It is thus evident that there is a zone in the atmosphere susceptible to electrical conductivity beginning at about 50 miles from the surface of the earth as shown by both the auroral height determinations and those of focus of the aurora of August 26 were at a height above the earth's surface not far from sixty to sixty-five miles.

C. C. Trowbridge
Columbia University

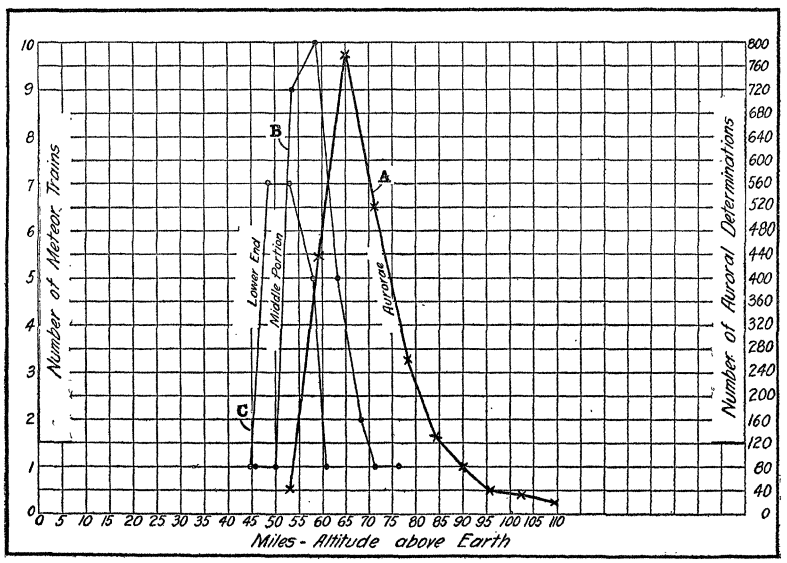


Fig. 4. Comparison of the heights of the aurora, determined by Carl Störmer's expedition at Bossekop during the spring of 1913, and the heights of meteor trains. In both cases the altitudes were determined by triangulation from two stations.

Curve *A*—2,400 determinations of the heights of the aurora.

Curve *B*—the heights of the middle portion of 30 meteor trains.

Curve *C*—the heights of the lower end of 21 meteor trains.

the meteor trains. The conducting layer in the earth's atmosphere which has been much discussed by those interested in the propagation of long electric waves is usually given as at an altitude of 35 to 40 miles by various writers on wireless telegraphy, as based on some theoretical deductions of Professor J. J. Thomson. The results given above seem to show that the main conducting layer of the atmosphere is considerably above the altitude heretofore accepted, and is at a height of from 50 to 70 miles.

The general agreement between the recently determined values of auroral heights and the altitude limits of the meteor train zone shown in Fig. 4 is very significant, and there is thus good evidence that the streamers forming the

## THE NINETEENTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

The nineteenth meeting of the American Astronomical Society was held in the Sproul Observatory of Swarthmore College, Swarthmore, Pennsylvania, on August 30 to September 2, 1916. This was the first meeting held east of the Allegheny Mountains since 1911, intervening meetings having been held in Pittsburgh, Cleveland, Atlanta, Evanston, and San Francisco.

It has been the policy of the society for some years past to hold its meetings at some one of the active observatories of the country. Astronomers are dependent, in a considerable measure in the nature of their contributions, on the equipment of their various observatories, and for a large part on the character and size of the telescope. It is, therefore, always of interest in the meetings to

see the observatories and instruments in detail; and by following the policy adopted the society will have eventually visited, and become directly acquainted with, the principal observatories of the country. The Observatory at Swarthmore College has been recently constructed, through the generous gift of the Honorable William Cameron Sproul. The principal instrument is a 24-inch refractor, constructed by the John A. Brashear Company. It is being devoted, for the most part, to photographic observations for the determination of stellar distances, and already has contributed, through the hands of the director, Professor John A. Miller, and his able staff of assistants, a considerable series of results of very high quality. This instrument was at the disposal of the members of the society on each evening, and we viewed with it star clusters, nebulæ, double stars, and the planets Jupiter and Uranus.

Swarthmore College is in beautiful surroundings; and the beauty of its campus was well matched by the generous hospitality extended to the society. Relaxation from the rather severe scientific program was provided in a reception by Professor and Mrs. Miller, a Pennsylvania Country Supper in the home of Senator Sproul, and in an excursion by automobile through the suburbs of Philadelphia to Valley Forge. The return from Valley Forge was made through Bryn Mawr to Haverford College, where we were welcomed by President Isaac Sharpless, and where tea was served by some of the ladies of the faculty. We visited here some of the buildings, and naturally took great interest in the well-found observatory. Continuing the ride, we arrived at dusk at the Flower Observatory of the University of Pennsylvania at Upper Darby. Here we were greeted by Provost Edgar F. Smith, Professor Eric Doolittle and his wife, and Professor C. L. Doolittle and his wife. We were the guests of the University of Pennsylvania for dinner, which was spread under the trees on the observatory grounds. Unfortunately it was cloudy in the evening, so that we were unable to have the expected opportunity of observing with the 18½-inch refractor. We did have opportunity, however, of inspecting the various instruments of this well-equipped observatory, and to see the work on double stars which Doolittle is so ably conducting. The return to Swarthmore was made late in the evening.

The following members of the society were in attendance:

Leah B. Allen,
A. T. G. Apple,
S. G. Barton,
L. A. Bauer,
A. F. Beal,
Harriet W. Bigelow,
E. W. Brown,
Annie J. Cannon,
C. A. Chant,
W. A. Cogshall,
R. H. Curtiss,
C. L. Doolittle,
Eric Doolittle,
J. C. Duncan,
W. S. Eichelberger,
Philip Fox,
Edgar Frisby,
Caroline E. Furness,
W. E. Harper,
Margaret Harwood,
François Henroteau,
Wm. T. Herriott,
Kiyotsugu Hirayama,
Mary M. Hopkins,
Charles J. Hudson,
Louise F. Jenkins,
C. C. Kiess,
O. M. Leland,
Walter A. Mâtos,
Paul Merrill,
Willis I. Milham,
John A. Miller,
S. A. Mitchell,
C. P. Olivier,
Edison Pettit,
E. C. Pickering,
John H. Pitman,
John M. Poor,
A. W. Quimby,
E. D. Roe,
H. N. Russell,
Frank Schlesinger,
Frederick Slocum,
M. B. Snyder,
Joel Stebbins,
Hannah B. Steele,
H. T. Stetson,
Florence J. Stocker,
Helen M. Swartz,
John Tatlock,
Stephen D. Thaw,
Robert Trümpler,
A. B. Turner,
F. W. Very,
A. van Maanan,
J. van der Bilt,
W. R. Warner,
D. T. Wilson,
W. L. Wright,
C. C. Wylie.

New members to the society were elected as follows:

H. C. Bancroft, 412 Taylor Avenue, West Collingswood, N. J.

Ruth D. Bannister, Dearborn Observatory, Evanston, Ill.

Arthur Floyd Beal, Albion College, Albion, Mich.

Martha Clare Borton, Princeton Observatory, Princeton, N. J.

Frederick Lyons Brown, Dearborn Observatory, Evanston, Ill.

Allan B. Burbeck, North Abington, Mass.

Clifford Charles Crump, Carleton College, Northfield, Minn.

Edith Eleanor Cummings, Laws Observatory, Columbia, Mo.

Clinton Harvey Currier, Brown University, Providence, R. I.

William Ewart Glanville, St. Peter's Rectory, Solomons, Md.

Edward Gray, 2635 Channing Way, Berkeley, Calif.

William LeRoy Hart, Harvard University, Cambridge, Mass.

François Henroteau, Detroit Observatory, Ann Arbor, Mich.

William T. Herriott, Allegheny Observatory, Pittsburgh, Pa.

Kiyotsugu Hirayama, Astronomical Observatory, Tokyo, Japan.

Arthur S. King, Solar Observatory, Pasadena, Calif.

Ora Miner Leland, 150 Triphammer Road, Ithaca, N. Y.

C. B. Lindsley, 855 East Ridgeway Ave., Cincinnati, Ohio.

Walter A. Mâtos, 309 College Ave., Swarthmore, Pa.

Harriet McWilliams Parsons, Vassar College, Poughkeepsie, N. Y.

Jesse Pawling, Naval Observatory, Washington, D. C.

Edison Pettit, Washburn College, Topeka, Kansas.

David B. Pickering, 81 South Burnett St., East Orange, N. J.
William Francis Rice, Wheaton College, Wheaton, Ill.
Robert Trümpler, Allegheny Observatory, Pittsburgh, Pa.
J. van der Bilt, Utrecht Observatory, Utrecht, Holland.
Reynold K. Young, Dominion Observatory, Ottawa, Canada.

At the last meeting, the election of officers took place.

*President*—E. C. Pickering.
*First Vice-president*—Frank Schlesinger.
*Second Vice-president*—W. W. Campbell.
*Treasurer*—Annie J. Cannon.
*Councilors for 1916–18*—E. W. Brown, J. S. Plaskett.

The following officers continue in service:

*Councillors, 1915–17*—Edwin B. Frost, Joel Stebbins.
*Secretary*—Philip Fox.

It was voted to hold a meeting of the society in conjunction with the American Association, at its coming general quadrennial meeting in New York, on December 26 to 30, 1916. Further, accepting the invitation of Professor Benjamin Boss, it was voted to hold the annual summer meeting of 1917 at the Dudley Observatory, in Albany, N. Y.

A committee composed of Messrs. W. W. Campbell, chairman; E. E. Barnard, F. B. Littell, Frank Loud, S. A. Mitchell and Edison Pettit, was appointed to further and facilitate cooperation for the observation of the coming favorable solar eclipse of June 8, 1918. The Committee on Meteors was enlarged by the appointment of C. P. Olivier, secretary; E. E. Barnard, W. J. Humphreys, F. R. Moulton and W. H. Pickering. A committee to consider instituting the grade of Associate Membership was also appointed. The members of this committee are: Messrs. Frank Schlesinger, chairman; C. A. Chant, G. C. Comstock, Philip Fox, W. T. Olcott and E. D. Roe.

Other committees of the society made reports on their work, but only one led to a motion recommending a course of action by the society. This was the Committee on Standard Equinoxes for Use in the Publication of Star Positions. The recommendation of this committee, which was adopted by the council and recommended for practise by members of the society, was "that in any publication involving star positions no equinoxes should be used intermediate between the years 1900 and 1925." If the plan of widely spaced standard equinoxes is adopted, it will greatly reduce the amount of labor now involved in the treatment of the star positions given for such a multiplicity of equinoxes.

The great European War, which has affected profoundly the whole world, has put its blighting hand on our society, in the death of Professor Karl Schwarzschild. At the last meeting of the society, the following resolution was unanimously adopted:

Whereas: In the death of Karl Schwarzschild on May 11, 1916, many of the members of this society have lost a warm friend, the society itself one of its most eminent members, and astronomy a brilliant and remarkably versatile contributor:

*Resolved:* That the society record in its minutes its sense of deep loss, and that copies of this resolution be engrossed and sent to Mrs. Schwarzschild, and to the Astrophysical Observatory at Potsdam.

Aside from committee reports, the scientific program consisted of fifty-two papers. The titles are given here, in the order of presentation:

1. F. Slocum: The Van Vleck Observatory.
2. E. W. Brown: The Progress of the New Lunar Tables.
3. Annie J. Cannon: Peculiar Spectra Found in Preparing the New Draper Catalogue.
4. C. P. Olivier: The Meteor System of Winnecke's Comet.
5. E. C. Pickering: Proper Motion of Stars in the Zone $-10°$ to $-14°$.
6. J. A. Miller: Summary of the Sproul Observatory Parallax Work.
7. Hannah B. Steele: The Parallax of Certain Binary Stars.
8. John H. Pitman: Choice of Comparison Stars in Parallax Determinations.
9. Philip Fox: First Results on the Dearborn Observatory Parallax Program.
10. K. Burns, W. H. Meggars, P. W. Merrill: Determination of Wave-lengths by Interference.
11. A. van Maanen: Remarks on the Motion of the Stars in $h\chi$ Persei.
12. W. S. Adams: Recent Stellar Spectroscopic Results.
13. C. J. Hudson: Irregularities in Refraction.
14. A. Hall: The New Repsold Micrometer for the 26-inch Refractor of the Naval Observatory.
15. H. L. Alden: Calibration of the McCormick Observatory Photometer Wedge.
16. S. A. Mitchell: Parallax Work at the McCormick Observatory.
17. R. H. Curtiss: The Widths of Hydrogen Emission Lines in Class B Spectra.
18. R. H. Curtiss: Some Structure Variations in Hydrogen Emission Lines in Class B Spectra.
19. H. N. Russell, Mary Fowler, Martha C. Borton: Photographic Observation of Eclipsing Variables.

20. H. Shapley: Colors of the Brightest Stars in Seven Globular Clusters.
21. H. Shapley: Notes on the Spectra of Cepheid Variables.
22. Leon Campbell: Cooperation in Variable Star Observing.
23. J. Kunz and J. Stebbins: Progress in Photoelectric Photometry.
24. F. H. Seares: The Color of the Polar Sequence Stars.
25. F. H. Seares: Distribution of Color in the Spiral Nebulæ.
26. Edison Pettit: Circumstances of the Solar Eclipse of June 8, 1918.
27. E. P. Hubble: On the Variable Nebula N. G. C. 2261.
28. F. W. Very: Lunar and Terrestrial Albedoes.
29. F. W. Very: The Spherical Albedoes of the Planets.
30. L. A. Bauer: Note on the Rotation Periods of the Planets.
31. C. C. Crump: Preliminary Note on the Spectrum of Gamma Lyræ.
32. H. N. Russell: On the Capture of Comets by Planets.
33. F. W. Very: Examination of "New Evidence" on the Solar Constant.
34. F. W. Very: Planetary Evidence in Respect to Solar Radiation.
35. F. W. Very: The Radiant Properties of the Earth from the Standpoint of Atmospheric Thermodynamics.
36. R. E. DeLury: The Effect of Haze Spectrum on Spectrographic Determination of the Solar Rotation.
37. R. E. DeLury: Note on a Supposed Variation in the Solar Rotation.
38. S. G. Barton: The Interrelations of the Asteroid Elements.
39. H. N. Russell: The Visibility of Jupiter by Daylight.
40. E. E. Barnard: A Small Star with the Largest Known Proper Motion.
41. W. W. Campbell, J. H. Moore: The Spectral Type and Radial Velocity of Barnard's Proper Motion Star.
42. F. G. Pease: Rotation and Radial Velocity of the Spiral Nebula N. G. C. 4594.
43. C. O. Lampland: Measurements of the Spiral Nebulæ N. G. C. 4254 and 5194 for Motion.
44. H. D. Curtis: Forms of Planetary Nebulæ.
45. Eric Doolittle: An Extension of Burnham's Catalogue of Double Stars.
46. J. A. Parkhurst: The Bases of Photographic Stellar Magnitudes.
47. Sarah F. Whiting: Diaries of the Tulse Hill Observatory.
48. V. M. Slipher: Spectrographic Observations of Nebulæ.
49. W. W. Campbell and J. H. Moore: Spectrographic Observations of Motion in the Planetary Nebulæ.
50. V. M. Slipher: Spectral Evidence of a Persistent Aurora.
51. C. E. St. John, Louise W. Ware: Systematic Errors in Rowland Table for Close Pairs of Solar Lines.
52. C. E. St. John: On the Mutual Repulsion of Solar Lines.

Abstracts for these papers are given in a somewhat fuller report of the meeting in the current numbers of *Popular Astronomy*, and only the main lines of the papers are commented on here. Those which pertain to details of observation are possibly sufficiently well described by the title.

It is very gratifying to hear from Professor Brown that the printing of the New Lunar Tables, computed along the lines of his complete Lunar Theory, is progressing rapidly, and that in the Ephemerides for 1923, we will, for the first time, have the results from them.

In the report by Miss Cannon on the peculiar spectra found in the observations for the new Draper Catalogue, we find that this catalogue, which is to be of immense service, also is nearing completion.

Mr. Olivier, following lines laid down by Schiaparelli, points out a new coincidence between a meteoric system and a comet's orbit.

Papers were presented by Miller, Steele, Pitman, Fox and Mitchell, dealing with stellar parallax results. Few movements in American astronomy are progressing more favorably than the campaign for extension of our knowledge of stellar distances. Many observatories are taking part in the campaign, and all are now contributing results. From the Sproul Observatory was a report on the parallax of 64 objects; the University of Virginia reported on the parallax of 96 stars; the Dearborn Observatory on 4 stars.

The paper of Mr. Adams was also of interest from the stellar parallax point of view, in that he here gives results from his very original and important spectroscopic method of estimating stellar distances.

Spectroscopists in general will be interested in the work of Burns, Meggars, and Merrill, who are extending the determinations, by interference methods, of wave-lengths of lines spaced at short intervals through the spectrum which may well be

used as standards in other determinations of wavelengths.

The fact that certain stars vary in brightness has of course long been recognized, and there are several papers here presented bearing on stellar magnitudes or on variables, by Leon Campbell, who comments on the rich and important contributions being made by associated amateurs; by Russell, who brings out some exceedingly important points from his treatment of eclipsing variables; by Shapley; by Kunz and Stebbins, who are developing their photo-electric cells; by Seares, who continues his contributions on the standard photometric field of the polar sequence; and by Parkhurst, who gives the results of his valuable experience on the bases of photographic stellar magnitudes. From various sources, important contributions are now being made, showing that the variation of light is not alone confined to the integrated light, but that marked changes of the character of the spectrum are also involved. At this meeting there were papers by Shapley, by R. H. Curtiss, by Adams, and by Miss Cannon, on this very fundamental matter.

In other directions where constancy had come to be regarded as perhaps the general condition, we are now finding marked changes. Mr. Hubble's paper on a variable nebula presented photographs of this remarkable object, showing that it had undergone astonishing change of form. Whether or not there is any relation between the change of form and the light variation of the associated star is not yet revealed. In 1914, at the Evanston meeting of the society, Slipher showed his first spectroscopic results, proving the rotation of certain nebulæ. At this meeting, he presented further evidence on the rotation of nebulæ, and contributions of similar nature were presented also by Campbell and Moore, and by Pease. Lampland gives evidence of rotation of two nebulæ from measurements of direct photographs.

It was following the presentation of Pettit's paper on the Circumstances of the Solar Eclipse of June 8, 1918, that the committee to further the cooperation in observing the eclipse was appointed.

Very's papers on the albedoes of the Moon, the Earth and the Planets, and the discussion which followed, particularly that by Mr. Russell, did much to clarify the ideas on this matter, where the results by given observers have been at variance and very perplexing.

Professor Barnard has recently found a faint star of about the eleventh photographic magnitude which, in individual proper motion, exceeds that of any heretofore recognized. In addition to Barnard's paper on this star, Campbell and Moore and also Adams contributed certain observations on its motion.

There have been very perplexing deviations in the values for the rotation of the Sun, as determined by various observers using the spectroscopic method, and also from observations made at different times by a single observer. The papers by DeLury give a sufficient and positive explanation of these deviations, and leave no reason for supposing that the rate of rotation of the Sun is variable from season to season.

In a paper on the extension of Burnham's Catalogue of Double Stars, Doolittle summarizes the work, which he has carried forward since Burnham turned over his manuscript and material to him. In doing this work, Doolittle is in a position to state at once whether any double star suspected of being new by any observer had already been noted as such. He is also in a position to state what objects have been recently and sufficiently observed, and he offers to give information on either of these points to any one who may wish to profit by such service. Double star observers, to work efficiently, must have information, at least on the latter point, and to have available the information which Doolittle has at hand will minimize the labor which its duplication would otherwise necessarily involve.

At the conclusion of the meeting, the following resolution of appreciation of courtesies was adopted:

*Resolved:* That the American Astronomical Society express to the President and Board of Managers of Swarthmore College, its thanks for the courtesies extended to the members of the society during the meetings at Swarthmore. The society desires also to express its appreciation of the numerous arrangements made for their comfort and convenience by Professor Miller and President Swain, and of the manner in which these have been carried out by the matron of Wharton Hall and others who have assisted in looking after the welfare of the visitors.

*Resolved:* That the thanks of the society be extended to Senator William Cameron Sproul, to the citizens of Swarthmore, to the president and trustees of the University of Pennsylvania, and to the president and board of managers of Haverford College for their hospitalities in connection with the visit of the society and its appreciation of the courtesies extended to its members.

*Resolved:* That the secretary be directed to communicate the substance of these resolutions to Presidents Swain, Smith and Sharpless, and to others who have assisted.

Philip Fox,
*Secretary*