the Bureau of Standards and the Optical Society on the Optical Exhibition: I. C. Gardner (Chairman); Henry D. Hubbard, Raymond Davis, G. H. Vaneman.

Committee on Exhibition of Books on Optics: Frederick E. Brasch, Chief, Smithsonian Division of the Library of Congress, and Secretary of the History of Science Society (Chairman); A. Fanti, Librarian, Bureau of Standards; I. C. Gardner, Bureau of Standards.

Optical Society Committee on Registration, Hotel Headquarters, and Dinner: Frederick J. Bates.

Optical Society Committee on Visit to the Naval Observatory: C. C. Kiess.

MINUTES OF THE EXECUTIVE COUNCIL

Cosmos Club, October 31, and Bureau of Standards, November 1
and November 3, 1928.

The preliminary report of the Secretary indicated status of the Society's membership on November 1st, as follows:

Regular Members.....	304
Associate Members.....	139
Honorary Members.....	6
Corporation Associates.....	6
Life Members.....	8
	<hr/>
Total.....	463

(The membership status given in this report is of October 30. Changes in membership (election to regular membership, etc.) were made by the Council after this report was compiled. Members who had submitted resignations and those dropped for non-payment of dues are taken into account in this table.)

Ten resignations by letter were received during the year. Thirteen members were dropped for non-payment of dues and thirty-three new members elected as associates. The names of these new members were read by the Secretary. Action on the resignations was referred by motion to the Secretary and Treasurer who were given power to accept resignations of those whose dues were paid.

The Committee on Time and Place for next annual meeting reported invitations from the University of Pittsburgh, and Pennsylvania State College. An invitation extended informally by F. K. Richtmyer to hold the next meeting at Cornell was favorably received. It was decided by vote of the Council to hold the next annual meeting in October at Cornell University, Ithaca, N. Y., subject, however, to receipt of a formal invitation from Cornell University and confirmation by the Council at the February meeting.

It was moved that future Councils consider Rochester and Pittsburgh for the meetings for 1930 and 1931 respectively.

The following associates were elected to regular membership:

J. W. Beams	A. W. McMahon
F. G. Brickwedde	D. Stockbarger
R. C. Gibbs	Wm. T. Anderson
R. L. Hanson	Burt H. Carroll
E. A. Harrington	W. H. Fulweiler

J. R. Harrison	R. E. Martin
H. J. Howard	A. H. Poetker
H. D. Hubbard	F. G. Slack
E. O. Lawrence	F. E. Swindells
H. W. Russell	T. R. Wilkins
H. F. Stimson	W. F. Little
F. G. Wick (Miss)	F. M. Kannenstine

It was moved that the Jury of Award of the Ives Medal consist of five members to be appointed by the President. The Council recommended the following appointments for this Committee, viz., Henry Crew, (Chairman), H. E. Ives, K. T. Compton, Theodore Lyman, L. T. Troland. This Committee was appointed by the President and confirmed by the Council.

The matter of publication of the proceedings of the Michelson Meeting was discussed. It was voted that the published proceedings should contain abstracts of papers, portrait of Professor Michelson, a bibliography of the published papers of Professor Michelson, a description of the optical exhibition but not details of exhibits.

A Committee on Publication of the Proceedings of the Michelson Meeting was appointed as follows:

C. C. Bidwell	P. D. Foote
H. D. Hubbard	F. K. Richtmyer
I. C. Gardner	

The Council voted that the special arrangement with the American Physical Society for reduced rates for the Journal of the Optical Society for members of the Physical Society be terminated with subscriptions ending December 31, 1929 and that the Treasurer and Secretary of the Physical Society be so informed.

A preliminary report of the Treasurer was presented for filing with the Secretary's records.

The meeting adjourned at 10:30 P.M. to meet November 1st, at the Bureau of Standards.

ADJOURNED MEETING—BUREAU OF STANDARDS—4 P.M. NOV. 1, 1928

The meeting was occupied by discussion of the question of the publication and care of the Society's Records and of the matter of annual publication of the Year Book. The Committee on Care and Publication of the Society's Official Records and Reports was unable to make any definite recommendations and the question was discussed at length by

the Council and the Committee sitting together. Although no definite action was taken there seemed to be general agreement that the Secretary, Treasurer and Business Manager of the Journal at the end of the year should submit for early publication in the Journal formal reports covering the preceding calendar year; and that these reports be published in a definite section inserted between the Optical and Instrument Sections; and that a standard caption and style of composition be adopted and adhered to such as *Optical Society of America, Report of the Secretary, or Report of the Treasurer, or Minutes of the Executive Council*; and that all such reports or notices be listed in the table of contents of the particular number in which they appear and also indexed in the volume.

The question of publication *annually* of the year book was discussed at length. The matter of expense and manner of publication was debated and no definite unanimity of opinion arrived at. There was a strong opinion that a biennial publication of this sort would be sufficient. No vote on the matter was taken.

The meeting adjourned at 5:30 P.M.

ADJOURNED MEETING—BUREAU OF STANDARDS—1 P.M. NOV. 3, 1928

By motion of the Council the Secretary was instructed to communicate with the Secretary of the Physical Society with a view to holding the customary joint meeting in New York in February.

A motion was passed that a registration fee of 50¢ be assessed at the annual meetings to defray the special expenses of the local committee.

It was moved that the deficit for expenses incurred by the local committee for the Michelson Meeting be defrayed by the Society. (Note: The local committee reported later that it had balanced its books; and declined to accept any reimbursement from the Society.)

The Editor of the Journal was instructed by vote of the Council to secure for publication in the Journal the paper of Professor Laurens which was presented by invitation at the Michelson Meeting.

It was moved and passed that the President appoint a committee on revision of the Constitution and By-Laws and that the President be a member of that Committee.

The meeting adjourned at 2:15 P.M.

CHARLES C. BIDWELL, *Secretary*

GENERAL ACCOUNT OF THE MEETING

The Michelson Meeting of the Optical Society of America was held November 1, 2, 3, 1928 at the National Bureau of Standards where the

Society and its guests were welcomed on the morning of November 1 by the Secretary of Commerce.

Its character as a celebration, the importance of papers which were presented, the demonstrations of unusual motion pictures, the simultaneous Optical Exhibition, the unprecedented attendance, and the enthusiasm with which this assembly paid its tribute of honor and respect to Professor Michelson all conspired to make it a most unusual meeting.

The notable event which the Society and hundreds of invited guests celebrated was the semi-centennial of the publication of Professor Albert A. Michelson's first contribution to science. This celebration, with Professor Michelson present as the guest of honor, took on quite spontaneously much the character of an informal birthday surprise party,—the fiftieth anniversary of Michelson's birth as a man of science. There was no set program of eulogy nor formal reviews of the work of the honored guest; but the whole assembly took upon itself to pay its spontaneous tribute of honor and respect to intellect and achievement.

The outstanding paper of the meeting was that presented by Professor Michelson himself,—“Results of Repetition of the Michelson-Morley Experiment.” In a lecture room which normally seats hardly more than 300, there had gathered to hear him probably about 500 people, while many more who came were unable to get in. Following this paper Professors Swann, Lyman, Richtmyer, and Miller spoke briefly in appreciation of Michelson's work, and in discussion of this paper.

The session at which Prof. Michelson presented his paper was followed by tea and an informal social gathering in the lecture hall.

On the evening of November 2 over two hundred persons attended the dinner in honor of Professor Michelson. They were much interested to hear Professor Michelson himself and his friend Professor C. E. Munroe tell their reminiscences of Michelson's early optical research at the U. S. Naval Academy.

Another notable event of the meeting was the formal presentation of the endowment for the Frederic Ives Medal to the Society by Dr. Herbert E. Ives, who has commissioned the Society to award the medal (usually biennially) “for distinguished work in optics.”

The showing of Prof. W. H. Wright's motion pictures of Jupiter and the demonstration of Technicolor motion pictures were received with such acclaim that it was necessary to repeat them twice in order to satisfy the demand to see them. In the three showings they were probably seen by nearly 1000 persons.

On the evening of November 1, about 120 out-of-town visitors to the meeting enjoyed a visit to the Naval Observatory. The demand for admission to this party was a striking illustration of the interest in astronomy. About 500 persons actually requested tickets and it is estimated that about 700 tickets would have been taken had they been available. Since the observatory authorities did not consider it feasible to handle a party greater than 120, the local committee was obliged to limit the party strictly to out-of-town members and guests, and unfortunately not even all of these could be accommodated.

The attendance at the meeting may be analysed and considered in several ways as will be done below. The actual figures as kept at the registration desk will be given; but it must be understood that the total of persons who attended one or more sessions was far in excess of this registration, as many came who did not register. It is estimated that about 1000 persons attended one or more sessions. There is no record of those who may have visited the Optical Exhibition without attending the meeting.

The registration records are of two kinds: (1) advance registration by mail; (2) registration at the desk in person. The essentially interesting features of the attendance are shown in the following tables.

Distribution between Members and Non-members.

	Members	Non-Members
(1) Number who registered in advance.....	89	315
(2) Number who registered in advance and also reported at at the registration desk.....	86	175
(3) Number who registered at desk without registering in advance.....	38	219
Total book registration (1)+(3).....	127	534
		661
Total number who actually reported at registration desk (2)+(3).....	124	394
		518

Distribution between Local and Out-of-Town Registration

	Local	Out-of-Town
Total book registration.....	380	281
Actual report at desk in person.....	248	270

Distribution of Local Registration between Members and Non-Members

	Members	Non-Members
	36	344

Distribution of Out-of-Town Registration between Members and Non-Members

	Members	Non-Members
	91	190

Estimated Attendance at Various Sessions

Thursday, November 1, A.M.	300
Thursday, P.M., total at three showings of motion pictures.	1000
Friday, November 2, A.M.	400
Friday, November 2, P.M.	500
(Many were turned away because the room would not hold the crowd.)	
Saturday, November 3, A.M.	300
Saturday, November 3, P.M.	300

CALENDAR OF MEETING

The sessions of the Optical Society occupied three days, November 1 to 3, inclusive. The Optical Exhibition was open from 9:00 A.M. to 5:00 P.M., October 31 to November 3, inclusive.

Visitors were invited to inspect the laboratories of the Bureau of Standards on Wednesday, October 31 and Monday, November 5, as well as during the days of the meeting.

Thursday, November 1

- 9:00 A.M. Welcome by the Secretary of Commerce.
 Business, Reports and Papers on Geometrical Optics, Photometry, Colorimetry, and Technic.
- 2:30 P.M. Demonstration of Technicolor Motion Pictures.
 Motion Pictures of the Planets.
- 8:00 P.M. Visit to Naval Observatory.

Friday, November 2

- 9:00 A.M. Papers on Physical Optics.
- 2:15 P.M. Extra Session (not on program).
 Demonstration of Panoramic Motion Picture Photography by System of Prof. Chrétien.
 Informal Communication on the Raman Effect by Prof. R. W. Wood.
- 3:30 P.M. Paper by Prof. Michelson and collaborators on "Results of Repetition of the Michelson-Morley Experiment."
- 4:00 P.M. Tea.
- 7:00 P.M. Dinner in Honor of Professor Michelson.

Saturday, November 3

- 9:00 A.M. Papers on Biological Optics.
- 2:30 P.M. Address by Dr. Leonard T. Troland on "Optics as Seen by a Psychologist."
 Papers on Physiological Optics.
- 8:15 P.M. Joint Meeting of the Philosophical Society of Washington and the Biological Society of Washington to which members of the Optical Society were invited. Address by Dr. Selig Hecht on "The Nature of the Sensitivity of Animals to Light."

TITLES OF ADDRESSES GIVEN BY INVITATION

A. A. Michelson, Francis Pease, and Fred Pearson: *Results of Repetition of the Michelson-Morley Experiment.*

Paul R. Heyl: *The History and Present Status of the Physicist's Idea of Light.*

C. J. Davisson: *Electrons and Quanta.*

Arthur H. Compton: *X-Rays as a Branch of Optics.*

R. W. Wood: *Recent Experiments on the Raman Effect.* (Informal presentation, illustrated by exhibit of apparatus used by Prof. Wood.)

John W. T. Walsh: *The Reduction of Glare from Automobile Headlights.*

H. Buckley: *The Theory of Interreflection in Light Wells.*

Leonard T. Troland: *Optics as Seen by a Psychologist.*

Henry Laurens: *The Physiological Effects of Radiation.*

John M. Arthur: *Some Effects of Radiant Energy on Plants.*

W. J. Crozier: *The Phototropic Behavior of Animals.*

F. M. Schertz: *Application of Transmittancy Measurements to Biochemistry.*

Selig Hecht: *The Nature of the Sensitivity of Animals to Light.*

(By arrangement with the Philosophical Society of Washington and the Biological Society of Washington, Professor Hecht's paper was presented at a joint meeting of those societies Saturday evening instead of at a regular session of the Optical Society.)

ABSTRACTS OF PAPERS PRESENTED

Committee on Standards of Photographic Intensity

L. A. Jones (*Chairman*); E. C. Crittenden, Raymond Davis, K. S. Gibson, A. C. Hardy, H. E. Ives, C. E. K. Mees, A. G. Worthing.

RESOLUTIONS DEALING WITH THE PHOTOGRAPHIC UNIT OF INTENSITY PRESENTED AT THE INTERNATIONAL CONGRESS OF PHOTOGRAPHY

At a meeting of the Scientific Section of the International Congress of Photography on the morning of Thursday, July 12, the report of the Committee of the Optical Society of America on the photographic standard of intensity was read, and the adoption of the recommendation relating to the standard itself was put as a motion by Dr. Mees and seconded by Dr. Sheppard.

Mr. Guild of the National Physical Laboratory considered that the definition proposed was not satisfactory since the sunlight was not of a sufficiently defined quality. He was not prepared to accept the standardization of it from Abbot's values. In the National Physical Laboratory, also, no difficulty had been met with in the use of ammoniacal solutions which were not found to change in closed cells, and since pyridine was difficult to obtain in a pure and colorless state, he recommended that ammonia be used instead. This point was also brought up by M. Calsavara of France.

Dr. Slater Price, acting as chairman, reviewed the differences between the English and American Committees, which depended on the fact that the Americans accepted one candle power of sunlight as the ideal standard, whereas the English prefer to accept as the photographic candle one candle power of a lamp of 2360°K. transmitted through the stated filter without reference to sunlight at all. Toy stated that the English Committee would accept such a definition. L. P. Clerc, speaking for the French Committee, stated that they had not been able to have any meetings on the subject, since the matter had not been referred to them before the Congress, and he could not therefore make any statement. Speaking for the Germans, who also protested against not having received any prior information, Dr. Lehmann, Dr. Goldberg, and Dr. Eggert were prepared to accept the proposed unit for the sensitometry of negative emulsions but not for the sensitometry of positive emulsions.

After a long discussion, Dr. Mees accepted the proposals of the English Committee and withdrawing his original motion proposed that the photographic unit of intensity should be defined as one visual candle power of a lamp having a temperature of 2360°K. transmitted through the given filter. M. Clerc and Dr. Slater Price pointed out that the composition of the filter was given to milligrams and recommended that in practice the weighing should be required only to centigrams. Mr. T. Smith of the National Physical Laboratory requested that a tolerance of ± 0.05 mm be fixed for the thickness of the liquid in each division of the cell.

The other two recommendations of the Committee were then discussed at some length, but no definite conclusion was reached.

On Friday afternoon the resolution which had been accepted for the standard of light was withdrawn on the motion of Dr. Slater Price, seconded by Dr. Mees. It was then resolved that the following resolution¹ shall be put in force as a decision of the Seventh International Congress of Photography as soon as it has been ratified by the national committees represented at the Congress:

"The photographic unit of intensity for the sensitometry of negative materials shall be defined as the intensity of a source of radiation having a luminous intensity of one international candle and produced by a gray body at a color temperature of 2360°K, together with a selectively absorbing filter made up as follows: Two solutions compounded according to the following formula, the complete filter to consist of a one-cm* layer of each solution contained in a double cell made by using three plates of borosilicate crown glass (refractive index, D line = 1.51), 2.5 mm thick."

Solution A

Copper Sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)	3.707 grams.**
Mannite ($\text{C}_6\text{H}_8(\text{OH})_6$)	3.707 grams**
Pyridine ($\text{C}_5\text{H}_5\text{N}$)	30.0 cc
Water (distilled) to make	1000 cc

Solution B

Cobalt Ammonium Sulfate ($\text{CoSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$)	26.827 grams**
Copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)	27.180 grams**
Sulfuric Acid (Sp. gr. 1.835)	10.0 cc
Water (distilled) to make	1000. cc

The other resolutions proposed by the American Committee were not passed.

*With a tolerance of ± 0.05 mm.

**For practical purposes a precision of one centigram will probably be sufficient.

¹ The exact wording of the resolution adopted was somewhat different from that here given. The correct form of the resolution is given in the British Journal of Photography, p. 432, July 20, 1928; and will be given in the report of the O. S. A. committee now in press.

I. C. Gardner

Bureau of Standards

**A TELESCOPE OBJECTIVE ESPECIALLY FREE FROM SPHERICAL
ABERRATION**

Specifications for a telescope objective, to be used by Dr. L. B. Tuckerman in his auto collimator forming a part of his extensometer, demand a 50 mm aperture, an equivalent focal length of 250 mm, longitudinal spherical aberration less than 0.05% of focal length, and a design such that it will be feasible to construct several objectives which shall differ in focal length by not more than 0.05%. To meet this last requirement an air space is necessary to permit adjustment of spacing for compensation of unavoidable differences in construction of individual components. The final design consists of two cemented doublets of barium crown and medium flint with the crown component in each case facing the parallel light and spaced 10 mm. Although there are 6 surfaces, only 4 different curvatures are required (an economy in manufacture) and spherical aberration and departure from sine condition are each well within 0.05% of focal length. The design has been executed and found to be satisfactory. Details of the application of algebraic method to design and discussion of tolerances allowable in the construction will be given.

I. C. Gardner

Bureau of Standards

AN OPTICAL DEPTH GAGE

This instrument is analogous to the self-contained coincidence-type military range finder except that the two optical systems united by the coincidence prism are microscopes instead

of telescopes. The magnifying power is approximately 90 diameters and the axes of the two systems are inclined to each other at an angle of 25° . A range finder coincidence-prism provides a circular field divided by a diameter. The images formed by the two microscopes are brought into the two halves of the field respectively, and are so focused that the dividing line and images are without parallax.

When an object is at the intersection of the two optical axes the images formed by the two microscope objectives are in coincidence at the center of the dividing line. Suitable fine adjustments are provided for bringing the two halves of the field into this relative position with precision. If the object is displaced along the line of sight by as little as 3 or 4 microns, it is detected by the lack of coincidence of the two fields. One therefore has an optical depth gage with a working distance between objective and object of approximately 50 mm, and with the probable error of a single observation of a displacement in the line of sight not greater than 3 or 4 microns. By having the instrument suitably mounted with precision ways, such as are used with the comparator or travelling microscope, displacements normal to the line of sight can be measured in the usual manner. The present instrument has been designed to be used for the measurement of internal screw threads and for this purpose it is provided with a special nose piece carrying an objective prism and an opaque illuminator of novel design. It can be used for any purpose where accurate measurements in the direction of the line of sight, as well as normal to it, are desired. As there is no physical contact between the instrument and the surface to which the measurement is to be made, it is particularly applicable to measurements where the pressure due to physical contact of the more usual methods introduces deformation which prevents the attainment of the desired precision.

A. H. Bennett

Bureau of Standards

AN INTERFERENCE METHOD FOR THE DETERMINATION OF AXIAL AND OBLIQUE ABERRATIONS

A method for the determination of the axial and oblique monochromatic aberrations of an optical system is described. The results are expressed directly in terms of the phase difference of various portions of the emergent wave front on arrival at any point along the axis or chief ray. The best focus is located at the point of minimum phase residuals. The simplicity of the apparatus, especially the use of but one auxiliary reflecting surface, lessens the probability of large instrumental errors. The method has been applied to several astronomical objectives and the results are presented in the form of contours showing phase difference over the wave front.

Bibliography:

Hartmann, *ZS. f. Instrumentenkunde*, 24, p. 110; 1904.

Gardner and Bennett, *J.O.S.A. & R.S.I.*, 11, p. 441; 1925. Twyman, *Phil. Mag.* (6), 35, p. 49; 1917.

John W. T. Walsh

National Physical Laboratory, England

(By Invitation)

THE REDUCTION OF GLARE FROM AUTOMOBILE HEADLIGHTS

In this paper an attempt is made to indicate a method for defining the beam characteristics of motor-car headlights so as to obtain the maximum visibility of objects on the off side of an opposing vehicle.

The method is based on the application of work by Holladay on the lowering of the contrast sensitivity of the eye which is caused by the presence of a glaring source of light in the field of view. Certain skeleton conditions are laid down for fulfillment by headlights in order that a certain figure of visibility may be obtained under specified conditions.

In a final section of the paper the proposal is made that vehicles should be provided with projectors giving a colored beam of light in the rearward direction so as to illuminate the off

side of the road behind them for a comparatively short distance. It is pointed out that this would probably be a very great help in securing adequate visibility on the road when vehicles are passing each other, and it is suggested that experiments should be carried out to determine the best conditions for such a system.

H. J. McNicholas

Bureau of Standards

APPARATUS FOR THE MEASUREMENT OF THE REFLECTIVE AND TRANSMISSIVE PROPERTIES OF DIFFUSING MEDIA

The equipment is designed for the measurement of the reflective and transmissive properties of diffusing media under definite and controlled conditions of illumination and observation. The intensity and state of polarization of various incident, reflected and transmitted beams of light are measured as functions of their direction and wave-length composition.

Two separate illumination units are provided, one for unidirectional and the other for completely diffused illumination of the sample. The photometric equipment is stationary. To realize the various desired directions of incidence and observation with the unidirectional illumination unit, the sample and source may each be differently orientated with respect to the fixed direction of observation. The source for completely diffused illumination is also constructed so that the sample may be observed in various directions from the normal to its surface.

The equipment is applicable to the study of various problems. Of these may be mentioned (1) the measurement of color and glossiness, (2) the grading of photographic materials, (3) the establishment of standards of reflection and transmission, (4) the covering power and tinting strength of paints and pigments, and (5) the optical properties of turbid media in their relation to the structure of such media.

This paper will appear in full in Bureau of Standards Journal of Research., Nov., 1928.

Herbert E. Ives

New York City

A CAMERA FOR MAKING PARALLAX PANORAMAGRAMS

Description of a camera for making transparencies which when viewed through an opaque line grating show stereoscopic relief through a wide range of distances and angles.¹ The essential feature of the camera is a mechanical coupling by means of which the camera lens, the sensitive plate and grating, and the object photographed, are kept in line as the camera moves from one side to the other of the normal from the camera track to the object.

Bibliography (1) Kanolt, U. S. Patent 1,260,682; 1918.

The present paper will appear in full in J.O.S.A. & R.S.I.

Frank Gray and Herbert E. Ives

Bell Telephone Laboratories, Inc.

OPTICAL CONDITIONS FOR DIRECT SCANNING IN TELEVISION

A discussion of the conditions for securing the maximum amount of light in a photoelectric cell placed behind a television scanning disc when an image is formed on the disc by a lens. Due to the breaking up of the image into a finite number of elements the amount of light available increases with the physical dimensions of the whole system. Results obtained with a large scanning disc and a lens forming images of sunlit objects are described.

This paper will appear in full in J.O.S.A. & R.S.I.

Arthur C. Hardy

Mass. Inst. of Technology

A RECORDING COLOR ANALYZER

A new recording photoelectric spectrophotometer was described at the Schenectady meeting of this Society. The instrument described a year ago included a galvanometer relay, a

commutator, and other pieces of electrical apparatus which gave considerable trouble in operation. These parts have now been eliminated by operating the motor directly from the amplified photoelectric current.

At present, the instrument covers easily the spectral band from 400 to 700 millimicrons. By means of an adjustable slit, the width of the spectral band reaching the photoelectric cell at any time is maintained at 10 millimicrons. Reflecting power or transparency values are determined with a reproducibility better than 0.1%. The time required for a complete spectral analysis of a specimen is approximately 30 seconds. The results are plotted graphically by the instrument on an 8½ by 11 sheet of paper.

By combining a mechanical integrating attachment with this instrument, the three primary excitation values are computed automatically. Thus, this instrument gives the subjective color sensation under any assumed conditions as well as the objective color analysis.

K. S. Gibson

Bureau of Standards

APPARATUS FOR ACCURATE AND RAPID MEASUREMENT OF SPECTRAL TRANSMISSION AND REFLECTION

Spectrophotometric apparatus is being designed and assembled at the Bureau of Standards which will eliminate many common sources of trouble, uncertainty and error while utilizing the speed and precision possible with the amplified photoelectric current. The essential features are as follows:

(1) Light is spectrally dispersed before being used photometrically. This prevents undue heating of the sample.

(2) A Van Cittert double monochromator produces this dispersion. Its use greatly reduces stray light and has other advantages regarding purity and intensity of spectral image.

(3) Light of any desired wave length enters a white-lined diffusing sphere through one of three small openings spaced 120° apart in the horizontal equatorial plane, and is diffused throughout the sphere.

(4) From the other two openings two beams of light, taken perpendicularly from the opposite interior surface, are led through a Martens photometer to a photoelectric cell. A scheme similar to Hardy's will enable the amplified photoelectric current to set the photometer automatically for equality of intensity.

(5) Midway between two of the openings in the sphere is a fourth opening, against which is placed the sample (properly shielded from direct illumination) whose reflectance is desired. Light reflected from this sample forms one of the two beams above noted.

(6) By rotating the whole sphere 120° about its vertical axis, the sample and sphere wall are interchanged. The reflectance of the sample in absolute value may thus be obtained without reference to any "white standard."

(7) For transmission measurements, by rotating the sphere 120° farther and placing a diffusing white material at the fourth opening, both beams originate from the sphere wall (effectively two sources, each of accurately uniform brightness). The sample is placed between the sphere and photometer and transferred from one beam to the other in the usual procedure.

(8) The light source may be an incandescent lamp, or a mercury or helium lamp or other source of homogeneous light. In the latter case all wave-length or slit-width errors are eliminated at certain wave lengths, and this advantage is available for reflection as well as transmission measurements.

(9) The transmission samples and sphere and (separately) the monochromator are enclosed and the enclosed air may be kept at any desired temperature.

Bibliography:

Van Cittert, *Revue d'Optique*, 2, p. 57; 1923.

Hardy & Cunningham, *J.O.S.A. & R.S.I.*, 16, p. 119; 1928.

McNicholas, *B. S. Jour. Res.*, 1, p. 29; July, 1928.

O. S. A. Com. on Spectrophotometry, *J.O.S.A. & R.S.I.*, 10, p. 169; 1925.

H. P. Gage

Corning Glass Works

SPECTROSCOPIC AND COLOR ANALYSIS OF RAILWAY SIGNAL GLASS STANDARDS

In 1908 the Railway Signal Association, now the American Railway Association Signal Section, adopted certain colored glasses as suitable medium standards for railway signals. In order to limit variation due to manufacturing conditions, it was specified that all railway colored glass should be tested against these standards by direct photometric comparison. The original 100 per cent standards were for red, yellow, green, lunar white, blue and purple. With these standards it is possible to accurately assign photometric values to signal glass of approximately the hue of the standards.

In practice a modified Lummer-Brodhun photometer is used employing a mirror with a design consisting of wide and narrow scratches.^{1,2} When a hue difference exists the fine scratches can be made to disappear even when the larger areas do not. Consistent photometric settings can be made by the same observer even with considerable hue difference such as between Carbon and Mazda C or Mazda and daylight. Routine inspection has been greatly facilitated by the design of a binocular instrument.²

Medium colors adopted in 1918 are defined by a spectrophotometric table.^{3,4}

Railway limits defined photometrically have not yet been defined colorimetrically and data will be presented on some preliminary calculations made in accordance with the Colorimetry Report.^{5,6} The calculated results are expressed as per cent red, green and violet sensations. Conversion of these factors into dominant hue and purity involves reference to a graph and is therefore liable to error. In the few instances where direct colorimetric observations are made in terms of hue and purity, it is recommended that these be translated into terms of the elementary sensations. The liability to error would probably be less reading the graph in this direction than the opposite.

Bibliography:

- ¹ Phys. Rev., 32, p. 628; June, 1911.
- ² Trans. I. E. S., 19, p. 508; July, 1924.
- ³ R.S.A. Specification 6918.
- ⁴ A.R.A., Signal Section Specification 5927.
- ⁵ J.O.S.A. & R.S.I., 6, p. 527; August, 1922.
- ⁶ International Illumination Congress 1928, paper 7-3.

A. H. Pfund

Johns Hopkins University

A NEW PHOTOMETER-HEAD

In the following it is shown how an essentially perfect photometer-head may be made from ordinary plate or window glass. A crack is first started whereupon the plate is heated locally with a bunsen burner until the crack runs the entire length of the plate. Over a limited region the newly-formed surfaces meet the original ones perpendicularly at all edges. By using such a plate as a photometer-head the line of demarcation can be made to disappear completely. This device, which may be used as an equality or contrast photometer, can be readily transformed into a flicker-photometer.

A. E. O. Munsell and I. H. Godlove

Munsell Color Company, Inc.

WHITE GLASS PHOTOMETRIC STANDARDS

Samples of white glass—where the original smooth glossy surface is not destroyed—offer the most permanent standards for photometric use. Such standards can be obtained in relatively non-selective form. The present work outlines a direct method for determining the spectral curve for such a white glass standard in *absolute terms* together with the integral reflection factor for this standard.

Although a layer of magnesium oxide is assumed to be non-selective, the neutrality of magnesium oxide layers of different thicknesses was determined, through three chromatic filters, on the Pfund multiple reflection colorimeter.¹ Two thicknesses were found balanced about and very close to the neutral point. Spectral curves were obtained, representing the ratio, wave length by wave length, of the magnesium oxide layers to a certain selected white glass standard. An average of these two spectral ratios—weighted in proportion to the relative non-selectivity of the two magnesium oxide samples, which they represented—was obtained, and the reciprocals of this average determined. The resultant spectral curve gave a faithful picture of the non-selectivity of the white glass standard, but the ordinates were not yet in absolute terms. The integral reflection factors for the two magnesium oxide layers in question were determined on a specially constructed Taylor Photometer and these factors were weighted in proportion to the non-selectivity of the magnesium oxide layers. This weighted reflection factor was multiplied with each of the ordinates of the weighted spectral curve, resulting in a spectral calibration of the white glass standard in absolute terms.

This spectral curve, when multiplied by proper visibility factors and integrated, gave the integral reflection factor of the selected white glass standard, also in fundamental "absolute" units.

¹ Physical and Chemical Examination of Paints, Varnishes, and Colors, by H. A. Gardener, Second Edition, pp. 21-23; 1925.

This paper will appear in full in J.O.S.A. & R.S.I.

Richard Hamer

Guelph, Ontario

A PRACTICAL LABORATORY MERCURY ARC

The author has devised a new improved portable mercury arc for demonstration and laboratory use, that will facilitate the teaching of spectrum analysis. The apparatus consists of an exhausted pear shaped bulb of pyrex about 3 inches in diameter with two insulated sections below. These are formed by a small glass tube projecting coaxially upwards into a wider tube which is sealed on to the lower part of the pear shaped bulb. Each has its own tungsten electrode. The arc is struck between the mercury in the inner tube and that in the outer on tilting the bulb. A little dimple at the top of the inner tube tends to prevent the arc from travelling around and enables one to focus the small intense arc on the slit of the spectrograph. The polarity also is important. A current of about 0.8 amperes regulated by suitable resistances is sufficient.

A small condensing chamber may be sealed on above and this may or may not be connected by a sidearm to one of the two insulated tubes of the lower portion. A short tube projects into the condensing bulb from the main bulb thus forcing the condensed mercury to drain down below and help to keep the relative mercury levels constant. Thus the arc persists and a certain cooling action exists also, which assists this.

The advantage over other types experimented with is that this one is compact, convenient, durable, economical, easy to make and easily started. With the cooling and condensing bulb arrangement in addition it can be depended upon to work for an indefinite time, giving almost a point source. By the addition of various alkaline salts other lines than the mercury ones can be demonstrated readily.

(The above paper was read by title.)

C. G. Abbot

Smithsonian Institution

RADIOMETRIC STELLAR ENERGY SPECTRA

Fifteen stars and the planet Jupiter were observed with a radiometer in the spectrum of a 60° flint glass prism with 40 centimeter objective, used in conjunction with the 100 inch reflector on Mount Wilson. Though the deflections were small, yet by aid of a special reading

scale very smooth and consistent curves were obtained, and these are illustrated by lantern slides.

This paper will appear in full in Contributions of the Mount Wilson Observatory.

C. C. Kiess

Bureau of Standards

THE WAVE LENGTHS OF THE D LINES OF SODIUM IN ABSORPTION AND EMISSION

The Fabry-Perot interferometer has been used recently, at the Bureau of Standards, to determine the wave lengths of D_1 and D_2 in absorption and emission. The source of white light was a point-o-lite lamp. The absorption tube was of pyrex, about 8 inches long, into which sodium was distilled in vacuo. During the experiments it was heated to various temperatures. The same type of tube equipped with electrodes, when excited by a small transformer, served as a bright source for the D lines in emission. The wave lengths thus obtained are presented in the following table, together with similar data from other sources.

	D_1	D_2
Wave lengths of D lines in absorption	5895.923	5889.950
" " " " " emission (Geissler tube)	.923	.949
" " " " " (vac. arc 6 cm) ¹	.927	.954
" " " " " air (Fabry-Perot) ²	.932	.965
" " " " " sun (Rowland corrected to AOBS) ³	.939	.971

Comparison of the absorption wave lengths with those of the vacuum arc at 6-cm and those found by Fabry and Perot from the flame in air shows a difference which may be accounted for as a pressure shift.

Comparison of the absorption wave lengths with those given in Rowland's Table (corrected to the international scale) shows redward shifts of 0.016A and 0.021A respectively for D_1 and D_2 . The calculated Einstein shift for these lines is 0.012A, which leaves a residual shift of 0.004A and 0.009A for D_1 and D_2 to be accounted for by other causes.

Present paper will appear in full in B. S. Jour. Res.

¹ Kiess, Bureau of Standards Jour. of Research, 1, p. 88; 1928.

² Fabry and Perot, Comptes Rendus, 130, p. 495; 1900.

³ Burns and Kiess, Publ. Allegheny Observatory, 6, p. 137; 1927.

C. M. Slack

Westinghouse Lamp Company

(Introduced by H. C. Rentschler)

LENARD RAY TUBE WITH GLASS WINDOW

For the widespread study of the effect of cathode radiation in the fields of chemistry, biology and luminescence a need has been felt for a more convenient and portable means of producing these rays.

It has been found possible to obtain glass windows of a certain shape sufficiently thin to allow electrons to be ejected through them at voltages above 20 K.V.

Windows 2.5 cm in diameter can be constructed .0005 cms thick and still withstand atmospheric pressure. This is accomplished by making an indrawn bubble on the end of a glass tube. This is so sealed to the glass envelope that the atmosphere produces a tension which in direction is the same at every point as that imposed during the formation of the bubble.

The simplicity of construction and the lack of grid structure in this form of window suggests many possibilities for its use. One of the most interesting is that of a cathode ray oscillograph in which the photographic plate could be outside the tube.

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W. D. Coolidge, Journal Franklin Institute, 202, pp. 693-736; 1926.

F. L. Mohler and C. Boeckner

Bureau of Standards

RECOMBINATION OF ATOMIC IONS AND ELECTRONS

A paper by one of the authors describes continuous atomic spectra excited in a thermionic discharge with relatively high current and pressure. The continuous bands extending to the violet from each series limit were ascribed to recombination of ions and electrons. In a continuation of this research an analysis of discharge conditions by means of a probe wire has been made in connection with spectrophotometer measurements of the intensity near the probe. On the recombination theory the intensity at a given frequency interval beyond a series limit will depend on the number of electrons of corresponding kinetic energy and on the probability that an effective collision will take place. The probe measurements show that the electrons have a strictly Maxwellian distribution with an average energy that can be accurately measured. Thus the relative probability of recombination as a function of the velocity can be computed. Results obtained in caesium and helium discharges include other relations between discharge characteristics and intensity.

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F. Mohler, *Phys. Rev.*, *31*, p. 187; 1928.

R. M. Langer

National Research Fellow, Bureau of Standards

(Introduced by F. L. Mohler)

LIGHT SCATTERING IN LIQUIDS

Experiments similar to those recently reported by Raman and Krishnan were carried out with very strong mercury illumination and quartz vessels. Lines not present in the source were detected with an E-2 Hilger quartz spectrograph fine slit with an exposure of ten seconds.

Half hour exposures with benzene showed many lines not reported by Raman and Krishnan. A group of doublets due to 3126 and 3132 is especially interesting.

In $C Cl_4$ the lines reported by Raman and Krishnan—*Nature*, August 25, 1928—were found as well as several others. The group shown in Fig. 1B of the article just quoted was repeated near 5461, 4047, 4078, 3663–50 and 3126–32 as well as 4358. The same group showed on the short wave length side of these lines. Near 4358 these lines of increased frequency (anti-Stokes lines) were almost one-fifth as intense as their mirror images in 4358.

A group of fairly sharp lines around 4358 (H_2SO_4 scattering) appeared broader around 3125 and 3131 while the same group (including several anti-Stokes components) near 2537 looked like a set of bands with diffuse edges. In methyl alcohol the modified radiation due to 2537 although diffuse could be set on to a tenth of an Angstrom unit. In ethyl alcohol the corresponding lines (slightly displaced to the red) were still sharper. They indicate strong absorption bands at about 3.5μ . Such bands have been found, for example, by Coblenz.

The intensity of the scattering of modified wave length increases very markedly in going from 5461 to 2537. Lines which are barely visible near 4358 are often plain near 3125 and very strong near 2537.

J. W. Beams, L. G. Hoxton, and F. Allison

University of Virginia

AN INTERFEROMETER IN WHICH THE TWO RAYS ARE ACCURATELY
POLARIZED IN PERPENDICULAR PLANES

Several types of interferometers using polarized light have been described and in the half shade interferometer a precision of one twenty-thousandth of a wave length is claimed.^{1,2} The precision of this type of instrument depends upon a measure of a change in ellipticity of polarized light rather than the usual shift of fringes. It has not, however, been generally used due probably to its sensitivity to slight temperature variations and the necessity of very fine optical parts. In the instrument, here described, the troubles due to temperature variations

have been practically eliminated while a poor quality of optical parts brings about a sacrifice in precision only.

Parallel, monochromatic light passes through a Nicol prism, then a crystal of Iceland spar or double image prism so oriented with respect to the Nicol that the perpendicularly polarized beams formed are equal in intensity. Each of these beams passes some distance to a mirror and is returned as nearly as possible on its path to the front surface of the double image prism where the two beams recombine to form elliptically polarized light. The smallest change in the ellipticity of this light that can be measured determines the sensitivity of the instrument.

This change in ellipticity of the light was measured by placing a half silvered mirror between the source and Nicol and focusing the light and dark bands formed on a system of slits identical in dimension with the bands. The image of these slits falls upon a photoelectric cell and any shift of the bands is recorded by a current through the photoelectric cell. The slit system and photoelectric cell method of measuring fringe displacements is of course not confined to this particular instrument but may be used in any interferometer where reasonably sharp fringes can be obtained.

The sensitivity here attained, although considerably less than that of the half shade interferometer, is larger than that of the ordinary instrument. The factors which limit it are discussed.

¹ Cotton, Comptes Rendus, 152, pp. 131-133; 1911.

² Skinner and Tuckerman, Phys. Zeit., 12, p. 620; 1911.

C. Boeckner

Johns Hopkins University

(Introduced by A. H. Pfund)

THE OPTICAL CONSTANTS OF QUARTZ FOR WAVE LENGTHS IN ITS 9μ REGION OF ANOMALOUS DISPERSION

The reflecting power of polarized light from quartz in the 9μ region is obtained at two angles of incidence. From these, by use of the exact Fresnel reflection power formula, the extinction coefficient and index of refraction are calculated for a series of wave lengths. The constants for amorphous quartz and for the ordinary ray of crystalline quartz are obtained.

The exact form of Fresnel's reflecting power formula is verified.

F. M. Schertz

Bureau of Chemistry and Soils, Department of Agriculture

(By invitation)

APPLICATION OF TRANSMITTANCY MEASUREMENTS TO BIOCHEMISTRY

A brief introductory historical review is given of transmittancy measurements. Spectrophotometric methods of determining the purity of organic compounds are compared with chemical methods now used. Colorimetric and spectrophotometric methods of comparing the concentration of a given substance in solution are compared. Examples will be given showing the application of transmission data to modern biological problems. The principles and procedures of Willstätter when used in connection with spectrophotometric methods offers hope of solving many of the present problems in biology which are not being solved by any present day methods. Details will be given as to how the method can be applied in preparing and testing chlorophyll *a* and chlorophyll *b* so that we may know these compounds are actually the same as those found in all green plants. Our knowledge on chlorophyll can only be extended by being positive that the pigments we are working with possess in every respect the same chemical and physical characteristics, and especially those physical characteristics which only transmittancy data will reveal, as does chlorophyll as it exists in every normal living green leaf. Data on the transmission of organic compounds offers much to the solution of the relation of light to matter.

H. J. McNicholas

Bureau of Standards

**THE ABSORPTIVE PROPERTIES OF CAROTIN AND XANTHOPHYLL IN
THE VISIBLE AND ULTRAVIOLET**

The absorptive properties of the pure pigments in solution have been measured throughout the visible and ultraviolet spectral range, and the changes in the absorptive properties followed as the pigments slowly oxidized in solution. These data indicate two definite stages in the oxidation of each pigment.

Relations between the frequencies of the absorption bands for each pure unoxidized pigment may be formulated in accordance with the known theory of molecular absorption spectra. The similarity of the absorption spectra of carotin, xanthophyll, chlorophyll-*a* and some derivatives of hemoglobin suggests the presence in each of these pigments of a common nucleus or symmetrical atomic grouping which is the carrier of the observed system of absorption bands.

This paper will appear in full in Bureau of Standards Journal of Research.

Janet Howell Clark

Johns Hopkins University

**MEASUREMENTS OF THE ULTRAVIOLET RADIATION IN SUNLIGHT
IN BALTIMORE DURING THE YEAR 1928**

A method previously published by the author¹ for measuring ultraviolet radiation, by means of the darkening of a light sensitive paint known as lithopone, has been standardized by substituting C.P. zinc sulphide moistened with saturated lead acetate for the lithopone. The rate of darkening of the zinc sulphide to a standard shade measures the energy of ultraviolet radiation in a band from 350–295 m μ .

Measurements were made every clear day at noon throughout the year and also throughout the day on a number of clear days in every month. These measurements give the daily and yearly variation in solar ultraviolet radiation in Baltimore during 1928.

American Journal of Physiology, 69, p. 200; 1924.

E. M. Lowry (*Introduced by L. A. Jones*)

Kodak Research Laboratories

SOME EXPERIMENTS WITH BINOCULAR AND MONOCULAR VISION

An account is given of a series of investigations of the brightness sensibility of the retina, in which both binocular and monocular vision were used. A new type of visual sensitometer is described which enables the operator to determine the brightness functions of the eye in a variety of ways. The instrument consists of a hemispherical bowl, one meter in diameter, equipped with an illuminating system which will give brightnesses from 0.01 to 600 millilamberts. This bowl serves as the sensitizing field. A mechanism is provided by means of which the threshold for brightness may be determined at any adaptation level. Contrast sensibility may also be measured at any brightness as well as the effect on threshold and contrast sensibility of introducing various objects into the visual field. In addition monocular and binocular acuity may be determined using the Ives form of acuity meter. Data and curves are given representing the results secured for a number of observers. Emphasis is laid on the necessity of determining the various functions of the eye binocularly if they are to be correctly interpreted in practice.

This paper will appear in full in J.O.S.A. & R.S.I.

Deane B. Judd

Bureau of Standards

**LEAST RETINAL ILLUMINATION BY SPECTRAL LIGHT REQUIRED TO
EVOKE THE "BLUE ARCS OF THE RETINA"**

Interest in the "blue arcs of the retina" first described by Purkinje has recently been renewed by Dr. Christine Ladd-Franklin who establishes in a series of communications¹ her

¹ Ladd-Franklin: J.O.S.A. & R.S.I., 12, p. 494, 1926; 14, p. 474, 1927; 16, p. 333, 1928. Comptes Rendus, 185, p. 584, 1927.

views that the blue arcs are due to the emission of light by the fibers of the optic nerve that pass over the surface of the retina. It has been repeatedly mentioned by Dr. Ladd-Franklin and others (Troland, Amberson, Druault, Ellis) that the blue arcs are obtained more easily with red light than with a stimulus of any other color. This suggests that the origin of the nerve activity causing the blue arcs lies in the retinal cones rather than in the rods, since the rods are relatively insensitive to red light.

The blue-arc phenomenon has been tentatively linked by the author² with a certain phase (called the Purkinje phase, or "Bidwell's ghost") of the after-image following momentary stimulation by light of the extra-foveal retina. The Purkinje phase undoubtedly depends on the action of the rods; hence, the two phenomena which are quite similar in some respects would differ in origin if the blue arcs were really initiated by cone action. As a check, then, on the origin of the nerve activity producing them, the blue arcs were aroused by pure spectral light (2° circular field), the retinal illumination being subsequently reduced until the blue arcs no longer appeared. In this way the retinal illumination required to evoke the blue arcs has been determined as a function of wave length for the author's right eye.

It was found that about 0.04 photons sufficed for light of wave length 400 $m\mu$ to 530 $m\mu$, whereas about 20 times that retinal illumination, or 0.8 photons, was needed with light of 620 $m\mu$. It may be shown that these illuminations result in nearly equal brilliances by rod vision. Hence, it is concluded that *at the lowest illuminations evoking them*, the blue arcs are due to nerve activity which originates not in the cones, but in the retinal rods.

² Judd: *Am. J. of Psych.*, 38, p. 527; 1927

MOTION PICTURE DEMONSTRATIONS

MOTION PICTURES OF THE PLANETS, MADE BY PROF. W. H. WRIGHT AT LICK OBSERVATORY.

These remarkable motion pictures of Jupiter in rotation which had evoked such applause at the Royal Astronomical Society last summer (H. N. Russell, *Scientific American*, September, 1928) were shown again by special request at this meeting of the Optical Society. Unfortunately Prof. Wright could not be present to comment on them; but although they are not "talking movies" in the ordinary sense, they did speak for themselves and were highly appreciated.

The following description of these pictures by Prof. Henry Norris Russell in the *Scientific American* for September, 1928 is quoted by permission of the publisher.

We are familiar with the "speeded up" moving pictures which show, for example, the opening of a flower before our eyes, but no one before Professor Wright has had the audacity to think of moving pictures of the rotation of a planet. Jupiter, which completes a rotation in a little less than 10 hours, was chosen for this bold attempt. Only in such a climate as that of California could there be any chance of success, for photographs must be taken at regular intervals of a minute or two all night long—or at least so long as the planet is high enough in the sky to observe satisfactorily. Even so, no single night's work suffices to follow a whole rotation, and two or three successive nights are required before every aspect of the planet has been recorded.

Extraordinary care and eternal vigilance must be exerted to see that the planet's images are all in correct register so that the final image on the screen does not oscillate, but this problem like others has been solved, thanks to the co-operation of Professor Wright and Dr. Mees of the Research Laboratory of the Eastman Kodak Company.

A capacity audience in the historic rooms of the Royal Astronomical Society watched the first showing of the films and broke into the heartiest applause. The diversified surface of the planet was shown in clearest detail and the steady rotation showed itself so simply and naturally that it was hard to realize what pains and labor had gone to speeding it up a thousand times until it became conspicuous to the eye. The Great Red Spot and the smaller details of the surface passed in stately procession across it. At one point in the revolution a satellite appeared at the side of the screen and advanced rapidly toward Jupiter. Just before it reached the planet the shadow of the satellite entered upon the disk, followed a moment later by the satellite itself which in contrast to the black shadow appeared as a pale grayish spot.

These pictures form the most remarkable presentation of the actual progress of stellar motions which has ever been shown. When and how they may become available to a larger public, the writer of these lines does not know. It is greatly to be hoped that they may be widely exhibited and if they are, that all who are interested in the heavens will take the opportunity to see them.

TECHNICOLOR MOTION PICTURES.

Dr. Leonard T. Troland, Director of Research and Process Control, Technicolor Motion Picture Corporation, showed five reels of beautiful pictures in color and supplemented the exhibition with some remarks on the process and the pictures.

(NOTE: Eastman Kodacolor motion pictures were shown as a part of the Eastman Exhibits in the Optical Exhibition.)

PANORAMIC MOTION PICTURE PHOTOGRAPHY BY MEANS OF THE SPECIAL LENS SYSTEM ("HYPERGONAR") OF PROFESSOR HENRI CHRÉTIEN, INSTITUT D'OPTIQUE, PARIS.

Dr. H. Sidney Newcomer presented a motion picture film taken and projected by means of the new cylindrical objective of Professor Chrétien.

The dimensions of a motion picture image as universally used are in the ratio of 3 to 4, in other words the pictures which we are accustomed to see are nearly square. This shape limits the artistic reproduction of many subjects which require additional width or height in order to appear in their entirety in true proportions. To overcome this limitation, in the case of panoramic pictures at least, several pictures have heretofore been projected onto one screen by means of several projectors operating simultaneously. However, in using this method in cinemaphotography, one encounters enormous mechanical and optical difficulties which are practically impossible to overcome. The possibility of obtaining more artistic and complete views of certain scenes where perspective or height is especially necessary to an impressive or realistic presentation of a subject is of great interest to the progressive motion picture art. Professor Chrétien has recently devised a new cylindrical lens combination which offers a very simple solution of this problem.

The special lens enlarges the field of view considerably but in only one direction. The direction of increase of field is chosen according to the demands of the subject. The films presented at the meeting showed pictures which were enlarged horizontally or vertically in the proportion of 2 to 1 according to the orientation of the axial plane of the lens. In this way the angular value of the field of view in one direction is doubled. In other words a view of double the dimensions in either the horizontal or vertical direction is compressed onto a standard size film, and by using the same lens system at the time of projection the compressed image is restored to its normal proportions.

On first thought the lens system seems to recall the anamorphat of Abbe but it differs from this system in two important particulars: (1) The axial planes of the cylindrical lenses which compose the objective all coincide; (2) the image and the object planes of the objective are the same. It is these particular features which place the lens in a category by itself. The second property permits the lens to be used in front of an ordinary photographic objective without disturbing the focus of the latter.

These two special features permit the lens to be easily corrected for astigmatism, coma, and spherical and chromatic aberrations. The distortion is also reduced, but this aberration does not affect the quality of the picture as it is automatically compensated for in the restitution of the image on the screen by projection through a similar optical system.

There are many uses to which this lens can be applied. It is probably sufficient at present to mention two other possibilities. Since the lens compresses the size of images it is possible to print from two negatives of ordinary size placed side by side onto one positive film. When the images are projected and restored to their normal proportions two events which took place at the same time but in different places may be shown simultaneously as if they were projected side by side from two standard projectors operating at once. It is also possible to freely compress a motion picture image so as to leave a considerable lateral free strip of film for the sound record used in the photoelectric production of talking pictures.