Proceedings of the Nineteenth Annual Meeting of the Optical Society of America

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.
October 18–20, 1934

THE nineteenth annual meeting of the Optical Society of America was held at the National Bureau of Standards, Washington, D. C., October 18 to 20, 1934.

The meeting was opened Thursday, October 18, at 9.30 A.M. by a welcome from Dr. Lyman J. Briggs, Director of the Bureau.

SESSION DEVOTED TO OPTICS OF ASTRONOMICAL INSTRUMENTS

The session Thursday afternoon was devoted to papers on "Optics of Astronomical Instruments." The following papers were presented by invitation:

The Influence of Present Trends in Research on the Design of Astronomical Telescopes and Accessories, by G. W. Moffitt, Yerkes Observatory

New Astrophysical Instruments of the Harvard Observatory, by F. L. Whipple and D. H. Menzel, Harvard College Observatory

Applications of Christianson Filters to Stellar Energy Spectra, by C. G. Abbot, Astrophysical Laboratory, Smithsonian Institution

Optics of Reflecting Telescopes, by Frank E. Ross, Yerkes Observatory

The Work of the Naval Observatory, by J. F. Hellweg, U. S. Naval Observatory

The Ritchey-Chrétien 40-inch Aplanatic Reflector—Principles of Design and Practical Results, by G. W. Ritchey, U. S. Naval Observatory.

VISIT TO THE U. S. NAVAL OBSERVATORY

On Thursday evening the Naval Observatory held open house for members of the Society and their guests. Opportunity was afforded for inspecting the instruments and looking through the large telescopes. The principal object of interest was the new Ritchey-Chrétien 40-inch reflector.

ANNUAL DINNER

Because of unfavorable weather the annual dinner of the Society could not be held on the lawn as planned but was held instead in the Hydraulic Laboratory of the National Bureau of Standards at 5.00 P.M., Friday, October 19. There was no formal program but the members found it a pleasant opportunity for visiting and informal discussions.

PUBLIC LECTURES

On Friday evening at 7.30 P.M. two public lectures were given. Mr. Charles Bittinger, Washington, D. C., gave a short talk on "Ultraviolet Murals at the Franklin Institute," illustrating the talk by painting a sketch with ultraviolet pigment under the illumination of a source of ultraviolet light.

This was followed by a lecture by Dr. F. G. Pease of Mount Wilson Observatory on "Modern Large Telescope Design." Dr. Pease gave an interesting discussion of the many problems involved in the design of the 200-inch telescope now in process of construction.

BUSINESS SESSION

A brief business session of the Society was held Saturday morning, October 20, President Rayton presiding. The Secretary and Treasurer laid before the Society the formal reports for the calendar year 1933* and gave informal statements of the changes which had taken place since January 1, 1934. The reports were accepted.

The Secretary was instructed to write to the National Bureau of Standards and to the U. S. Naval Observatory expressing the thanks of the Society for the hospitality which it had enjoyed.

* Published in the J. O. S. A. **24**, 308–311 (1934).

EXHIBITION OF INSTRUMENTS

The exhibition of instruments and products in which the application of optical principles plays an important part in design, construction, or use, attracted much attention. Beside the fine exhibits of commercial apparatus there were exhibits from research laboratories showing new experiments and recent developments in apparatus.

Registration

Members 73, Guests 15, Total 88.

Sessions for the Reading and Discussion of Contributed Papers

Sessions for the reading and discussion of contributed papers were held as follows:

Thursday, October 18, at 9.30 A.M.
Friday, October 19, at 9.30 A.M.
Friday, October 19, at 1.00 P.M.
Saturday, October 20, at 10.00 A.M.

The authors' abstracts of these papers are appended.

Meeting of the Board of Directors

Sessions of the Board of Directors were held on Wednesday afternoon and evening, October 17.

L. B. TUCKERMAN, *Secretary.*

Minutes of the Fourth Meeting of the Directors of the Optical Society of America, Incorporated

WASHINGTON, D. C.
October 17, 1934

BESIDES the transaction of routine business, the following items of general interest to members of the Society were taken up.

Use of Coated Paper

It was voted that commencing with January 1, 1935, the Editor should arrange for the use of a satisfactory coated paper for the Journal so as to facilitate the use of photographic illustrations in connection with articles.

List of Members to be Issued

It was voted that in or with the March, 1935 issue there should be published a list of members and such other material as might be prepared by a committee appointed by the President, the committee to have power to decide the manner of issue and the number of copies.

The Treasurer noted that the estimated extra cost involved in using coated paper and in issuing the membership list would still allow a balanced budget.

Report of Representative on American National Committee on International Congresses on Photography

Professor A. C. Hardy, representative of the Optical Society of America on the American National Committee on International Congresses on Photography, reported that the committee had in active preparation its report for the meeting to be held in Paris, July 7–13, 1935.

Report of Representative on U. S. National Committee of the International Commission on Illumination

In the absence of Mr. Frank Benford, representative of the Optical Society on the U. S. National Committee of the International Commission on Illumination, Mr. E. C. Crittenden reported that the committee would meet November 9 to prepare for the meeting of the Commission in Berlin, July 2–9, 1935.

Ives Medal

It was noted that in accordance with the terms of the foundation the Ives Medal would be awarded again in 1935.

Transfer from Associate to Regular Membership

The following were transferred from associate to regular membership:

Carl E. Bahn (942 R)
J. A. Ball (964 R)
Vola Price Barton (757 R)
Julian M. Blair (948 R)
F. Chapin Breckenridge (594 R)
Brooks A. Brice (882 R)
Laurence Burns (963 R)
Gordon A. Chambers (474 R)
J. H. Ellis (494 R)
Gustave Fassin (943 R)
David L. Gamble (950 R)
E. O. Hulburt (970 R)
David L. MacAdam (930 R)
Gjon Mili (952 R)
Cyril J. Staud (961 R)

L. B. TUCKERMAN, *Secretary.*

Program of Sessions for Contributed Papers*

(Titles and Abstracts of Papers)

1. Surface Color. Deane B. Judd, *National Bureau of Standards.* (20 minutes.)

Their tristimulus specifications are sufficient for deciding if the colors of two surfaces are the same; but, since the visual mechanism has widely varying sensitivity depending on simultaneous stimulation of adjacent areas and on previous general stimulation, the tristimulus specification of a surface is not sufficient to determine its color. The present work deals with the usual case of the observer well adapted to the illuminant. The aim is to determine surface color in terms of hue, brilliance and saturation from tristimulus specifications by including also specifications of the background.

The surfaces used were 15 papers, roughly inch-square, of known spectral reflectance. The 5 illuminants were daylight and 4 chromatic illuminants, each of the latter consisting of an incandescent lamp combined with a highly selective glass filter of known spectral transmission. The two backgrounds used were dark gray and white cardboard. Estimates of hue, brilliance, and saturation made by 8 observers on each of the 150 colors were correlated with tristimulus specifications computed from the known spectral energy distributions. It was found that brilliance could be satisfactorily represented by the formula due to Adams and Cobb:[1] Brilliance $=aR/(R+R')+b$, R and R' being the reflectances of sample and background, respectively, and a and b, constants. It was found that saturation of the colors of papers having nearly the same reflectance as the background is roughly proportional to distance on the uniform-scale Maxwell triangle[2] between the point representing the sample color and that representing the background color; that is, for such papers the background color usually is taken as of zero saturation. For such papers also, hue could be correlated closely with the direction of the line connecting the two points. Colors notably lighter than the background assumed somewhat the hue of the illuminant while those much darker than the background tended toward the complementary.

It seems possible from preliminary trials to write empiric formulas giving hue and saturation in quantitative accord with these results, but successful formulas have not yet been found.

[1] J. Exp. Psych. 5, 39 (1922); J. O. S. A. and R. S. I. 9, 932 (1922).
[2] J. O. S. A. 24, 163 (1934).

2. Color Blending Computations in Psychological Terms. I. H. Godlove, *Color Service Laboratories, Washington, D. C.* (15 minutes.)

The tristimulus specifications of Munsell colors afford data for testing various rules for computation of hue and saturation of blends obtained by rotation directly from psychological specifications of the components. If we assume only that component colors and their blend may be represented in Euclidian cylindrical coordinates and that Newton's and Talbot's laws are valid, we obtain for the case of two hues separated by one-fifth of the hue circuit

$$\tan\beta=\frac{0.951\ S_2}{0.309\ S_2+vS_1}\quad\text{and}\quad S=\frac{(n^2+1.618)^{\frac{1}{2}}}{1+v}\cdot S_2$$

where β is the angle between the vertical planes through the points representing the first color and the blend, S is the saturation of the blend, S_1 and S_2 the saturations of the components,

$$v=(V_2-V)/(V-V_1),\qquad n=vS_1/S_2$$

and the V's are the brilliances of the 2 components and the blend. Making some simple approximations, and using a 100-step hue scale numbered from the hue of the first component, we obtain

$$H=\frac{vS_1H_1+S_2H_2}{vS_1+S_2}.$$

Alternatively, if we assume that hue-number is the weighted mean of the hue-numbers of the components, and similarly for saturation, the weighting factors W and w being, respectively, $A\cdot V\cdot S$ and $A\cdot V$, where A is the fractional area, then we obtain

$$H'=\frac{W_1H_1+W_2H_2}{W_1+W_2}\quad\text{and}\quad S'=\frac{w_1S_1+w_2S_2}{w_1+w_2}.$$

Formulas for H and S have been published by Miss Nickerson and used by others. Her hue formula and the formula for H' are mathematically equivalent to the approximate one for H for the case of constant brilliance, though they have been used for combinations of different brilliances; her formula for saturation is the reduction form of S' at constant brilliance, and of S at constant hue and brilliance, though used for the general case, becoming absurd when the components are complementary.

On interpreting the computed specifications of 23 blends of 2 components each to Munsell notations, it is found that the Nickerson hue formula does not agree with the data quite as well as the other formulas; and her saturation formula does not agree quite as well as the formula for S, for large hue range, but for small hue ranges gives about equal agreement. Since the errors are greater than the probable uncertainty in the data, it is concluded that the local irregularities in the Munsell data are such as not to justify the use of any of the formulas for large hue ranges.

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

* The abstracts were preprinted in the program subject to correction by the authors. Corrections that have been communicated to the secretary have been made in the abstracts reprinted below.

3. Aviation Lighting Research at the National Bureau of Standards. (Illustrated.) F. C. BRECKENRIDGE, *National Bureau of Standards.* (20 minutes.)

Aviation lighting research is carried on at the National Bureau of Standards for the Bureau of Air Commerce, Commerce Department and Bureau of Aeronautics, Navy Department. Typical illustrations of the development of aircraft landing lights and position lights will be shown and methods of beacon photometry will be described. An outline of present projects will also be given.

4. Determining the Difficulty of Visual Tasks. M. LUCKIESH AND F. K. MOSS, *Lighting Research Laboratory, General Electric Company.* (20 minutes.)

The importance of seeing emphasizes the necessity of devising means for determining the difficulty of visual tasks. In recent years the problem has been attacked through elaborate and tedious laboratory researches. The results are valuable in helping to lay the foundation for a science of seeing, but such methods are not practicable for general application. However, they seem to lead to correlations which are helpful in the development of simple devices which may easily be used. Such devices may involve the determination of threshold visibility which in itself is not necessarily a measure of the difficulty of seeing, but by establishing correlations between this factor and ease of seeing, such measurements become practicable in appraising at least the relative difficulty of a series of visual tasks. The general principles involved and some simple devices will be discussed. Particular emphasis will be placed upon a visual thresholdometer and results obtained with it.

Bibliography:
A brief paper entitled "A Visual Thresholdometer" has been transmitted to the J. O. S. A.

5. A Convenient Set of Equations for Computing Third Order Aberrations. I. C. GARDNER, *National Bureau of Standards.* (15 minutes.)

The Seidel equations for the third order aberrations of the surfaces of a lens system, composed of thick lenses, have been transformed into a set of equations particularly convenient for logarithmic computation and especially adapted for use in conjunction with trigonometric computations for the separation of the third order and the higher order aberrations.

6. A Graphical Method of Locating Conjugate Image Points. HAROLD F. BENNETT, *Optical Shop, Washington Navy Yard.* (10 minutes.)

A graphical method of locating conjugate points of a lens is demonstrated. This method, while not new except for minor modifications, seems to merit a much wider use than it now has. It presents a simple geometrical figure by the aid of which the relative positions of object and image may be easily followed as either is moved through any range of positions from plus to minus infinity. It may be applied to any lens or mirror system for which the principal points and principal foci may be located. It is expected to prove useful in planning optical systems and also in acquainting students with the applications of the Gaussian lens equations.

7. The Spectrographic Program of the National Geographic-U. S. Army Stratosphere Flight. BRIAN O'BRIEN AND T. A. RUSSELL, *Institute of Optics, University of Rochester, N. Y.* (20 minutes.)

Determinations of the height and distribution of ozone in the earth's atmosphere, based upon measurements of the ultraviolet solar spectrum as received at the earth's surface, indicate the center of gravity of the ozone layer at an elevation of 30 to 50 kilometers, and little or no ozone below 10 km. It has appeared probable that ozone exists in the region between 10 and 20 km above the earth's surface in amounts which would be measurable providing sufficiently refined instruments could be carried to these heights. The present balloon, with its great weight carrying capacity and an estimated ceiling well over 20 km, provided an unusual opportunity for making such measurements.

Estimation of atmospheric ozone by intensity measurements within and just outside the long wavelength end of the Hartley band has proven very successful at ground stations and was adopted here. Two quartz spectrographs of medium dispersion, equipped with evaporated aluminum wedges for the measurement of intensity, were provided for this purpose. These received, respectively, direct sunlight and skylight 8° from the horizon, the latter providing a more sensitive measure of the lower limit of the ozone layer.

At wavelengths shorter than the Hartley band of ozone the solar spectrum as received at the earth's surface is limited by the absorption of oxygen. At an elevation of 20 km with the partial pressure of oxygen less than 6 percent of that at sea-level, the possibility exists of photographing the solar spectrum in the region around 2100A between the oxygen and ozone bands. A third quartz spectrograph was provided for this purpose, intensities being measured as in the larger instruments by means of an evaporated aluminum wedge. Special provisions were made to eliminate scattered light of longer wave-length. Quartz was selected for high transmission to 1850A, and the sensitivity of the instrument was much increased by the use of an Eastman type I–0 emulsion coated with the fluorescent collidine derivative described by Mees.

8. Stratosphere Spectrographs. H. F. KURTZ AND GUSTAVE FASSIN, *Bausch & Lomb Optical Company.* (20 minutes.)

The three spectrographs built for the U. S. Army-National Geographic Stratosphere Flight will be described. The purposes for which each was intended will be set forth. The optical systems will be described. The mechanical construction, including the details of the automatic operating mechanism, will be discussed.

9. A Testing Camera for Photographic Objectives. I. C. GARDNER AND F. A. CASE, *National Bureau of Standards.* (10 minutes.)

A new camera for testing photographic objectives will be described. This apparatus has been specially designed in order to facilitate the tests of the large number of airplane camera lenses which are sent to the National Bureau for test. With this equipment a negative is obtained on which are registered 100 or more individual exposures made of a test chart and, from this negative, fairly complete information can be obtained regarding all the aberrations of the photographic objective. The results of some of these tests will be shown.

10. The Fifty-Inch Precision Copying Camera of the U. S. Coast and Geodetic Survey. O. S. READING, *U. S. Coast and Geodetic Survey.* (10 minutes.)

Repeated revision surveys of the coast and harbors of this country require photographic equipment capable of reproducing the new surveys accurately enough to fit the old without expensive and slow adjustment. During the past year the largest precision copying camera in the world has been completed to accomplish this work for the U. S. Coast and Geodetic Survey. The adjustments and precautions used to attain precision of one or two thousandths of an inch in photographs made with the camera are briefly described.

11. A Proposal in Nomenclature. CLAYTON H. SHARP, *Consulting Engineer, White Plains, N. Y.* (5 minutes.)

The name given to any new scientific device should be distinctive and, if possible, descriptive. A good name should be given in early infancy, before one less desirable has become established. In the nomenclature of photoelectric devices the name "photoelectric cell" is by common consent reserved for the alkali metal, vacuum cell. "Photoresistance cell" and "photo-voltaic cell" are acceptable descriptive names for their respective classes. The designations given to the newest class of cells, "barrage" or "barrier-layer" cells, are neither distinctive nor descriptive and give no intimation that they are photoelectric devices at all. The name "photo-e.m.f. cell" is proposed for criticism and discussion. The objections which readily occur to this name do not seem to be very weighty in view of the aptness of the term and the convenience which would result from its use.

12. A Filter Isolating 560 mμ. KASSON S. GIBSON, *National Bureau of Standards.* (10 minutes.)

A filter freely transmitting a narrow spectral region centering at 560 mμ and strongly absorbing at all other wave-lengths in the visible spectrum is of use in certain problems in (1) the colorimetry of sugar solutions,[1] (2) optical pyrometry,[2] (3) abridged spectrophotometry,[3] and (4) photometry.[4] A filter has recently been designed having the following components:

Designation of glass	Thickness in mm
1. Corning 351	4.55
2. Corning didymium	5.82
3. Jena VG 3	1.99
4. Jena BG 18	1.94

These are cemented together with Canada balsam.

This 4-component filter has the following characteristics:

Wave-length (mμ)	Transmission	Wave-length (mμ)	Transmission
530	0.001	560	0.275
540	.002	565	.212
545	.003	570	.010
550	.028	520 and less	less than .001
555	.174	575 and greater	less than .001

The spectral centroid of the transmitted light varies from $560._0$ mμ for I.C.I. illuminant *A* (incandescent light, 2848° K) to $559._8$ mμ for I.C.I. illuminant *C* (average daylight). The luminous transmission is 0.03_3 for illuminant *A* and 0.03_5 for illuminant *C*.

The spectral transmissions of the filter and its components will be illustrated and comparisons made with other similar filters. The transmission curve of the present filter has a ratio of height to width more than twice as great as the similar ratios for the other filters, including the one by Livingston[4] in which three of the four components of the present filter were used, although at different thicknesses. The present filter had been constructed before his description was published.

[1] Peters and Phelps, Techn. Pap. Bur. Standards 21, 261 (1927); Bur. Standards J. Research 2, 335 (1929); Brewster, Bur. Standards J. Research (in press).
[2] Hottell and Broughton, Ind. Eng. Chem. 4, 166 (1932).
[3] Appel, Am. Dyestuff Reporter 17, 49 (1928).
[4] Livingston, J. O. S. A. 24, 227 (1934).

13. Radiometric Measurements of Heat Absorbing Glass. ROGER S. ESTEY, *Electrical Testing Laboratories, New York, N. Y.* (10 minutes.)

As a class, heat absorbing glasses include all those which are relatively more transparent to visible than to invisible radiations. They are used in various applications for reducing the heat received from light sources. Special glasses used in windows to keep out solar heat are of present commercial importance and their testing is therefore of scientific interest. The effectiveness of a glass in a particular application can be determined theoretically by comparing the spectral transmission curve of the glass with the spectral energy distribution of the source. Practically, the light and heat transmission are each determined by single measurements using the source for which the sample is designed. In the case of the sun the infrared transmission of the atmosphere is too variable to permit close comparisons between measurements made at different times and good weather is too uncertain for convenience. Unmodified tungsten lamp radiation has been substituted for the sun as a test source to some extent. The differences between lamp and sun measurements are large and variable depending on glass color and thickness. If the tungsten light is modified by a daylight filter and if the tungsten radiation is modified by a filter producing an energy distribution approximately like that of solar radiation a laboratory source is produced which yields transmission values in much closer agreement with solar measurements. Data are presented showing the degree of agreement in light and heat transmission measurements made on various heat absorbing glasses using the sun and laboratory sources.

14. The Scattering of Light by Suspensions of Cells. HAROLD MESTRE, *Yale University.* (20 minutes.)

Because of their speed and objectivity photometric methods offer great possibilities for the study of suspensions of bacteria or other cells. The utility of such methods depends largely upon the extent to which the measurements can be interpreted in terms of the suspended cells. This implies an instrument of known optical characteristics, and an understanding of the manner in which such a suspension distributes a light flux incident upon it as a function of such variables as the size, shape, and numerical concentration of the cells, their index of refraction relative to the suspension medium, and the presence of pigment or of Rayleigh scattering.

There has first been considered the scattering of a collimated beam incident on a suspension of perfect dielectric spheres in a transparent medium. The diameter of the spheres (1 micron) and their refractive index relative to the medium (1.045) have been chosen to resemble as closely as possible a suspension of spherical bacteria in ordinary culture media. It has been shown by Blumer[1] that under these conditions the equations of Mie become useless for calculation of the distribution of the emergent flux.

From probability theory it is shown that the portion of the incident flux transmitted undeviated, without incidence on cells, approximately obeys Beer's law when concentration is represented by the product of the cross-sectional area of a sphere and the number per unit volume. With very large spheres, or high numerical concentrations, systematic departure occurs.

The angular distribution of the flux incident on a single sphere has been calculated by a method similar to that of Shoulejkin,[2] and expressions found to describe the effects on this primary distribution produced by succeeding incidences in a suspension. The fraction of the incident flux emergent within a given solid angle has been computed, as a function of cell size and numerical concentration, for several solid angles, so that the effect of differences in the angular aperture of the photometric system can clearly be seen. The effects of the other variables mentioned above have also been briefly considered with special reference to the design of the photometric system.

[1] H. Blumer, Zeits. f. Physik **38**, 304 (1926).
[2] W. Shoulejkin, Phil. Mag. **48**, 307 (1924).

15. Effect of Ultraviolet Rays on Virulence of Snake Venoms. DAVID I. MACHT, *Pharmacological Research Laboratory, Hynson, Westcott and Dunning, Inc., Baltimore, Md.* (15 minutes.)

Solutions or suspensions of dried scales of venom from cobra, rattlesnake and copperhead were made in physiological saline. The virulence of such suspensions was tested on various animals and on plants. Most of the zoopharmacological experiments were performed on mice injected with venom, while the phytopharmacological tests were made on seedlings of *Lupinus albus* according to the writer's special method.[1] When the potency of a given suspension had been determined, samples thereof in quartz cells were irradiated with mercury vapor lamps for different periods of time. It was found that exposure for ten minutes to the rays of a Kromayer lamp produced appreciable deterioration of the venom, and longer exposures rapidly effected more detoxification. Rays from a Kromayer lamp, passing through a Wood filter, produced little deterioration even after long exposure of venom. Radiations from a mercury lamp, passing through a chlorine gas filter, were more effective than the longer ultraviolet rays. Cobra venom is more resistant to the influence of ultraviolet rays than Crotalus venom. A different series of experiments was made on mice first injected with a potent snake venom and afterwards exposed to ultraviolet rays for possible therapeutic action. No antidotal effect was noted; in fact, these animals succumbed more rapidly than the controls injected with the same venom but not irradiated. Further experiments were made with suspensions of venom treated with x-rays and radium emanations, respectively. The results of this investigation, together with other interesting physiological data obtained from experiments on larger animals, will be described in a complete paper. While the ultraviolet rays destroy snake venom in quartz vessels, they are useless for therapeutic irradiation of poisoned animals except when directly applied to open wounds containing the venom.

[1] Macht, Science **71**, 302 (1930).

16. The Measurement of Gloss. RICHARD S. HUNTER, *Henry A. Gardner Laboratory, Washington, D. C.* (15 minutes.)

This paper is a discussion of the general problem of gloss measurement. Glossiness and luster are effects to be associated with regular reflection. However, no single measurement of reflection seems adequate to evaluate gloss under all the circumstances in which it appears. The different devices which are offered as gloss measuring instruments can be presented as evidence of the number of types of reflection measurements that are called gloss measurements. Furthermore, the different viewpoints from which gloss is evaluated seem to demand these different methods of measurement.

Some examples of these different types of gloss evaluation are to be shown. The instruments used to measure gloss can be compared to show the physical methods employed. Two general methods of gloss measurement are used: (1) measurement of the resolution, or sharpness of images reflected in the gloss surface and (2) measurement of the regular reflection coefficient of the gloss surface. Because, in general, each particular type of instrument operates under its own set of conditions, no two instruments measure the same thing.

Bibliography:
Detroit Paint Production Club Standard Method of Gloss Measurement, Scientific Section Circular No. 423 (1933) of the National Paint, Varnish and Lacquer Association, Washington, D. C.
R. S. Hunter, Scientific Section Circular No. 456 (1934) of the National Paint, Varnish and Lacquer Association, Washington, D. C.
R. L. Ingersoll, J. Opt. Soc. Am. 5, 213 (1921).
L. A. Jones, J. Opt. Soc. Am. 6, 140 (1922).
M. O. Pelton, Trans. Opt. Soc. (London) 31, 184 (1929–30).
A. H. Pfund, Proc. A. S. T. M. 25 (II), 396 (1925); J. Opt. Soc. Am. 20, 23 (1930).
Sward and Levy, Scientific Section Circular No. 380 (1931) of the National Paint, Varnish and Lacquer Association, Washington, D. C.

17. The Interpretation of Data Obtained with Spectrophotometers of the Polarization Type. ROBERT D. NUTTING, *Massachusetts Institute of Technology.* (15 minutes.)

Many spectrophotometers utilize polarizing prisms and determine the reflectance of the sample by plane polarized light. In general, the reflectance of the sample is independent of the azimuth of the plane of polarization but there are some materials, notably textiles, for which the reflectance depends upon the azimuth. It can be shown mathematically that, if the reflectance is measured for two azimuths at right angles to one another, the arithmetic average of the two values is the reflectance for ordinary, or unpolarized, light. This is true regardless of the azimuths selected. Experimental data are presented which indicate the applicability of this principle to the measurement of the color of textile fabrics.

18. The Eye as an Integrator of Short Light Flashes. J. W. BEAMS, *University of Virginia.* (10 minutes.)

The way in which the eye integrates the intensity of a series of very short flashes of light has been investigated. Light from a straight incandescent filament, after reflection in a rotating mirror, was brought to focus on a slit. The duration of each flash was equal to the time required for the image of the filament to sweep across the slit and the number of flashes per second was equal to the rotational speed of the mirror. Since the number of flashes per second was always great enough to avoid flicker, their integrated intensity could be compared with a steady continuous source. For this comparison source, light from the incandescent filament mentioned above was passed through two nicol prisms and brought to focus on the upper part of the slit. In the field of view of an eyepiece placed behind the slit the image of this comparison source appeared above and just touching that consisting of the light flashes. It was found when the intensity of the comparison source was adjusted, by rotating one nicol, to give a "match" of the two images, that this "match" was independent of the rotational speed of the mirror over the range studied. The rotating mirror[1] was both supported and driven by air jets and its axis of rotation was accurately vertical at all rotational speeds used. Since the amount of energy that passed through the slit was independent of the rotational speed of the mirror but the duration of each flash was inversely proportional to this speed, it is concluded that over the range studied the eye integrates the energy in the light flashes in the same way and independently of the length of the light flashes. The duration of the light flashes was varied from 10^{-6} to 10^{-8} second and the two images in the field of view of the observing eye piece could be "matched" with a precision of 2.5 percent.

Bibliography:
[1] See Beams, R. S. I. 1, 667 (1930); Beams, Weed and Pickels, Science 78, 338 (1933).

19. A General Purpose Amplifier and Its Specific Use in the Actinometry of Photoflash Lamps. S. MCKAY GRAY AND HOWARD J. ECKWEILER, *Electrical Testing Laboratories, New York, N. Y.* (20 minutes.)

In consequence of a need for the amplification of both transient and audiofrequency periodic electrical phenomena sufficient to operate a Duddell-type oscillograph with an element sensitivity of 1.2 mm/m.a., a direct-coupled vacuum-tube amplifier has been constructed incorporating the following features: A transconductance of 0.44 ampere/volt which is constant over a range of 0.12 ampere; a voltage-amplification of 578; a maximum *linear* current amplification of 4.4×10^7 requiring an input resistance of 100 megohms; the compensation of the interelectrode capacitances to effect the cancellation of distortion introduced by the shunted currents necessary to charge these capacitances; and a maximum of stability.

The specific use of this general purpose amplifier in the measurement of the actinic intensity *vs.* time function of photoflash lamps and flashlight powders is described as an illustrative example of its employment.

A brief outline is given of the method employed for the correction of the spectral sensitivity of a photoelectric cell to approximate that of Eastman *Verichrome* or of Eastman *Super Pan* film. The methods of standardization, etc., are either detailed or outlined.

Extension into other fields of usefulness is indicated by reference to measurement of transient light phenomena, the determination of rapid color temperature variations, the calibration of photographic shutters, etc.

The present paper will appear in full in Review of Scientific Instruments.

20. Relative Photographic Effectiveness of Some Light Sources. W. E. FORSYTHE AND M. A. EASLEY, *Incandescent Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.* (20 minutes.)

Besides the regular incandescent lamps and the blue bulb photographic lamp there are two photo-flood lamps and a movie-flood lamp, and in addition four photo-flash lamps that are used for taking pictures under different conditions. Some of the characteristic data of these lamps are given in Table I.

The relative photographic effectiveness of the photo-flash lamps was measured for both the maximum intensity and total light output while the incandescent lamps were measured at normal intensity. The regular 115 volt, 500 watt lamp was used as a standard, to calibrate the film with 1/500 second exposure time for the maximum intensity of the photo-flash lamp and 1/25 second for all other calibrations. The time of exposure for the incandescent lamps was 1/25 second and for the photo-flash lamps was determined by the length of flash.

The films used for measuring the relative photographic effectiveness were developed in Eastman D76 developer to a contrast of approximately 0.8 and the values of the relative effectiveness given in the table are for a density of unity. The relative photographic effectiveness of these sources differs with the type of emulsion. The results given in the table are the average values obtained on two different brands of commercial, orthochromatic and supersensitive panchromatic films.

TABLE I.

Lamp	Volts	Lumen output	Color temp.	Photographic effectiveness Total 1	Total 2	Total 3	Maximum 1	Maximum 2	Maximum 3
500-W	115	9800	2950°K	1	1	1	1	1	1
1500-W (blue bulb)	115	18000		3.7	3.1	2.6			
250-W photo-flood	115	8600	3490	1.3	1.2	1.0			
1000-W "	115	32000	3410	4.6	4.5	3.9			
2000-W movie-flood	115	67000	3430	11.2	10.8	9.4			
Photo-flash		Output in lumen seconds							
No. 10		26000		210	142	110	500	460	330
No. 20		52000		310	260	245	1180	840	580
No. 75		180000		1250	900	750	1580	1380	1050

Notes: 1 = Commercial film
2 = Orthochromatic film
3 = SS panchromatic film

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

21. Simplified Microdensitometer Based on that of Hartmann. S. Jacobsohn and W. H. Kliever, *The Gaertner Scientific Corporation.* (5 minutes.)

The microphotometer of Hartmann suffers from several disadvantages which have been removed in this construction. The stage has been inclined to the horizontal and the reflection at the photometer cube transferred to the element which images the wedge. A convenient posture is thus attainable and the annoyance of adjusting the plate in the field by the help of a perverted image is avoided. The stage is provided with a T-square rest for the plate, adjustable by rack and pinion. The field of spectrum lines may be seen at the same time as measurements are made owing to a construction of the photometer cube having a slit of rather short length. Instead of the photographic wedge of the original instrument a neutral gelatine wedge is employed and grain introduced by a fixed plate, on which the comparison microscope is focused. The wedge readings are therefore proportional to the densities. Data are given showing the sensitivity and accuracy of the instrument.

Bibliography:
Zeits. f. Instkde. 19, 77.

The present paper will appear in full in R. S. I.