

THE
MISCELLANEOUS DOCUMENTS

OF THE
SENATE OF THE UNITED STATES

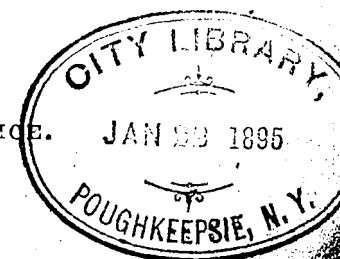
FOR THE

SECOND SESSION OF THE FIFTY-FIRST CONGRESS.

IN SEVEN VOLUMES.

Volume 1.—Nos. 1 to 25 (inclusive.)
Volume 2.—No. 26.
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LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., February 25, 1890.

SIR: In conformity with the requirements of the act of incorporation approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.
The PRESIDENT OF THE SENATE.

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REPORT
OF
THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about 100 members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government, without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year, the Academy has held three sessions. The first was the regular annual meeting held in Washington, D. C., April 16 to 19, 1889; the second was a scientific session, in Philadelphia, November 12 to 14, 1889, and the third was a special session in Philadelphia, November 13, 1889.

STATED SESSION.

HELD IN WASHINGTON CITY, APRIL 16 TO 19, 1889.

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe.	Cook, G. H.	Hilgard.	Newcomb.
Abbot.	Cope.	Hill, G. W.	Peirce.
Allen.	Dutton.	Hyatt.	Peters.
Barker.	Ferrel.	Langley.	Powell.
Bell.	Gibbs, W.	Marsh.	Pumpelly.
Billings.	Gilbert.	Mayer.	Putnam.
Brewer.	Gill.	Meigs.	Remsen.
Brooks.	Goode.	Mendenhall.	Rowland.
Brush.	Gould.	Michelson.	Schott.
Chandler, S. C.	Hague.	Mitchell, S. W.	Walker.
Coffin.	Hall, A.	Morton.	Wood.
Comstock.	Hall, J.	Newberry.	Wright.

At this session the following papers were read and discussed:

1. PEIRCE, C. S.: On Sensations of Color.
2. GIBBS, W., and HARE, H. H.: Notice on the Method and Results of a Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals. (Read by Dr. Hare.)
3. COPE, E. D.: On the Pliocene Vertebrate Fauna of Western North America. Discussed by Messrs. Gilbert and Cope.
4. TODD, D. P.; presented by S. Newcomb: On Composite Coronagraphy. Discussed by Messrs. Langley and Peters.
5. PEIRCE, C. S.: On Determinations of Gravity.
6. COPE, E. D.: On the North American Proboscidea.
7. HALL, A., Jr.; presented by G. J. Brush: On the Mass of Saturn. Discussed by Messrs. A. Hall, G. W. Hill, Peters, and Newcomb.
8. REMSEN, IRA: On the Rate of Reduction of Nitro-compounds.
9. REMSEN, IRA: On Some Connection between Taste and Chemical Composition.
10. MENDENHALL, T. C.: Recent Researches in Atmospheric Electricity. Discussed by General Greeley.
11. MICHELSON, A. A.: Measurement by Light Waves. Discussed by Mr. Rowland.
12. ROGERS, W. A.: Additional Experimental Proof that the Relative Coefficient of Expansion between Baily's Metal and Steel is Constant between the Limits Zero and Ninety-five Degrees Fahr. (Read by title.)
13. MICHELSON, A. A., and MORLEY, E. W.: On the Feasibility of the Establishment of a Light-wave as the Ultimate Standard of Length. Discussed by Messrs. Peirce, Rowland, and Michelson.
14. CHANDLER, S. C.: On the General Laws pertaining to Stellar Variations. Discussed by Messrs. Gould, G. W. Hill, Newcomb, Chandler, and Peters.
15. PETERS, C. H. F.: Review of the Trivial Names in Piazzi's Star Catalogue.
16. NEWBERRY, J. S.: On Cretaceous Flora of North America. Discussed by Messrs. Cope and Newberry.
17. HITCHCOCK, ROMYN; presented by A. Hall: Spectrum Photography in the Ultra-Violet. (Read by title.)
18. WALCOTT, C. D.; presented by R. Pumpelly: The Plane of Demarcation between the Cambrian and Pre-Cambrian Rocks. Discussed by Mr. Newberry.
19. TODD, D. P.; presented by S. Newcomb: Report of the American Eclipse Expedition to Japan, 1887.
20. REMSEN, IRA: On the Nature and Composition of Double Halides. (Read by title.)
21. ABBE, CLEVELAND: Terrestrial Magnetism. (Read by title.)
22. BROOKS, W. K.: North American Pelagidae. (Read by title.)
23. BROOKS, W. K.: Development of Crustacea. (Read by title.)

ELECTIONS.

The election of officers, for a term of 6 years, took place on Wednesday, April 17, 1889, and resulted as follows:

President, Prof. O. C. MARSH.

Vice-President, Prof. S. P. LANGLEY.

Home Secretary, Prof. ASAPH HALL.

The following members were selected for the council for the ensuing year: Messrs. G. J. Brush, B. A. Gould, M. C. Meigs, S. Newcomb, Ira Remsen, and F. A. Walker.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

1. That the assessment for the ensuing year be \$5.
2. That the proposed changes in the deeds of trust of the Draper and Smith funds, authorized by the resolution adopted last year, be indefinitely postponed.

HOME SECRETARY'S REPORT.

The home secretary submitted the following report for the past year:

April 16, 1889.

The current business of the Academy has been carried on as in former years.

The printing of the memoirs has made some progress. Part I of Vol. IV has been printed, but owing to delay in getting the plates only one hundred and seventy-seven copies were delivered to the Academy. These have been nearly all distributed to members and foreign associates. The printing of Part II of Vol. IV has not been begun on account of delay with the drawings. The drawings are now completed, and the printing of Part II will begin soon.

In accordance with the direction of the council, the printing of the third volume of biographical memoirs was begun a year ago, and the memoirs of William B. Rogers, Edward T. Tamm, Edward B. Hunt, James C. Watson, and James B. Eads, have been printed. These memoirs make seventy-nine pages of print. Five hundred copies have been struck off, and are held by the printers, Judd & Detweiler, until the volume is completed.

The annual of the Academy referred to in Rule XII has been understood to mean the constitution, rules, and list of members, and has been issued each year. The cost of printing and distributing this annual is about \$40 a year. The publication of this matter again in the annual report of the president has been thought by some of the members to render the annual unnecessary, but the secretary has not thought himself at liberty to discontinue it.

REPORTS OF COMMITTEES.

Mr. Gibbs, for the committee on the election of foreign associates, submitted a report recommending the election of Lieut. Gen. Don Carlos Ibañez, director of the Geodetic Survey and the Census of Spain, and president of the international committee of weights and measures. The foreign secretary was authorized to cast the vote of the Academy for that gentleman, who was declared elected.

At Mr. Langley's request, the committee on reserving public lands on and near Mount Whitney, California, for scientific purposes, was continued.

The home secretary, for the committee on publication, made a statement concerning the printing of the memoirs, and expressed the hope that the style of printing might be improved in the future.

Mr. Gill, representing the committee on publications of the Academy, reported progress.

The president and Mr. Coffin made statements concerning the action of the committee on the relation of the Academy to the Government.

The board of direction of the Bache fund presented a report, which was read by Mr. Gibbs and accepted. (See Appendix D, p. 37.)

Mr. Newcomb submitted the report of the board of trustees of the Watson fund. This report was accepted. (See Appendix D, p. 48.)

THE JAMES WATSON MEDAL.

At a public session of the Academy, held on the evening of April 17, 1889, the second James Watson gold medal and the sum of \$100 in gold were presented to Prof. Edward Schönfeld, director of the Bonn Observatory, Germany.

At the same session, a biographical memoir of the late Prof. Spencer F. Baird was read by Dr. Billings.

NEW MEMBERS.

At this meeting, the following new members were elected: Prof. Lewis Boss, Prof. Charles S. Hastings, Prof. Arthur Michael, Prof. Sereno Watson, and Prof. Charles A. White.

NEW FOREIGN ASSOCIATE.

Lieut. Gen. Don Carlos Ibañez, of Madrid, Spain, was elected foreign associate of the Academy.

TREASURER'S REPORT.

WASHINGTON, D. C., April 16, 1889.

SIR: The committee appointed to audit the treasurer's accounts and to compare them with the report made by the committee upon the securities held by the Academy respectfully report that they have examined the books and the accounts of the treasurer, and that they have compared the vouchers with the disbursements reported, and have compared the receipts with the record of dues received from members and with the record of interest received from invested funds of the Academy, and find the same to be correct.

IRA REMSEN.
S. C. CHANDLER.
G. W. HILL.
Committee.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

REPORT.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences.

1. General fund.

Balance brought forward from April 17, 1888	\$213.56
Received during year	503.26
Total to be accounted for	\$716.82
Disbursements during year	306.05
Balance cash on hand	410.77
Available balances = *\$377.77 + \$500 in 3.65 bonds.	

2. Bache fund.

Balance brought forward from April 17, 1888	\$1,648.82
Received during year	13,985.73
Total to be accounted for	\$5,634.55
Disbursements during year	2,133.60
Balance cash on hand	3,500.95
Available balance = †\$11.05.	

3. Watson fund.

Balance brought forward from April 17, 1888	\$2,197.65
Received during year	836.74
Total to be accounted for	\$3,033.79
Disbursements during year	12,735.40
Balance cash on hand	298.39
Available balances = ‡\$198.39 + \$1,500 in 3.65 bonds.	

4. Draper fund.

Balance brought forward from April 17, 1888	\$565.64
Received during the year	200.00
Total to be accounted for	765.64
Disbursements during the year	35.33
Balance cash on hand	740.31
Available balances = \$480.31 + \$260 reserve.	

* \$33 due secretary from general fund.

† Includes transfer of \$1,500 District of Columbia 3.65 bonds to Watson fund.

‡ \$36 due Bache fund from Philadelphia City board.

\$ 100 due to accompany Watson medal.

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5. Smith fund.

Balance brought forward from April 17, 1888	\$939. 10
Received during year	324. 00
Total to be accounted for	\$1, 263. 10
Disbursements during year	25. 32
Balance cash on hand	1, 237. 78
Available balances = \$705.78 + \$532 reserve.	
A detailed account current, with vouchers, is herewith submitted.	
Very respectfully,	

J. W. BILLINGS.

Treasurer, National Academy of Sciences.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

REPORT ON SECURITIES.

The following report of the committee to examine securities held by the Academy was read and approved:

WASHINGTON, D. C., April 16, 1889.

SIR: The committee appointed to inspect and verify the bonds and securities and other property of the National Academy begs leave to report that it has performed that duty on April 11, 1889.

The bonds and securities of the Academy at present deposited by its treasurer at the Washington Safe Deposit Company's office, 916 Pennsylvania avenue, were inspected and verified individually, and were found to correspond to the list in the treasurer's book.

1. Bache trust fund.

United States 4½ per cent. registered bonds	\$42, 100
United States 4 per cent. registered bonds	3, 850
City of Davenport 6 per cent. loan	1, 000
City of Philadelphia 6 per cent. loan	600
Total Bache fund	\$47, 550

Also, land warrant No. 62740 for 160 acres of land in Missouri.

2. Joseph Henry fund.

An agreement with the Pennsylvania company for insurance on lives and granting annuities as to the final disposition of the Joseph Henry fund of \$40,000.

3. Watson trust fund.

United States 4½ per cent. registered bonds	\$6, 200
United States 4 per cent. registered bonds	850
Certificates of stock of Michigan Mutual Life Insurance Company	6, 700
Total Watson fund	13, 750

4. Henry Draper medal fund.

United States 4 per cent registered bonds	5, 000
Also, a deed of trust of Mary Anna Palmer Draper, giving \$6,000 to the Academy.	

REPORT OF THE NATIONAL ACADEMY OF SCIENCES, 1889. 11

5. J. Lawrence Smith medal fund.

United States 4½ per cent. registered bonds	\$7, 200
Also a deed of trust of Sarah Julia Smith, giving \$8,000 to the Academy.	

6. Income of the Bache and general fund.

District of Columbia 3.65 bonds	2, 000
Of this, \$1,500 belongs to the income of the Watson fund, and \$500 to the income of the general fund.	

Total of securities held by the Academy	75, 500
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For the convenience of the auditing committee, a detailed statement of every bond and security, as found by your committee, is herewith inclosed.

Respectfully submitted by,

CHARLES A. SCHOTT.

THEODORE N. GILL.

Committee.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

ADDRESS BY THE PRESIDENT.

The president made a short address, in which he spoke of the policy of the Academy, its relations to the Government in the past, and the proper action for the future.

DEATH OF MEMBERS.

The president announced the death of Dr. J. C. Dalton, who died February 2, 1889.

Dr. S. Weir Mitchell was appointed to prepare a biographical notice.

The president also announced the death of two foreign associates, Dr. R. Clausius, of Bonn, and Professor Chevreul, of Paris.

INVITATIONS.

The members of the Academy were invited to attend the meeting of the Anthropological Society, Tuesday evening, April 16.

The President of the United States received the members of the Academy, Wednesday, April 17, at 12 o'clock.

The Secretary of the Smithsonian Institution extended an invitation to each member of the Academy and family to attend a reception at the Institution on Thursday evening, April 18, at half past 8 o'clock.

The hospitalities of the Cosmos Club were extended to the members of the Academy during their stay in Washington.

The Academy adjourned April 19, to meet in Philadelphia, November 12, 1889.

SCIENTIFIC SESSION.

HELD IN PHILADELPHIA, NOVEMBER 12 TO 14, 1889.

A scientific session, for the reading of papers only, having been called by the council, as announced at the April meeting, the Academy met at the University of Pennsylvania, Philadelphia, on November 12, 1889.

The president, Prof. O. C. Marsh, presided at this meeting.

The following members were present during the session:

Barker.	Gill.	Mendenhall.	Rood.
Billings.	Gould.	Michael.	Rowland.
Brewer.	Hall, A.	Michelson.	Sellers.
Brooks.	Hall, J.	Mitchell, S. W.	Wood.
Chandler, C. F.	Langley.	Newberry.	Wright.
Cope.	Leidy.	Newcomb.	Young.
Gibbs, W.	Lesley.	Powell.	
Gilbert.	Marsh.	Pumpelly.	

The following papers were read and discussed:

1. LANGLEY, S. P.: On the Economy of Energy in the Glow-worm. Discussed by Messrs. W. Gibbs, Langley, Barker, C. F. Chandler, and Rood.
2. ROOD, O. N.: On Photometry of Colored Light. Discussed by Messrs. Langley, Young, and Rood.
3. GIBBS, W.: On certain Pyrophosphates. Discussed by Mr. Barker.
4. COPE, E. D.: On the Vertebrata of the Miocene of the Cypress Hills of Canada.
5. HALL, A.: On Saturn and its Rings. Discussed by Messrs. Rood, Gibbs, Young, Langley, and Hall.
6. GIBBS, W., and HARE, H. H.: On the Results of the Systematic Study of the Action of Definitely related Chemical Compounds upon Animals. (Read by Dr. Hare.) Discussed by Mr. Gibbs.
7. BARKER, G. F.: On Zinc Storage Batteries. Discussed by Mr. C. F. Chandler.
8. MICHELSON, A. A.: On Relative Wave-lengths. Discussed by Messrs. Rowland, Gould, and Michelson.
9. PICKERING, E. C.: On the Spectrum of Zeta Ursæ Majoris. (Read by Mr. G. F. Barker.)
10. RYDER, J. A.: presented by T. Gill: On the Persistence and Meaning of the Bi-concave centrum of the Vertebrae of Vertebrates. Discussed by Messrs. Gill and Ryder and the President.
11. BROOKS, W. K.: On the Early Stages of Echinoderms. Discussed by Messrs. Gill and Brooks.
12. GILL, T.: On a Peculiar Ordinal Modification as Exemplified by Fishes of the Family Halisauridae.
13. GOULD, B. A.: On the New Prototypes of the Kilogramme and the Metre. Discussed by Messrs. Newcomb, Rowland, and Gould.
14. HALL, J.: Remarks upon the Present State of our Knowledge in Reference to a Revision of the Genera of Brachiopoda for the Paleontology of New York, Vol. VIII.
15. BREWER, W. H.: On the Heredity of Acquired Characters. Discussed by Messrs. Wood, Brooks, Powell, Brewer, Gill, and Ryder.
16. MICHAEL, A.: On the "Positive-negative" Hypothesis in its Application to Organic Chemistry.
17. NEWCOMB, S.: On the Results of the Transits of Venus observed in 1761 and 1769.
18. NEWCOMB, S.: On the Theory of Cosmical Temperature. Discussed by Mr. W. Gibbs.

19. POWELL, J. W.: On the Desert Ranges.

20. WOOD, H. C.: On Hypnotic Cases without Suggestion. Discussed by Messrs. Newcomb and Wood.

21. NEWBERRY, J. S.: On the Laramie Group. Discussed by Messrs. Powell and Newberry.

22. MARSH, O. C.: On the Skull of the Gigantic Ceratopsidae. Discussed by Mr. Newberry.

23. MARSH, O. C.: On American Mesozoic Mammals. Discussed by Messrs. Gill and Marsh.

DEATH OF MEMBERS.

The president announced the deaths of Prof. F. A. P. Barnard, Prof. George H. Cook, Prof. Elias Loomis, and Prof. Leo Lesquereux, and appointed Prof. O. N. Rood, Prof. J. S. Newberry, Prof. H. A. Newton, and Prof. J. Peter Lesley, respectively, to prepare the biographical notices.

The president also announced the death of Mr. James P. Joule, of England, a foreign associate of the Academy.

Notice was given by the president that memoirs for the next volume, ready for publication must be sent in by December 1, 1889.

The scientific session then adjourned to meet in Washington on the third Tuesday in April, 1890.

SPECIAL SESSION.

HELD IN PHILADELPHIA, NOVEMBER 13, 1889.

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy met at the University of Pennsylvania Philadelphia, November 13, 1889, the president, Prof. O. C. Marsh, presiding.

The president laid before the Academy the purpose of the present business session, which was the consideration of his annual report to Congress. He said that this report would contain both the deeds of gift and an account of the grants made from the trust funds of the Academy since these funds were received.

RECOMMENDATIONS.

The home secretary read the recommendation of the council that the president's annual report be approved by the Academy, and that the president be authorized to include in this report the proceedings of the present meeting, as well as those of the last April session.

This recommendation was adopted by the Academy.

Mr. George F. Barker presented the following recommendation of the committee on the Henry Draper medal:

The committee on the Henry Draper medal recommend to the National Academy of Sciences the award of the Henry Draper medal to Prof. Henry A. Rowland, of Baltimore, for his researches on the solar spectrum.

This recommendation was adopted by the Academy.

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NOMINATIONS.

Five nominations for membership in the Academy were read by the home secretary. These will be acted on at the April meeting, 1890.

RESOLUTIONS.

Mr. W. Gibbs presented the following resolutions, which were adopted by the Academy:

Resolved, That the Academy tender to the provost, trustees, and faculty of the University of Pennsylvania their grateful acknowledgments for the abounding hospitality with which they have been received, and for the ample facilities provided for their meetings.

Resolved, That the Academy cordially thank the Historical Society of Pennsylvania for the reception so gracefully offered, and which afforded the Academy an opportunity to make the acquaintance of the members of one of the most distinguished historical associations in our country.

The special session then adjourned.

Respectfully submitted.

O. C. MARSH,

President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolecott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Leconte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherford, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. And be it further enacted, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

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organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March three, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, June 10, 1882.

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, June 24, 1884.

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented; which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred, at the meeting at which they

are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least 60 days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1889.

	Expiration of term.
MARSH, O. C., <i>President</i>	April, 1895
LANGLEY, S. P., <i>Vice-President</i>	April, 1895
GIBBS, WOLCOTT, <i>Foreign Secretary</i>	April, 1895
HALL, A., <i>Home Secretary</i>	April, 1895
BILLINGS, JOHN S., <i>Treasurer</i>	April, 1893

ADDITIONAL MEMBERS OF COUNCIL, 1889-'90.

BRUSH, G. J.	NEWCOMB, S.
GOULD, B. A.	REMSEN, I. R.
MEIGS, M. C.	WALKER, F. A.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, <i>Chairman</i> .	MARSH, O. C.
CHANDLER, C. F.	MITCHELL, S. WEIR.
	PUMPELLE, R.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.	NEWCOMB, S.
HILGARD, J. E.	NEWTON, H. A.
MEIGS, M. C.	PEIRCE, C. S.
	TROWBRIDGE, W. P.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, <i>Chairman</i> .	GOULD, B. A.
DANA, J. D.	HALL, A.
	NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., <i>Chairman</i> .	BREWER, W. H.
	POWELL, J. W.

On Publication.

THE HOME SECRETARY.	COFFIN, J. H. C.
BILLINGS, J. S.	NEWCOMB, S.
	POWELL, J. W.

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On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.

COFFIN, J. H. C.
HILGARD, J. E.
MEIGS, M. C.

POWELL, J. W.

TRUST FUNDS.

Board of Direction of the Bache Fund.

DANA, J. D.

HILGARD, J. E.

GIBBS, W.

Board of Trustees of the Watson Fund.

NEWCOMB, S., Chairman.

COFFIN, J. H. C.

GOULD, B. A.

The Henry Draper Fund.

BARKER, G. F., Chairman.

NEWCOMB, S.

GIBBS, W.

WRIGHT, A. W.

YOUNG, C. A.

The J. Lawrence Smith Fund.

GIBBS, WOLCOTT, Chairman.

HALL, A.

BRUSH, G. J.

PUMPELLY, R.

RUTHERFORD, L. M.

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MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1890.

	Date of Election.
ABBE, CLEVELAND	Washington, D. C. 1879
ABBOTT, HENRY L., U. S. A.	Army Building, New York City. 1872
ALLEN, J. ASAPH	American Museum, New York City. 1876
BARKER, GEORGE F.	3909 Locust St., Philadelphia, Pa. 1876
BARTLETT, WILLIAM H. C.	75 Locust Hill Ave., Yonkers, N. Y. —
BELL, A. GRAHAM	Washington, D. C. 1883
BILLINGS, JOHN S., U. S. A.	Washington, D. C. 1883
BOSS, LEWIS	Albany, N. Y. 1889
BOWDITCH, HENRY P.	Cambridge, Mass. 1887
BREWER, WILLIAM H.	New Haven, Conn. 1880
BROOKS, W. K.	Johns Hopkins University, Baltimore, Md. 1884
BROWN-SEQUARD, CHARLES E.	Paris, France. 1868
BRUSH, GEORGE J.	New Haven, Conn. 1868
CHANDLER, CHARLES F.	New York City. 1874
CHANDLER, SEYMOUR C.	16 Craigie St., Cambridge, Mass. 1888
COMSTOCK, CYRUS B., U. S. A.	Whitestone, Long Island, N. Y. 1884
COOKE, JOSIAH P.	Cambridge, Mass. 1872
COPE, EDWARD D.	2100 Pine St., Philadelphia, Pa. 1872
COUES, ELLIOTT	Washington, D. C. 1877
CRAFTS, JAMES M.	École des Mines, Paris, France. 1872
DANA, EDWARD S.	New Haven, Conn. 1884
DANA, JAMES D.	New Haven, Conn. —
DAVIDSON, GEORGE	San Francisco, Cal. 1874
DUTTON, CLARENCE E., U. S. A.	Washington, D. C. 1884
FARLOW, W. G.	Cambridge, Mass. 1879
FERREL, WILLIAM	1641 Broadway, Kansas City, Mo. 1868
GENTH, FREDERICK A.	W. Philadelphia, Pa. 1872
GIBBS, JOSIAH WILLARD	New Haven, Conn. 1879
GIBBS, WOLCOTT	Newport, R. I. —
GILBERT, GROVE K.	Washington, D. C. 1883
GILL, THEODORE N.	Washington, D. C. 1873
GOODE, G. BROWN	Washington, D. C. 1888
GOULD, BENJAMIN A.	Cambridge, Mass. —
HAGUE, ARNOLD	U. S. Geological Survey, Washington, D. C. 1885
HALL, ASAPH, U. S. N.	Washington, D. C. 1875
HALL, JAMES	Albany, N. Y. —
HASTINGS, CHARLES S.	New Haven, Conn. 1889
HILGARD, EUGENE W.	Oakland, Cal. 1872
HILGARD, JULIUS E.	Washington, D. C. —
HILL, GEORGE W.	Washington, D. C. 1874
HILL, HENRY B.	Cambridge, Mass. 1883
HOLDEN, EDWARD S.	San José, California. 1885
HUNT, T. STERRY	Montreal, Canada. 1873

	Date of Election.
HYATT, ALPHEUS.....	<i>Soc. of Nat. History, Boston, Mass.</i> 1875
JACKSON, CHARLES L.....	<i>Cambridge, Mass.</i> 1883
JOHNSON, SAMUEL W.....	<i>New Haven, Conn.</i> 1866
KING, CLARENCE.....	<i>62 Cedar St., New York City.</i> 1876
LANGLEY, SAMUEL P.....	<i>Washington, D. C.</i> 1876
LEIDY, JOSEPH.....	<i>Philadelphia, Pa.</i> 1884
LESLEY, J. PETER.....	<i>1008 Clinton St., Philadelphia, Pa.</i> —
LECONTE, JOHN.....	<i>Berkeley, Cal.</i> 1878
LECONTE, JOSEPH.....	<i>Berkeley, Cal.</i> 1875
LOVERING, JOSEPH.....	<i>Cambridge, Mass.</i> 1873
MARSH, O. C.....	<i>New Haven, Conn.</i> 1874
MAYER, ALFRED M.....	<i>Hoboken, N. J.</i> 1872
MEIGS, MONTGOMERY C., U. S. A.....	<i>Washington, D. C.</i> 1865
MENDENHALL, THOMAS C.....	<i>Washington, D. C.</i> 1887
MICHAEL, ARTHUR.....	<i>Somerville, Mass.</i> 1889
MICHELSON, ALBERT A.....	<i>Worcester, Mass.</i> 1888
MITCHELL, HENRY.....	<i>Boston, Mass.</i> 1885
MITCHELL, S. WEIR.....	<i>1524 Walnut St., Philadelphia, Pa.</i> 1865
MORSE, EDWARD S.....	<i>Salem, Mass.</i> 1876
MORTON, HENRY.....	<i>Hoboken, N. J.</i> 1874
NEWBERRY, J. S.....	<i>New York City.</i> —
NEWCOMB, SIMON, U. S. N.....	<i>Washington, D. C.</i> 1869
NEWTON, H. A.....	<i>New Haven, Conn.</i> —
NEWTON, JOHN, U. S. A.....	<i>New York City.</i> 1876
OLIVER, JAMES E.....	<i>Ithaca, N. Y.</i> 1872
PACKARD, A. S.....	<i>Providence, R. I.</i> 1872
PIERCE, CHARLES S.....	<i>U. S. Coast Survey, Washington, D. C.</i> 1877
PETERS, C. H. F.....	<i>Clinton, N. Y.</i> 1876
PICKERING, EDWARD C.....	<i>Cambridge, Mass.</i> 1873
POWELL, JOHN W.....	<i>Washington, D. C.</i> 1880
PUMPELLE, RAPHAEL.....	<i>Gibbs Ave., Newport, R. I.</i> 1872
PUTNAM, FREDERICK W.....	<i>Cambridge, Mass.</i> 1885
REMSEN, IRA.....	<i>Johns Hopkins University, Baltimore, Md.</i> 1882
ROGERS, FAIRMAN.....	<i>147 S. Fourth St., Philadelphia, Pa.</i> —
ROGERS, WILLIAM A.....	<i>Waterville, Me.</i> 1885
ROOF, OGDEN N.....	<i>New York City.</i> 1865
ROWLAND, HENRY A.....	<i>Johns Hopkins University, Baltimore, Md.</i> 1881
RUTHERFORD, LEWIS M.....	<i>175 Second Ave., New York City.</i> —
SCHOTT, CHARLES A.....	<i>Washington, D. C.</i> 1872
SCUDDER, SAMUEL H.....	<i>Cambridge, Mass.</i> 1877
SELLERS, WILLIAM.....	<i>1600 Hamilton St., Philadelphia, Pa.</i> 1873
SMITH, SIDNEY I.....	<i>New Haven, Conn.</i> 1884
TROWBRIDGE, JOHN.....	<i>Cambridge, Mass.</i> 1878
TROWBRIDGE, WILLIAM P.....	<i>New York City.</i> 1872
TRUMBULL, J. H.....	<i>Hartford, Conn.</i> 1872
VERRILL, A. E.....	<i>New Haven, Conn.</i> 1872
WALKER, FRANCIS A.....	<i>Boston, Mass.</i> 1878
WATSON, SERENO.....	<i>Cambridge, Mass.</i> 1889
WHITE, CHARLES A.....	<i>Washington, D. C.</i> 1889
WOOD, HORATIO C.....	<i>1925 Chestnut St., Philadelphia, Pa.</i> 1879
WRIGHT, ARTHUR W.....	<i>New Haven, Conn.</i> 1889
YOUNG, CHARLES A.....	<i>Princeton, N. J.</i> 1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER.....	<i>Cambridge, Mass.</i>
LONGSTRETH, MIERS F.....	<i>Derby, Pa.</i>
LYMAN, THEODORE.....	<i>Brookline, Mass.</i>

DECEASED MEMBERS.

	Date of Death.
*AGASSIZ, LOUIS.....	Dec. 14, 1873
*ALEXANDER, J. H.....	March 2, 1867
*ALEXANDER, STEPHEN.....	June 25, 1883
*BACHE, ALEXANDER DALLAS.....	Feb. 11, 1867
*BAIRD, SPENCER F.....	Aug. 19, 1887
BARNARD, J. G.....	May 14, 1882
BALFARD, F. A. P.....	April 27, 1889
*CASWELL, ALEXIS.....	Jan. 8, 1887
*CHAUVENET, WILLIAM.....	Dec. 13, 1870
*CLARK, HENRY JAMES.....	July 1, 1873
COFFIN, JAMES H.....	Jan. 6, 1873
COFFIN, JOHN H. C.....	Jan. 9, 1890
COOK, GEORGE H.....	Sept. 22, 1889
DALTON, J. C.....	Feb. 2, 1889
DAVIS, CHARLES H.....	Feb. 18, 1877
*DRAPER, HENRY.....	Nov. 20, 1882
*DRAPER, JOHN W.....	Jan. 4, 1882
*EADS, JAMES B.....	Mar. 8, 1887
ENGELMANN, GEORGE.....	Feb. 11, 1884
*FRAZER, JOHN FRIES.....	Oct. 12, 1872
*GARR, WILLIAM M.....	May 30, 1878
*GILLISS, JAMES MELVILLE.....	Feb. 9, 1865
*GOULD, AUGUSTUS A.....	Sept. 15, 1866
*GRAY, ASA.....	Jan. 30, 1888
*GUY ST, ARNOLD.....	Feb. 7, 1884
HAYDEN, F. V.....	Dec. 22, 1887
*HENRY, JOSEPH.....	May 13, 1878
*HADLEY, JAMES.....	Aug. 1, 1864
*HITCHCOCK, EDWARD.....	Feb. 27, 1864
*HOLBROOK, J. E.....	Sept. 8, 1871
*HUBBARD, J. S.....	Aug. 10, 1863
*HUMPHREYS, A. A.....	Nov. 28, 1883
*HALDEMAN, S. S.....	Sept. 10, 1880
*KRIEHLAND, JARED P.....	Dec. 10, 1877
*LANE, J. HOMER.....	—, 1880
*LECONTE, JOHN L.....	Nov. 15, 1883
LESQUEREUX, LEO.....	Oct. 25, 1889
LOOMIS, ELIAS.....	Aug. 16, 1889
*MAJAN, D. H.....	Sept. 16, 1871
*MARSH, G. P.....	July 23, 1882
*MEEK, F. B.....	Dec. 21, 1877
*MORGAN, LEWIS H.....	Dec. 14, 1881
*NORTON, WILLIAM A.....	Sept. 21, 1883
*POURTALES, L. F.....	July 17, 1880
RODGERS, JOHN.....	May 6, 1882
ROGERS, ROBERT E.....	Sept. 7, 1884
*ROGERS, WILLIAM B.....	May 30, 1882
*SAXTON, JOSEPH.....	Oct. 26, 1873
*SILLIMAN, BENJ., Sr.....	Nov. 24, 1864

	Date of Death.
SILLIMAN, BENJ., JR.	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S.	April 30, 1873
*TORREY, JOHN	March 10, 1873
*TOTTEN, J. G.	April 22, 1864
*TUCKERMAN, EDWARD	March 15, 1886
*WARREN, G. K.	Aug. 8, 1882
*WATSON, JAMES C.	Nov. 23, 1880
*WINLOCK, JOSEPH	Jan. 11, 1875
*WOODWARD, J. J., U. S. A.	Aug. 17, 1884
WORTHEN, A. H.	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W.	Hildelberg.
AIRY, SIR GEORGE B.	Greenwich.
OWEN, SIR RICHARD	London.
BURMEISTER, C. H. C.	Buenos Ayres.
STRUVE, OTTO VON	Pulkora.
ADAMS, J. C.	Cambridge.
CAYLEY, ARTHUR	Cambridge.
DELSHOLTZ, BARON H. VON	Berlin.
PASTEUR, LOUIS	Paris.
STOKES, SIR GEORGE G.	Cambridge.
SYLVESTER, J. J.	Oxford.
HOOKER, SIR J. D.	Kew.
THOMSON, SIR WILLIAM	Glasgow.
AUWERS, ARTHUR	Berlin.
BERTRAND, J. L. F.	Paris.
HUXLEY, T. H.	London.
VIRCHOW, RUDOLPH VON	Berlin.
BERTHELOT, M. P. E.	Paris.
DE CANDOLLE, ALPHONSE	Geneva.
KÖLLIKER, ALBERT VON	Würzburg.
RICHTHOFEN, F. VON	Berlin.
HOFMANN, A. W.	Berlin.
IBÁÑEZ, CARLOS	Madrid.

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.	MICHEL CHASLES.
CARL ERNST VON BAER.	SIR RODERICK I. MURCHISON.
HENRY MILNE-EDWARDS.	VICTOR REGNAULT.
MICHAEL FARADAY.	H. W. DOVE.
L. ELIE DE BEAUMONT.	C. A. F. PETERS.
SIR DAVID BREWSTER.	JUSTUS VON LIEBIG.
G. A. A. PLANA.	ALEXANDER BRAUN.
F. W. A. ARGELANDER.	JOACHIM BARRANDE.
FRIEDRICH WÖHLER.	ADOLPHE WÜRTZ.
J. B. DUMAS.	THEODORE VON OPPOLZER.
J. B. J. D. BOUSSINGAULT.	G. R. KIRCHOFF.
M. E. CHEVREUL.	RUDOLPH CLAUDE.

JAMES P. JOULE.

* Biographical notices have been presented of those designated by a *.

APPENDIX D.

TRUST FUNDS OF THE ACADEMY.

The National Academy of Sciences has been authorized by Congress to hold trust funds, and up to the present time, five gifts of importance have been received. The proceeds of four of these are available, and have already rendered much aid in promoting original research in science. The increasing usefulness of these various gifts makes it desirable to place together on record the original instruments of trust, and an account of the grants made from these funds since they were received by the Academy.

THE BACHE FUND.

The first important gift received by the Academy was from its first president, Alexander Dallas Bache, who left the greater part of his property in trust to the Academy, at his death in 1867. The income of the fund has been available for about 18 years, and the special grants made are stated in the report which follows the various instruments of gift relating to the trust.

EXTRACT FROM THE WILL OF ALEXANDER DALLAS BACHE.

March 13, 1862.

Item: As to all the rest and residue of my estate, including the sum of \$5,000 placed at the disposal of my wife in case she should not desire to make any disposition of the same, I direct my executors hereinafter named to apply the income thereof, after the death of my wife, according to and under the direction of Joseph Henry, of Washington, Louis Agassiz and Benjamin Peirce, of Harvard College, Massachusetts, to the prosecution of researches in physical and natural science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the three above-named gentlemen, or any two of them. I constitute a board of direction for the application of the income of my residuary estate for the above objects after the death of my said wife. The class of subjects to be selected by this board and the results of such observations and experiments to be published at the expense of my trust estate under their directions out of the income thereof but without encroaching on the principal.

In case of the death or inability to act of all or any of the three gentlemen I have named, in my wife's lifetime, my will is that she shall supply their places in the board of direction by an instrument of writing, either testamentary or otherwise, desiring that, in the selection of the persons to administer the income of the trust fund hereby created, she will have regard to the selection of persons whose attention has been directed to the same branches of science as those I have named, and so that each of

the departments of physics, mathematics, and natural history shall be represented in the board. In case of any vacancy occurring in the board of direction after its organization, and after the death of my wife, by reason of the death, inability, or refusal to act, or resignation of any of its members, my will is that the surviving or remaining member or members, for the time being, shall have power to fill such vacancies so occurring in the board by the selection of other person or persons to fill such vacancies, and so on from time to time as vacancies occur. My intention being that the board of direction shall have power to continue its existence, and to filling all vacancies occurring in their body from time to time, I direct that a minute of their proceedings be kept, and that the appointment of any member by the board shall be notified in writing to the trustees, for the time being, of my residuary estate. In the event of any failure of the board, for the time being, to direct the application of the income of my said residuary estate, or to continuing its existence by filling vacancies occurring in their body, my will is that the application of the income thereof for the purposes and objects declared in this clause of my will shall be made by the trustees, under the direction of the American Philosophical Society of Philadelphia.

Item: I hereby nominate and appoint my friends, Peter McCall, esq., and Morton P. Henry, esq., of the city of Philadelphia, and the survivor of them, to be the executors of and trustees under this my last will and testament:

CODICIL, JULY 15, 1863.

Item: I give and devise to my sister, Sally Franklin Wainwright, the house purchased by me, situated No. 396 West Twentieth Street, in the city of Washington, between G and H streets, to be held and enjoyed by her during the term of her natural life. After her death I direct the said house shall pass with the residue of my estate (subject to a life estate of my wife, Nancy Clarke Bache, therein, in case she should survive my sister) to the "National Academy of Sciences," upon the trusts set forth as to the said residue of my estate.

Item: My will is that, upon the death of my wife, all the rest and residue of my estate shall be paid over to and vest in the corporation of the National Academy of Sciences, incorporated by act of Congress, passed the 3d day of March, A. D. 1863, whom I hereby appoint trustees in the place of my said executors under the fourth clause of my said will, to apply the income, according to the directions in the said clause contained, to the prosecution of researches in physical and natural science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the board of direction in the said clause named. My will further is, that, in case of any failure of the board for the time being to direct the application of the income of my residuary estate, or to continue its existence by filling vacancies occurring in their body, the application of the income thereof for the purposes and objects declared in the said clause shall be made under the direction of the National Academy of Sciences instead of the American Philosophical Society, of Philadelphia. In all other respects the said application of the income to the purposes aforesaid to be made by the same persons and under the same rules as I have prescribed in the said clause of my will.

Duly sworn to before Samuel Lloyd, February 27, 1867, in the city and county of Philadelphia.

BACHE TRUST FUND.

By the above will of Prof. A. D. Bache, his property, after the death of Mrs. Bache, passes to the National Academy of Sciences as a trust fund, the income of which is to be applied to the prosecution of

researches in physics and natural science, in such manner as shall be agreed upon by the board of direction, appointed by the fourth clause of his will. On the death of Mrs. Bache, which occurred in February, 1870, the executors proceeded to settle the estate. After paying various legacies, the amount of the trust fund was about \$41,250.

The treasurer was given full power, by a vote of the Academy, to receive the trust fund and to act as attorney in fact for the Academy in all matters pertaining thereto. At his own suggestion, he was also required to give bonds for the faithful discharge of his duty in the sum of \$50,000.

It was resolved that the whole fund should be invested in United States securities as early as practicable.

THE LAST WILL AND TESTAMENT OF NANCY CLARKE BACHE.

I hereby, in pursuance and exercise of the power of appointment contained in the last will and testament of my husband, Alexander Dallas Bache, devise, bequeath, and appoint the sum of five thousand dollars of the principal of the estate of my said husband, over which I have a power of appointment by his will, to be paid by his executors, or by such person or persons as shall hold the principal of the estate at my death, to my nephew, Henry Wood Bache, absolutely; and I hereby request my nephew, in case he should die unmarried and without issue, to make such a disposition of this amount by will as will secure it to be paid at his death to the National Academy of Sciences, at Washington, to be held by that corporation upon the same trusts and for the same purposes as are declared by my husband in his will, as to the residue of his estate after my death. I expressly desire, however, that it shall be understood that this request shall not be construed into any direction which would interfere with his full control of the principal, which is to be paid into his hands directly.

Second. I hereby direct the house, No. 1624 Chestnut street, in which I now reside, to be sold by my executor hereinafter named, within a reasonable time after my death, either at public or private sale, and after deducting from the purchase money any debts or expenses connected with the sale, and the administration of my estate, which, with the cash on hand or other property which I may own or possess at my death, shall be sufficient to satisfy, I direct my executor to pay over the net proceeds to the National Academy of Sciences, at Washington, to be held by that corporation as trustees in trust to apply the income thereof to the prosecution of researches in physical and natural science, according to the directions contained in the last will and testament of my husband as to the residue of his estate after my death in the same manner as if all the directions contained in the last will and testament of my husband and in the codicil thereto were herein repeated at length: my object being to make precisely the same disposition of the proceeds of this house as was made by my husband of his residuary estate after my death.

Third. I direct all the medals and diplomas of my husband, and the large photograph of him now in my possession, to be deposited and remain with the National Academy of Sciences. I have made a memorandum of the disposition of certain other articles which I desire shall be carried into effect as if contained in this will. I appoint Morton P. Henry, of Philadelphia, executor of this my last will and testament.

CODICIL TO THE LAST WILL AND TESTAMENT OF NANCY CLARKE BACHE, DATED APRIL 19, 1869.

Item: I hereby direct my executor to pay out of the proceeds of the sale of my said house, No. 1624 Chestnut street, Philadelphia, which I have directed to be sold, the sum of five hundred dollars to my nephew, Henry Wood Bache, for his own use and

benefit. I further direct my executor to invest five thousand dollars of the proceeds of sale of said house in his own name, as trustee, in such securities as he may think proper, and to pay the income thereof to my nephew, Henry Wood Bache, during his natural life. After the death of my nephew, I direct that the principal of the said sum of five thousand dollars shall go to the National Academy of Sciences, at Washington, in trust for the same uses and purposes as are declared as to the proceeds of sale of said house by my said will. I expressly declare that the above bequests to Henry Wood Bache are in addition to the five thousand dollars I have appointed to him out of my husband's estate. *Item*: I give and bequeath to my faithful servant, Isabella Mallihan, the sum of one hundred dollars, to be paid to her out of the proceeds of sale of said house. *Item*: I give and bequeath to my sister-in-law, Mrs. Sophia A. Irwin, the sum of one thousand dollars, to be paid to her out of the proceeds of sale of my said house. *Item*: I desire my executor to permit my sister, Mrs. Littlefield, to occupy my house for six months after my death free of rent, if she should desire to do so, during which time it shall remain unsold. *Item*: I hereby declare that the balance of the proceeds of the sale of my said house shall go, after paying and providing for the above legacies, as is set forth and declared in my said will, which in all other respects I hereby republish and declare as my last will and testament.

Sworn and subscribed before John Campbell, deputy register, in the city and county of Philadelphia, January 20, 1870.

STATEMENTS REGARDING THE BACHE FUND.

In April, 1871, the treasurer, Mr. Fairman Rogers, announced that the proceeds of the estate left to the Academy by the late Prof. A. D. Bache, had been formally handed over to him by the executors; that these funds amounted to \$40,515.07, together with an annual ground rent of \$102, and some land in Missouri not now available; and that in conformity with the resolutions adopted by the Academy, he was converting the securities into United States bonds as soon as practicable, and had given bonds in the sum of \$50,000.

In April, 1872, the treasurer made a financial report concerning the Bache trust fund, and stated that the annual income amounted at present to about \$2,500 in gold. He presented his bond to the Academy, which was approved and placed in the custody of the president.

The president informed the Academy that the board of direction had made two appropriations; one for the promotion of a magnetic survey of the United States, under the direction of Mr. Hilgard, and one for investigations of sun spots, by Professor Winlock.

In April, 1876, Mr. Henry, on the part of the board of direction, gave a statement of appropriations made for the past year.

The treasurer submitted a report of the condition of the fund, showing that the available income balance was \$2,426.97. Upon his suggestion, a resolution was adopted by the Academy, authorizing the sale of the ground-rent forming part of the assets.

In April, 1877, on motion it was—

Resolved, That all apparatus procured at the charge of the Bache fund for the use of investigator shall be duly receipted for by those to whom it is loaned, according to forms to be prescribed by the board of direction, and shall be returned to the

officer having charge of the property of the Academy whenever the investigation for which it was provided is completed, but that it shall at all times be held subject to the disposal of the Academy.

At a meeting of the Academy held in April, 1879, it was reported by the treasurer that, by the death of Henry Wood Bache, the Bache fund would be increased by the amount of \$4,650, according to the terms of the will of Mrs. A. D. Bache.

It was therefore—

Resolved, That Fairman Rogers, treasurer, be authorized to receive from the trustees of Henry Wood Bache, under the will of Mrs. A. D. Bache, all cash and securities payable to the National Academy of Sciences in the settlement of his accounts as trustee, and that he be further authorized to execute all papers required in the transaction.

At the stated session, in April, 1884, Mr. Hilgard, on the part of the board of direction of the Bache fund, made a statement of the present condition of the fund, explaining the policy which had formerly guided the board, and the rules adopted by the present board, with the view to having the fund more directly applied to distinct objects, the results of which might be published as "Memoirs of the Bache Fund."

REPORT ON THE BACHE FUND.

At the session of the National Academy held at Washington in April, 1888, resolutions were passed calling upon the board of direction of the Bache fund to present a detailed report of their expenditures from the fund up to the present time. A wish was at the same time expressed that references should be given to memoirs and papers containing results obtained through the application of the fund.

The present report is intended to comply as far as possible with the request of the Academy. It is drawn, the greater part, at least, from memoranda furnished by Prof. J. H. C. Coffin, from 1881 to 1887, treasurer of the Academy.

So far as can now be determined, it has from the beginning been the custom of the board of direction, in case of approval of any application for money from the Bache fund, to indorse their approval upon the application, and then to forward the application to the treasurer for payment.

When the present board came into office, formal rules were adopted requiring the production of proper vouchers for expenditures, and also making it necessary that the board of direction should be unanimous. For many years past, Prof. J. E. Hilgard, as the only member of the board residing in Washington, has been chairman of the board, and has conducted business directly with the treasurer. Applications for money have, it is believed, been most frequently made to him, but sometimes to the other two members of the board. The difficulty in making out an absolutely perfect list of all the appropriations made by the board arises from the fact, that the orders prior to April 19, 1884, were stolen

from the treasurer's box (together with all other vouchers) in the Academy room in the Smithsonian Institution. It is believed, however, that the list herewith furnished up to April, 1888, is nearly, if not quite complete. The list is as follows:

1871. Sept. 6, to Prof. J. E. Hilgard for the magnetic survey of the United States	\$500.00
1872. Jan. 16, to Prof. J. E. Hilgard for the same	500.00
1872. Jan. 16, to Prof. Joseph Winlock for investigations of sun spots	400.00
1872. Apr. 29, to Prof. J. E. Hilgard for the magnetic survey of the United States	500.00
1872. July 20, to Prof. Joseph Winlock for investigations of sun spots	400.00
1872. Nov. 28, to Prof. J. E. Hilgard for magnetic survey of the United States	1,000.00
1873. Feb. 17, to Prof. Joseph Winlock for investigations in solar physics ..	1,200.00
1873. Nov. —, to Prof. J. E. Hilgard for magnetic survey	1,200.00
1874. Mar. 16, to Prof. Joseph Winlock for the same as No. 3	500.00
1874. June 15, to Prof. J. E. Hilgard for magnetic survey	1,200.00
1875. June 17, to Prof. J. E. Hilgard for magnetic survey	1,000.00
1875. Oct. 5, to Prof. J. E. Hilgard for magnetic survey	500.00
The magnetic survey of the United States made at the charge of the Bache fund was terminated in 1876. The results obtained up to that time were published in detail in the Coast Survey Report for 1882, Appendix 14, 188 pp., 4to.	
The money received by Professor Winlock was employed under his direction in observations of the sun, as described in the preface to vol. VIII of the Annals of the Observations of Harvard University, and the results were published in the second part of the same volume.	
1875. Oct. 25, to Charles S. Peirce	400.00
(Two grants, one of \$1,200 for the study of color; one of \$500 for the comparison of sensations.)	
1876. Apr. 28, to Prof. A. M. Mayer for acoustic researches	250.00
Professor Mayer's results are contained in the Memoirs of the National Academy of Sciences, vol. III, Part I, 53-84.	
1876. May 24, to Prof. J. E. Hilgard for the magnetic survey of the United States	1,000.00
1876. Sept. 18, to Charles S. Peirce	400.00
1876. Nov. 18, to Prof. S. P. Langley	500.00
1876. Dec. 12, to Charles S. Peirce	400.00
1877. May 16, to Prof. Wolcott Gibbs for researches on the complex inorganic acids	100.00
1877. June 13, to Prof. A. M. Mayer for researches on the nature of the discharge of the inductorium	500.00
Memoirs Nat. Acad. vol. III, Part I (1884).	
1877. Oct. 5, to Prof. J. E. Hilgard for the magnetic survey of the United States. Computations of field work from 1871 to 1876	600.00
1877. October 22, to Prof. Wolcott Gibbs for researches on the complex inorganic acids	200.00
1877. Nov. 1, to Prof. S. P. Langley	500.00
1878. Sept. 30, to Charles S. Peirce	500.00

1878. Sept. 30, to C. R. Powalky, PH. D.	\$500.00
For a new reduction of La Caille's observations of fundamental stars in the southern heavens in 1749-1757. Published in the report of the Coast and Geodetic Survey for 1882, Appendix No. 21, 1879.	
June 17, to R. W. Willson, treasurer Fort Worth eclipse party, to pay part of the expense of publishing the observations made by the party at Fort Worth, in July, 1878.	
Published: "Report of the observations of the total solar eclipse, July 29, 1878, made at Fort Worth, Texas."	
1879. Jan. 17, to Leonard Waldo for work on eclipse party	100.00
Report published by John Wilson & Son, Cambridge, and distributed to leading observatories and societies.	
1879. May 10, to Samuel Hein (object not stated)	150.00
1879. May 20, to Prof. Wolcott Gibbs for work on complex inorganic acids ..	300.00
1879. Aug. 2, to J. C. Watson (object not known)	1,000.00
1880. Feb. 17, to the American Journal of Science for magnetic maps	60.00
1880. Mar. 13, to Prof. C. S. Lyman, for the board of managers of the Yale observatory to aid the thermometric bureau of the observatory in purchasing standard thermometers and other instruments for its necessary equipment	500.00
Reports published: "Report of the Board of Managers of the Observatory of Yale University to the President and Fellows," 1880-'81 to 1887-'88.	
1881. June 6, to Prof. S. P. Langley for observations on the physical constitution of the sun	1,000.00
1881. Dec. 9, to Prof. Wolcott Gibbs for work on complex inorganic acids ..	300.00
Dr. Gibbs's work on the complex inorganic acids is not yet completed. Five installments have been published in the Proceedings of the American Academy of Arts and Sciences, vols. XV, XVI, XVII, XVIII, XIX.	
1882. July 14, to Prof. S. Newcomb for experiments on the velocity of light ..	1,200.00
The results of this investigation were published in the astronomical papers of the American Ephemerides, vol. II, parts III and IV.	
1883. Apr. 25, to Mr. Rockwell for the eclipse party	800.00
1883. June 6, to Mr. Rockwell for the eclipse party	600.00
1883. Nov. 27, to Prof. E. S. Holden for observations of the aurora borealis and zodiacal light	300.00
1883. Nov. 27, to Prof. E. S. Holden for the purchase of an aurora spectro-scope, \$300 (less \$20.26 returned), \$279.74. This instrument is now at the Washburn Observatory, Madison, Wis. In consequence of the removal of Professor Holden to California a short time after it was received, no work suitable for publication was done with it. Professor Holden refunded \$20.26.	
1884. Sept. 17, to Prof. S. P. Langley for observations on the physical constitution of the sun	1,500.00
Professor Langley's work has been done partly at the expense of the Bache fund, and partly at the expense of other funds, and his results have been published together so that a precise reference to what has been done with the Bache fund alone is not possible. We may, however, cite the following: American Journal of Science, August, 1887; Memoirs of the National Academy of Sciences for 1882, vol. —; American Journal of Science for March, 1884; the same for January, 1886; the same for August, 1886.	

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1881. Oct. 22, to Prof. Ira Remsen for observations on the influence of magnetism upon chemical action	\$500.00
Two preliminary papers have been published in the American Chemical Journal, vol. VII, p. 430. A paper giving the complete results will soon be published in the American Chemical Journal.	
1881. Nov. 6, to Prof. H. B. Hill for the study of pyrometric acid	200.00
The results of this work have been published in Leibig's Annalen, vol. CCXXXII, p. 42; in the Berichte der Deutschen Chem. Gesellschaft, XVIII, 995; XX, 252; XX, 3359; and in the Proceedings of the American Academy of Arts and Sciences, XXI, 1-5; XXII, 315; XXIII, 187. Other papers are in press or nearly ready for publication.	
1881. Nov. 20, to Prof. E. S. Holden for observations on 303 fundamental stars	400.00
1881. Dec. 4, to Dr. E. H. Hall for investigations in electricity	500.00
Results published in the August and October numbers of the American Journal of Science for 1888.	
1881. Dec. 26, to W. M. Davis for observations on the motion of clouds as indicating upper currents	50.00
No published report has been made.	
1885. March 26, to W. M. Davis for observations on thunder storms	200.00
1885. April 6, to Prof. E. S. Holden for observations on 303 fundamental stars	225.00
Professor Holden's work on the observations of fundamental stars appeared in the publications of the Washburn Observatory, vol. IV, 1885.	
1885. May 1, to Prof. A. A. Michelson for work on the velocity of light. . .	283.35
1885. June 11, to Prof. E. C. Pickering for observations on stellar photography	1,000.00
Professor Pickering's results have been published in the Memoirs of the American Academy of Arts and Sciences, XI, 179; XVIII, No. 4, of the Annals of Harvard College Observatory; in vol. XVIII, No. 6, of the same; and vol. XVIII, No. 8.	
1885. July 2, to Prof. J. E. Hilgard for the magnetic survey of the United States. Supplementary work	50.00
1885. July 8, to Prof. J. E. Hilgard for same	150.00
1885. July 8, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn	300.00
1885. Nov. 9, to Mr. A. G. Webster for an investigation of the mechanical equivalent of heat by an electric method.	250.00
Nothing was accomplished by this work. The apparatus was forwarded to the treasurer at Washington, and \$29.11 of the money refunded.	
1885. Dec. 31, to Prof. E. C. Pickering for observations on stellar photography	1,000.00
1886. Feb. 27, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn	300.00
1886. March 3, to the New England Meteorological Society for observations on thunder storms	300.00
1886. July 28, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn	300.00
Mr. Hall, under Dr. Elkin's direction, made observations in 1885-1887, and has since that time been engaged in reducing the same. The details are not ready for publication, but the results of his work were communicated to the Academy at its meeting in April, 1889.	
1886. Sept. 29, to Dr. B. A. Gould for measurements of the Cordova photographs	500.00

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1886. Oct. 7, to Prof. E. C. Pickering for work on stellar photography	\$1,000.00
1887. Jan. 30, to Dr. B. A. Gould for measurements of the Cordova photographs	500.00
1887. Mar. 22, to Prof. A. A. Michelson for researches on light	500.00
The results of this work have been published in the American Journal of Science and Arts for May, 1886.	
1887. Mar. 24, to Prof. H. A. Rowland for continuation of work on solar spectrum	1,000.00
Professor Rowland's results have not been published in full. They are partly contained in the American Journal of Science for March, 1887, and are embodied in Professor Rowland's magnificent photographic map of the solar spectrum, second series, 1888. Nine plates, 12 by 36 inches.	
1887. June 2, to Prof. S. Newcomb for the Eclipse Expedition to Japan	2,000.00
The full report of the expedition, by Prof. D. P. Todd, was presented to the Academy, April 19, 1889.	
1887. July 26, to Prof. A. A. Michelson for researches on light	500.00
1887. Nov. 15, to Prof. Wolcott Gibbs for a systematic study of the action of chemical compounds upon the animal system	1,000.00
1888. Apr. 25, to Prof. T. C. Mendenhall, to carry on seismological researches.	100.00
1888. June 10, to Prof. E. D. Cope for the purpose of conducting researches on the extinct vertebrata of North America: for the payment of the salary of one expert préparateur of the fossils in extracting them from the rock, cementing fragments, etc.	600.00
1888. Sept. 15, to Prof. E. D. Cope (appropriation No. 2) for the payment of expenses involved in work on vertebrate paleontology	600.00
1888. Nov. 2, to Prof. D. P. Todd, to defray the expense of printing and distributing instructions with reference to observations to be made by volunteers on the total eclipse of January 1, 1889	125.00
The results are embodied in part in a paper <i>On composite coronagraphy</i> , read before the Academy, April 17, 1889.	
1888. Dec. 7, to Prof. Wolcott Gibbs (second appropriation) for a systematic study of the action of chemical compounds upon the animal system.	1,000.00

As already stated, it is believed that this report is complete, as the treasurer's books were not shown together with the applications and vouchers. As it is very desirable, however, that the report should be made as complete as possible, the undersigned would suggest that it should be printed before final acceptance by the Academy, and that printed copies should be distributed among members who have received appropriations from the fund, with the view of obtaining any correction necessary.

Respectfully submitted.

JAMES D. DANA.
WOLCOTT GIBBS.
J. E. HILGARD.

THE JOSEPH HENRY FUND.

At the April meeting, 1878, the treasurer of the Academy made a statement respecting the "Joseph Henry Fund" of \$10,000, contributed by Fairman Rogers, Joseph Patterson, George W. Childs, A. J. Drexel, F. A. Drexel, Charles H. Rogers, J. G. Fell, Isaac Lea, Asa Packer, John Welsh, W. Blanchard, James Lennox, executors of the estate of John C. Green, Mrs. John C. Green, Robert L. Stuart, Miss

C. L. Wolfe, William Libbey, E. N. Dickerson, Cyrus W. Field, Thomas A. Scott, W. W. Corcoran, George P. Wetmore, Thomas H. Powers, J. S. Morgan, J. Pierrepont Morgan, I. V. Williamson, John W. Garrett, Charles S. Coxe, Cyrus H. McCormick, J. E. Caldwell, William Weightman, Alexander Brown, Henry C. Gibson, J. Donald Cameron, Samuel M. Felton, H. H. Houston, and Nat. Thayer, "as an expression of the donors' respect and esteem for Professor Henry's personal virtues, their sense of his life's great devotion to science, with its results of important discoveries, and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind," which sum of \$40,000 they have caused to be invested in certain securities, and to be deposited with and held by the Pennsylvania Company for insurance of lives and granting annuities in trust, from time to time to collect the income thereon, and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor to deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust under the name and title of the 'Joseph Henry Fund,' the principal to be forever held intact, and the income to be from time to time applied by the said National Academy of Sciences, in its sole discretion, to assist meritorious investigators, especially in the direction of original research."

A resolution was adopted accepting said trust, and directing, authorizing, and empowering Fairman Rogers, treasurer of the Academy, in its name and upon its behalf, to affix its corporate seal to and to execute all such deeds, writings, and assurances in law as may be necessary to carry the said trust into effect.

On motion of Mr. W. B. Rogers it was unanimously—

Resolved, That the National Academy of Sciences hereby present their grateful acknowledgments to Messrs. Joseph Patterson, Fairman Rogers, George W. Childs, and the other subscribers to the "Joseph Henry Fund," for the generous contributions by which they have expressed their appreciation of the lifelong and disinterested scientific labors of the revered president of the Academy, and have provided an important future addition to its means of scientific usefulness.

THE WATSON TRUST FUND.

This trust fund was left to the Academy by one of its most distinguished members, Prof. James C. Watson, at his death in 1880. An extract from the will and the action of the Academy in reference to it are given below, and also the awards since made by the Academy from this fund.

EXTRACT FROM THE WILL OF JAMES C. WATSON.

The will of the late James C. Watson contains, with bequests to several members of his family, the following provisions:

Fifth. I give and devise, subject to conditions and legacies hereinbefore and hereafter mentioned, all the rest, residue, and remainder of my real and personal estate to the National Academy of Sciences of the United States of America, of which I am a member, which said Academy was incorporated by act of Congress approved March

3, A. D. 1863, to be aggregated, kept, and invested as a perpetual fund, the income of which shall be expended by said Academy for the promotion of astronomical science.

I direct that all the stocks, bonds, and securities owned by me (than those specifically bequeathed otherwise) be converted into money on the most advantageous terms possible, and as soon as it may be advantageous to do so, and paid over to the treasurer of said National Academy of Sciences. I direct that any other personal property belonging to me, as well as any real estate of which I may die possessed, except my books and scientific papers, be sold and disposed of as soon as may possibly be done advantageously to the interests of my estate, and that the proceeds thereof be paid over to the treasurer of said National Academy of Sciences.

I direct that my books and scientific papers be transferred to said National Academy of Sciences, to become part of the library of said Academy.

In order to carry out the wish hereinbefore expressed as to the disposal of the income from the fund resulting from my estate hereby devised to said National Academy of Sciences, I do hereby direct that the designation of the particular objects and work which may be aided by this fund shall be determined, subject to approval by a vote of the Academy, by a board of trustees, three in number, who shall be members of the Academy, and elected, after the first herein named, by said Academy whenever a vacancy may occur by death or otherwise. The trustees so appointed shall hold said office, unless voluntarily relinquished by them, during the period of their membership in said National Academy of Sciences; and I do hereby appoint and constitute Julius E. Hilgard, of the U. S. Coast Survey, and Simon Newcomb and J. H. C. Coffin, professors of mathematics, U. S. Navy, all of Washington, in the District of Columbia, to be the first board of trustees for the purposes herein named.

It is my wish that the Academy may, if it shall deem proper, provide for a gold medal of the value of \$100, to be awarded, with a further gratuity of \$100, from time to time, to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of reward and contributing to our science.

It is my further wish that provision be made for preparing and publishing tables of motion of small planets which have been discovered by me as soon as it may be practicable to do so, and I devise that in all cases the trustees and Academy shall act in harmony to obtain results of the greatest possible aid to our science from the income fund resulting from my estate. I desire that results so obtained shall be published as speedily as possible, in such manner as may be provided by the Academy.

I direct that the said National Academy of Sciences take all necessary and proper measures to invest the fund resulting from the property hereby devised where they may be safe and yield the greatest possible income consistent with safety.

This will is dated July 11, 1874.

STATEMENT IN REGARD TO THE BEQUEST OF THE LATE PROFESSOR WATSON, BY MR. NEWCOMB, CHAIRMAN THE TRUSTEES.

April, 1881.

It is known to members of the Academy that our late lamented colleague, Prof. James C. Watson, has bequeathed all his estate, after satisfying certain claims and paying certain annuities to relatives, to the National Academy of Sciences, in trust for the promotion of astronomical researches. Having been named one of the executors, I took occasion during a journey to Madison last January to inform myself of the condition of the estate, and the probable benefits to be derived from it. I find that, although almost the entire property was in the State of Michigan, yet, as he was a resident of Wisconsin at the time of his death, and as his estate was entirely personal, the courts of the latter had exclusive jurisdiction of the bequest.

As none of the executors named in the will are residents in Wisconsin, and as they are widely scattered, it will be difficult for more than one to act, and the administration will have to be conducted under the direction of the probate court at Madison.

It is difficult to see what amount, if any, the Academy will ultimately receive for the purposes desired by the testator, owing to two causes, the unsettled condition of several business enterprises in which our colleague had invested much of his means, and the indefinite character of his business arrangements with the University of Wisconsin. The only item of the estate to which even approximate cash value can be assigned consists of stock and policy in the Mutual Life Insurance Company of Michigan, the total value of which probably amounts to about \$30,000.

The next item in importance is the Printing and Publishing Company of Ann Arbor, of which the deceased owned 400 shares out of the total of 500. The actual cost of this stock was about \$26,000, but the property at present owned by the company is of so miscellaneous a character and it is so complicated by litigation as to make it hardly possible even to guess at the value of its assets.

I judge, however, from a general examination of its property, that should the company go into liquidation it might realize anywhere from \$5,000 to \$15,000, but a debt of \$5,000 is due from it, so that the net amount may range from zero to \$10,000, the lower ultimate being more probable than the upper one.

The next item in importance is the Chase Publishing Company of Toledo, which is said to be profitable, but to it no definite value can be assigned.

On the other hand, our colleague at Madison expended considerable sums on improvements of the observatory and its grounds, without any distinct understanding with the board of regents as to who should ultimately bear the expense. These improvements include the Watson solar observatory, the students' observatory, the fitting up of the director's house, the purchase of the transit instrument, and several other items. An amount of between \$5,000 and \$10,000 is, I believe, due on these various improvements, so that if the estate is to pay for them all it will be materially diminished.

I may also add that, under the laws of Wisconsin, Mrs. Watson is entitled in lieu of the provision made for her in the will to accept one-third of the net proceeds of the estate. It has been suggested that in the event of the estate not realizing the amount expected an arrangement should be made with Mrs. Watson to allow her the entire income from it during her life on condition of the entire amount reverting to the Academy on her death. This arrangement will probably commend itself if the amount shall be found insufficient to carry out the objects which our lamented colleague had at heart in making the bequest.

The matter of the action of the Academy on the Watson bequest was referred to the council.

STATEMENTS RELATING TO THE WATSON FUND.

The final account of Leopold Gruner, the only executor named in the will, was rendered to the county court of ——— County, in the State of Wisconsin, May 31, 1882.

Mrs. Annette H. Watson claimed, and was allowed under the laws of Wisconsin, one-third of the estate of her late husband in lieu of the bequests made her.

The decree of the court, made July 5, 1882, adjudges that the said executor retain in his hands the sum of \$3,000 for the purpose of paying the annuity bequeathed by the said James C. Watson, deceased, to his mother, Rebecca E. Watson.

That all the rest, residue, and remainder of said personal estate, consisting of the sum of \$5,057.25 in cash, 174 shares of said stock of the Michigan Mutual Life Insurance Company, and the undivided two-thirds of said miscellaneous books, and all

and singular the said books and scientific papers as delivered by said executor to it, be, and the same are hereby, assigned and set over to the said National Academy of Sciences, its successors and assignees.

Under this decree, the Academy received from the executor \$7,057.25 in cash and 134 shares of stock of the Michigan Mutual Life Insurance Company, of the par value of \$6,700, the reduction of 40 shares of the Michigan Mutual Life Insurance Company and the increase of \$2,000 having been made at the request of Mrs. Watson.

At the April meeting, 1883, the treasurer of the Academy, Mr. Coffin, presented the following resolutions in regard to the bequests of the late James C. Watson, which were adopted:

Resolved, That the National Academy of Sciences accepts the bequests of the late James C. Watson for the trust and purpose expressed in his will.

Resolved, That the Academy approves of the appropriation made by the board of trustees of \$500, or as much of the same as may be necessary, to aid in the observation of the total solar eclipse on May 6, 1883.

In April, 1884, the following recommendations of the trustees of the Watson fund, upon the advice of the council, were adopted by the Academy (these recommendations are based on the present cash balance of \$1,292.75, and the annual income of present investments, \$748):

(1) That the invested fund be increased by the addition of \$850.25, so that its par value may equal, as near as may be, \$13,750.25, the sum received from Professor Watson's estate.

(2) That dies, with suitable designs, be prepared for a medal to be awarded from time to time to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward and contributing to the progress of astronomy, in compliance with the expressed wishes of Professor Watson.

(3) That there be set aside annually the sum of \$500, or as much thereof as may be necessary and available, to commence work on tables of the small planets discovered by Professor Watson, as also expressly desired by him in his bequest to the Academy, such work to be under the direction of Mr. Newcomb.

At the stated meeting of the Academy held in Washington, in April, 1885, Mr. Coffin, on the part of the board of trustees of the Watson fund, reported that, since the session of the Academy in April, 1884, in accordance with resolutions then passed, the invested fund had been increased to \$13,750, the sum received from the bequest of Professor Watson, and progress had been made in procuring a model of the proposed Watson medal, and the work on the small planets, under the direction of Mr. Newcomb, had been commenced, but no money had yet been drawn from the treasury for that purpose.

At the April session, 1886, Mr. Newcomb, at the request of the board of trustees of the Watson fund, presented the following resolution, which was adopted by the Academy:

Resolved, That the Watson medal and a further sum of \$100 in gold be awarded to Dr. Benjamin Apthorp Gould, for his valuable labors for nearly 40 years in promoting the progress in astronomical science, and especially for his successful establishment of the National Observatory of the Argentine Republic, as manifested in the six volumes of observations recently prepared and published by him.

By vote of the Academy, the trustees of the Watson fund were authorized to take the proper steps for having the medal struck.

Mr. Newcomb reported that, while appropriations of money had been made for carrying out that part of Professor Watson's will which provided for the making of tables of the asteroids, work had been only partially commenced, owing to the difficulty of finding a sufficiently skilled computer to make such computations. They had been obliged to send abroad to find a person to make the computations necessary to enable an unskilled computer to continue the work on the other planets.

During the Washington meeting of the Academy, April, 1887, the president stated that Mr. Hilgard had resigned his position on the board of trustees of the Watson fund, and that Mr. B. A. Gould had been appointed to fill the vacancy.

PRESENTATION OF THE FIRST WATSON MEDAL.

At a public session of the Academy, held on the evening of April 20, 1887, the first James Watson medal and the sum of \$100 in gold were presented to Dr. B. A. Gould for his valuable labors for nearly 40 years in promoting the progress of astronomical science.

The president of the Academy, Professor Marsh, in his address in making this presentation, gave an account of the great work accomplished by Dr. Gould. The following extracts from this address will place on record here the main reasons for the first award of the Watson medal:

EXTRACTS FROM THE PRESIDENT'S ADDRESS.

The name of Benjamin Apthorp Gould, whom we are thus to honor to-night, is so familiar by his recent works, that we are in danger of forgetting his services as the pioneer in introducing the methods, culture, and ideas of German astronomy into this country. The years 1840 to 1843 might almost be considered as those of the birth of American astronomy. Then were founded the Washington and Cambridge Observatories, which brought forth such men as Walker, Hubbard, and Bond. Dr. Gould was then a student at Harvard, imbibing from Professor Pierce that enthusiasm for scientific work which that teacher so well knew how to inspire. Soon after graduation, Mr. Gould sailed for Europe to pursue under Bessel, Gauss, and others, the study of his favorite science in its most advanced phases. Winning the degree of PH. D. at Göttingen, he returned home full of student's honors, and started the *Astronomical Journal*. Later, he was appointed by Bache as head of the longitude department of the Coast Survey, in which position it

was a part of his duty to perfect and apply the method of determining longitudes by telegraph.

The *Astronomical Journal* was largely a labor of love, as the income could not possibly balance the outlay. Discontinued in 1861 on account of the advent of the civil war, it has recently been reestablished after a silence of just 25 years. In 1868, Dr. Gould resigned his position on the Coast Survey, and shortly afterward accepted an invitation from the Argentine Government to found a national observatory in that country.

Sailing for his new post of duty in 1870, he expatriated himself for a period of 15 years. It is more especially for his work during this period that the distinction which we celebrate to-night was conferred upon him.

The northern hemisphere being the seat of civilization and the home of the astronomers of the world, the natural result was that the phenomena of the southern heavens were much less studied than those of the northern. Ardent astronomers were from time to time attracted thither to reap the harvest which nature had sown, as Lacaille in 1750, and Herschel in 1830, but such men could simply do little in a field so great. Permanent observatories were from time to time established. First, that at the Cape of Good Hope, by the British Government; then, that of the Chilean National Observatory, at Santiago, by our late honored associate, James M. Gilliss; and yet more recently, the Melbourne Observatory, by the government of South Australia. But these institutions were not prepared to make that complete survey of the southern heavens which our associate had planned.

Dr. Gould's great works are:

(1) The *Uranometria Argentina*, one volume, with large atlas. This work comprises a catalogue and map of all the stars down to the seventh magnitude, from the south pole to 10 degrees north declination, the position and magnitude of each being given. It is not a mere catalogue, but embodies an exhaustive study of the distribution of stars of different magnitudes and their relations to the Milky Way.

(2) The *Argentine General Catalogue*, one volume, 4to, contains the places of nearly 33,000 (32,448) stars, determined with the highest accuracy with the meridian circle. Three determinations of each star were generally made. The catalogue is followed by a list of the stars contained in some of the most noted clusters.

(3) The *Cordoba Zone Catalogues*, seven volumes, give the places of 73,160 stars down to the tenth magnitude.

The mere statement of these numbers affords no conception of the labor involved in these works. We may fairly compare the general catalogue with the zone observations projected by the International Astronomical Society more than twenty years ago. As far back as 1863, the work of determining the position of all the stars north of the equator down to the ninth magnitude was divided up among such observatories of Europe and America as were prepared to participate in it.

Their work is still incomplete, while that of our associate, commenced long afterwards, lies finished before us.

Many variable stars were discovered during these investigations, and two whose proper motion is about 6" annually are equaled by only one other, so far as is known.

Eleven hundred photographs of southern star clusters taken during the years 1872-1883 have been preserved, and are now undergoing measurement.

Five volumes of meteorological observations have been published from stations established in all parts of the Argentine territory, giving the climate relations of the southern half of the continent, and establishing the isothermal lines.

The observatory and a national meteorological office were left in full organization and activity.

This vast and comprehensive work is embraced in 13 quarto volumes already published, and 6 are now prepared for publication, making 19 in all.

PRESENTATION OF SECOND WATSON MEDAL.

In 1888, at the April meeting of the Academy, the board of trustees of the Watson fund recommended that the second Watson medal be given to Prof. Edward Schönfeld, director of the University of Bonn, Germany, for his services in cataloguing and mapping the stars visible in our latitudes, and especially for his recently published southern *Durchmusterung*. This recommendation was approved by the Academy.

The following report was presented to the Academy by the board of trustees, giving the reasons for the award of the Watson medal to Professor Schönfeld:

REPORT OF THE TRUSTEES UPON THE AWARD OF THE WATSON MEDAL.

To the National Academy of Sciences:

The Board of Trustees of the Watson fund recommend that the Watson medal, with \$100 in gold, according to the provisions of the trust, be awarded by the Academy to Prof. Edward Schönfeld, Director of the University Observatory at Bonn, for his services in cataloguing and mapping the stars visible in our latitudes, and especially for his recently published southern *Durchmusterung*.

The plan of forming a catalogue of all the stars brighter than the tenth magnitude, from the north pole to the equator, was conceived many years since by our late honored associate, the illustrious Argelander. The actual work was begun in the spring of 1852; but was so severe that, after a year, Argelander was obliged to restrict his personal share in it to labors of revision and verification, leaving the actual telescopic survey to others, chief among whom were his assistants and

pupils, Dr. Schönfeld, now his successor in the Observatory, and Dr. Krüger, now Director of the Observatory at Kiel.

This magnificent undertaking was thoroughly accomplished, and the results, under the title of *Durchmusterung des nördlichen Himmels*, were published in three quarto volumes, the last of which appeared in 1862. This classic work has been since then, and must long remain, one of the most indispensable books of reference for the practical astronomer. It derives, if possible, an additional importance from serving as the basis for the vast undertaking of accurately determining the positions of all stars north of the equator to the ninth magnitude inclusive. This has been going forward for about twenty years, by the coöperation of a number of the principal observatories of the world, under the guidance of the *Astronomische Gesellschaft*, an international organization, in the establishment and conduct of which, Professor Schönfeld has taken a conspicuous part.

Meanwhile, his researches concerning the variable stars, both his many discoveries, and his thorough study of the laws which govern their variation, have not merely placed Professor Schönfeld in the foremost rank of the investigators in this department of astronomy, but, in the universal opinion of astronomers, at the head of all busy laborers in this field. To him, questions of doubtful nomenclature or notation have been submitted by astronomers of whatever nationality, and his verdict always commands universal acceptance. In this, as in the other fields of stellar astronomy already mentioned, the mantle of his great predecessor, Argelander, has fallen upon worthy shoulders, and the Observatory of Bonn has maintained its peculiar and unsurpassed eminence.

But the greatest achievement of Professor Schönfeld, and that which has especially prompted the trustees of the Watson fund in their recommendation of this award, is his last published work, the extension of the *Durchmusterung* from the equator to the southern tropic. Not only has he accomplished this in full conformity with the previous survey of the northern sky, in which he took so important a part, but he has emulated the example of his predecessor and teacher by the improvement of previous methods. The experience which he has attained in the northern *Durchmusterung* enabled him to extend the limit of brightness up to which his catalogue is exhaustive, and the 23 degrees of southern declination which it includes have been explored and surveyed by himself alone; he having made all the observations personally, and having personally computed them, and personally edited and superintended their publication. This southern extension of the census of the sky contains — stars, the positions of all of which have been reduced to the epoch of Argelander's *Durchmusterung*, and which are all likewise represented upon charts constructed with all attainable accuracy.

So brilliant and priceless a contribution to our stellar knowledge would demand recognition, even had it not been preceded by the other important and conspicuous labors to which we have referred.

The board of trustees has consequently felt no hesitation in its unanimous recommendation to the Academy.

SIMON NEWCOMB.
J. H. C. COFFIN.
B. A. GOULD.

WASHINGTON, April 18, 1888.

At a public session of the Academy, held on the evening of April 17, 1889, the second James Watson gold medal and the sum of \$100 in gold were presented to Prof. Edward Schönfeld, Director of the Observatory of Bonn, Germany.

As Professor Schönfeld was not present at this meeting, the foreign secretary was instructed to forward the medal and \$100 in gold to him through the German embassy. This was done, and the medal and fund were duly received by Dr. Schönfeld, who has since acknowledged their receipt and expressed to the Academy his high appreciation of the honor thus conferred upon him.

THE HENRY DRAPER FUND.

At the April session in 1883, the president announced that Mrs. Henry Draper, widow of Dr. Henry Draper, late an honored member of the Academy, had presented to the National Academy of Sciences a fund of \$6,000 for the establishment of a gold medal to be awarded every two years to the individual in this or any country who makes the most important discovery in astronomical physics, the value of said medal to be \$200, and the fund, in case the medal should not be awarded, to be applied by the Academy to investigations in the same department of science.

The text of the deed of gift is as follows:

DEED OF TRUST OF MRS. HENRY DRAPER.

Know all men by these presents that I, Mary Anna Palmer Draper, of the city, county, and State of New York, in consideration of the premises, and of the acceptance of the within trust by the National Academy of Sciences, and also in consideration of divers other good and valuable considerations, I, the said Mary Anna Palmer Draper, hereto moving, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over unto the said National Academy of Sciences, and to their successors forever, a certain fund or sum of \$6,000, with the interest and income thereof, to have and to hold the same in trust, nevertheless upon the special trusts, and for the uses and purposes following, to wit:

First. In trust to invest, and to reinvest, the said sum of \$6,000, and to keep the same invested in good and safe securities, or in such other manner as shall be, in their opinion, best for the preservation and maintenance of said fund.

Second. In trust to use the interest and income thereof for the purpose of striking a gold medal, which shall be called the "Henry Draper Medal," shall be of the value

of \$200, and shall be struck in a die to be selected and presented to said National Academy of Sciences, by me, the said Mary Anna Palmer Draper. And the said medal shall be awarded and presented from time to time by the said National Academy of Sciences to any person in the United States of America or elsewhere, who shall make an original investigation in astronomical physics, the results of which shall be made known to the public, such results being, in the opinion of the said National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition; provided, however, that said medal shall not be presented or awarded more frequently than once in 2 years, and provided, also, that the investigation for which it is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust that if discoveries of equal importance shall be made in astronomical physics at or about the same time in the United States of America, and also in some other part of the world, each of which discoveries might, in the opinion of the said Academy, entitle the discoverer to be considered as a competitor for said medal, preference shall be given in the awarding thereof to discoveries made by a citizen of the said United States of America.

Fourth. In trust that if the said die shall at any time be lost, destroyed, broken, or in any way rendered unfit for the purpose of striking the said medal, a new die shall be procured, exactly similar to the one selected and presented as aforesaid, and shall be paid for out of the interest and income of the said fund; and such sum or sums of money as shall at any time or times be necessary for the proper care, custody, and protection of the said die or of the said fund hereby given, shall also be taken from and out of the interest and income of the said fund, whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust that if at any time or times the interest and income of the said trust fund of \$6,000 shall exceed the amount necessary for the striking of said medal and the care of the said die, and of the fund, such surplus over and above the sum or sums so required for the purposes of the trust as hereinbefore recited and set forth shall be used in such manner as shall be selected by said National Academy of Sciences, in aid of investigation and work in astronomical physics to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of \$6,000, and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In witness whereof I, the said Mary Anna Palmer Draper, have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be subscribed by its president, this thirteenth day of April, in the year one thousand eight hundred and eighty-three.

[SEAL.]

MARY ANNA PALMER DRAPER.

Sealed and delivered in the presence of—

EDWARD A. DIXON.

MORNAY WILLIAMS.

As to Mary Anna Palmer Draper.

O. C. MARSH,

President of the National Academy of Sciences.

Witnesses to the signature of O. C. Marsh—

J. H. C. COFFIN.

ASAPH HALL.

SAM'L H. WALKER.

Executed and acknowledged before Mornay Williams, notary public, New York County.

Acknowledgment of officer of the Academy before Samuel H. Walker, notary public, District of Columbia.

It was moved and adopted that the deed of Mrs. Henry Draper be entered at length in the minutes of the meeting.

The following resolution was recommended by the council and adopted:

Resolved, That a permanent committee of five be appointed to consider the subject of the bestowal of the Henry Draper medal, and to recommend to the Academy, from time to time, such persons as they may consider deserving of the medal, with the ground of their recommendation.

In accordance with this resolution the president appointed the following members as the committee on the Henry Draper medal:

G. F. Barker, <i>Chairman</i> ,	
W. Gibbs.	A. W. Wright.
S. Newcomb.	C. A. Young.

The following resolution relative to the fund presented by Mrs. Henry Draper was reported and adopted:

Resolved, That the National Academy of Sciences accepts the fund of six thousand dollars presented to it by Mrs. Mary Anna Palmer Draper, and engages to maintain the same upon the trusts for the uses and purposes mentioned and set forth in a certain deed executed by her on the 13th day of April, in the year of our Lord one thousand eight hundred and eighty-three, and signifies such acceptance by causing the corporate seal of the Academy to be affixed and the said deed to be signed by its president.

The president appointed the following committee to consider the form of a resolution of thanks to Mrs. Draper: Messrs. W. Gibbs and G. F. Barker.

In 1884, at the April meeting, it was resolved, on recommendation of the council, that the home secretary have engrossed and properly signed the resolution of thanks to Mrs. Draper drawn up at the stated session of the Academy in 1883, as follows:

Resolved, That the grateful acknowledgments of the National Academy of Sciences are due to Mrs. Draper for the confidence which she has shown in selecting the Academy as the trustee of a fund designed to reward scientific labor, and by so doing to commemorate the services of one who was loved for his virtues, and honored for his eminent success in the branch of science to which he devoted his noble and useful life.

PRESENTATION OF FIRST DRAPER MEDAL.

At the stated session of the Academy in 1885, the committee on the Henry Draper medal reported that it had had before it the claims of various investigators working in the field of astronomical physics, and had considered fully their claims to the distinction implied in the award of this medal by the Academy.

That, as a result of its investigations, the committee recommended to the Academy the award of the first Henry Draper medal to our fellow-member, Prof. S. P. Langley, for his researches and discoveries in relation to solar radiation. This recommendation was adopted.

The following is the report of the committee:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

By a resolution of the Academy, adopted April 19, 1883, it is made the duty of the committee on the Henry Draper medal "to recommend to the Academy, from time to time, such persons as they may consider deserving of the medal, with the ground of their recommendation."

The original deed of trust provides that "the said medal shall be awarded from time to time by the said National Academy of Sciences to any person in the United States of America or elsewhere, who shall make an original investigation in astronomical physics, the results of which shall be made known to the public, such results being, in the opinion of the said National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition."

In accordance with the above resolution of the Academy, and with the provisions of the deed of trust, the committee on the Henry Draper medal begs leave to report that it has taken into consideration the researches which have recently been made by the men of science of this and other countries in the department of astronomical physics, and that in consequence of such examination the committee unanimously recommends that the Academy award the Henry Draper gold medal to Prof. Samuel P. Langley, of Allegheny, Pennsylvania. The committee bases this recommendation upon the numerous investigations of a high order of merit which have been made by Professor Langley within the past few years in solar physics, and especially in the domain of radiant energy. In corroboration of its opinion, the committee desires to specify the following memoirs, in which the results of these investigations are, for the most part, embodied:

1. *On the Minute Structure of the Solar Photosphere.* (Am. J. Sci., III, vii, 87, February, 1874.)

This paper gives the result of two years' work, and announces the discovery (since confirmed by Janssen) that four-fifths of the sun's light comes from less than one-fifth of its surface. It was illustrated with a plate containing the most detailed representation of a sun spot, which had appeared up to that time.

2. *The External Aspects of the Sun.* (J. Frank. Inst., August and September, 1874.)

In this paper, the noted engraving of the "typical sun spot" appeared for the first time. It was executed for the purpose of giving material for passing judgment on the current theories of sun spots, and had undoubtedly a considerable influence in determining the present conviction of students of solar physics that the surface of the sun is essentially gaseous or cloudlike. This engraving has been reproduced by Secchi, Proctor, Young, and nearly every author who has written on the subject.

54. REPORT OF THE NATIONAL ACADEMY OF SCIENCES, 1889.

3. *On the Comparison of Certain Theories of Solar Structure with Observation.* (Am. J. Sci., III, ix, 192, March, 1875. Published simultaneously in *Memorie degli Spettroscopisti Italiani*, Vol. IV.)

A statement of the above consequences more in detail.

4. *Sur la température relative des diverses régions du soleil.* Première Partie. Les noyaux noirs des taches; Deuxième Partie. Région équatoriale et régions polaires. (Comptes Rendus, March 22 and 29, 1875.)
5. *Étude des radiations superficielles du soleil.* (Comptes Rendus, September 8, 1875.)

The author shows in these papers the existence of a remarkable thermochroic action in the solar atmosphere, such that the vibrations of great wave-length are less absorbed than the visible and ultra-violet. He proves also that no such difference between the polar and equatorial radiation as has been asserted by Secchi exists. Hence, it follows that the sun, if deprived of his atmosphere, would appear blue. This statement, however, was first made in explicit terms at the Detroit meeting of the American Association for the Advancement of Science.

See the paper entitled—

6. *The Solar Atmosphere.* (Am. J. Sci., III, x, 490, December, 1875. Suppl. No.)
7. *Measurement of the direct effect of Sun spots on Terrestrial Climates.* (Monthly Not. Royal Astr. Soc., November, 1876.)

Here the author essays a new method of determining whether sun spots affect terrestrial climates or not, although he does not undertake to say whether they may not be the indices of some other action which does affect them. Considering the spots merely as interruptions of a determinate quantity of the solar heat, he succeeds in demonstrating that their total effect (from this point of view) on terrestrial climates can not alter the mean temperature of the earth by so much as one degree Fahrenheit.

8. *On certain Remarkable Groups in the Lower Spectrum.* (Proc. Am. Acad., 1878.)

Contains the author's discovery of the duplicity of the rays in the "great A" group of the solar spectrum.

9. *On the Temperature of the Sun.* (Proc. Am. Acad., 1878.)

In this paper, the author publishes the results of his comparison of the heat and light of the sun with that of the molten steel in the Bessemer converter. At this time (so late as 1878) the temperature of the sun was maintained by physicists of high repute to be not over 1500° C. The author's object in this comparison was not to determine this temperature, but to furnish irrefragable proof that it was at any rate very much higher than that which physicists, misled by Dulong and Petit's law, had assigned to it. Incidentally, the conclusion was reached that this celebrated law itself is absolutely unreliable, a position which is now fully conceded.

10. *Observations on Mount Etna.* (Am. J. Sci., III, xx, 33, July, 1880.)

The author here gives the results of his studies made during the winter of 1878-'79, upon the upper slopes of Mount Etna, which were connected with the improvement of solar observation by the employment of a station at a high altitude.

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11. *The Progress of Solar Physics.*

An address as president of the physical section of the American Association for the Advancement of Science, delivered at Saratoga in August, 1879. (Proc. Am. Assoc., xxviii, 51, 1879.)

12. *The Bolometer and Radiant Energy.* (Proc. Am. Acad., xvi, 1890.)
13. *The Bolometer.* (Proc. Am. Metrol. Soc., December, 1880.)
14. *The Actinic Balance.* (Am. J. Sci., III, xxi, 187, March, 1881.)

His solar studies having convinced him that two-thirds of the sun's radiant energy was unexplored for want of the proper apparatus, the author spent the year 1880 in experiments on the construction of an instrument for analyzing and measuring this and like forms of energy. This instrument which he called the bolometer, from *Bolē* and *μετρον*, is described in the papers above mentioned.

15. *Sur la distribution de l'énergie dans le spectre solaire normal.* (Comptes Rendus, March 21, 1881.)
16. *Distribution de l'énergie dans le spectre normal.* (Comptes Rendus, July 18, 1881.)
17. *La distribution de l'énergie dans le spectre normal.* (Ann. Chim. Phys., February, 1882.)

The first fruit of the use of this new instrument was the demonstration that the amount of heat which the earth receives from the sun (the solar constant) had been greatly underestimated, owing, among other causes, to inability previously to measure the solar heat in sufficiently small portions of the spectrum. The leading facts in regard to the distribution of energy in the normal spectrum, from the sun, and the distribution of this solar energy before absorption by the earth's atmosphere, are given in these papers.

18. *The Selective Absorption of Solar Energy.* (Am. J. Sci., III, xxv, 160, March, 1883. Also, Ann. Phys. Chem., XIX, 1883, and Ann. Chim. Phys., V, xxix, 497, August, 1883.)

Treated more fully in "The Professional Papers of the Signal Service. No. xv. Researches on Solar Heat and its Absorption by the Earth's Atmosphere. Expedition to Mount Whitney, 1884."

The results already announced were so important in their bearing on the science of terrestrial meteorology that the author conducted, under the joint auspices of the Allegheny Observatory and the United States Signal Service, an expedition to the Sierra Nevadas of Southern California, the results of which were published extensively in American and foreign scientific journals. In the first article above mentioned is an account of the leading facts observed; which are that the sun's light is essentially blue, and that what we call "white" light is due to the absorption of these blue rays, first by the sun's atmosphere and then by our own. It had always been supposed that the sun's red and infra-red rays were powerfully absorbed by our own atmosphere, which acted, according to the familiar comparison of Poisson and Pouillet, like the glass cover of a hot-bed, which absorbs solar heat more and more as we approach the infra-red. This universally-accepted belief was directly contradicted by these researches, and it was shown that the nature as well as the

amount of the absorption of the solar rays had been so wholly misunderstood that the general outlines of these important truths were here given for the first time. The value of the solar constant, which until now had been accepted, was radically altered, Pouillet's value, 1.7 calories, being raised to 3. In connection with this, a map was given of the infra red solar spectrum, containing numerous lines and bands hitherto unknown; and, what was wholly new, with their places fixed upon the normal or wave length scale by direct observation.

19. *Memoir on the Experimental Determination of Wave-lengths in the Invisible Prismatic Spectrum.* (Mem. Nat. Acad. Sci., 1881 (Read October, 1883). Also Am. J. Sci., III, xxvii, 163, March, 1884, and Ann. Phys. Chem., July, 1884.)

Almost, if not absolutely, all of our present knowledge of the constitution of bodies forming the external universe is dependent upon our information concerning the wave-lengths of the energy they send us, of which that coming in the form of light and which is visible is but the smaller portion. Inasmuch as until lately we have known almost nothing about any waves but visible ones, all our knowledge about terrestrial and other dark-heat radiation is in a condition of empiricism even to-day; a fact which is a great reproach to physical science. This arises chiefly from our want of knowledge in the past of any means of determining what these wave-lengths are, or, as a consequence of this, from our inability to analyze the invisible spectrum (in which two-third of the solar energy resides) in the way we can analyze the visible. The memoir above mentioned fixes the wave-lengths of solar heat, which had been known hitherto in the visible spectrum only, throughout its whole extent, and for the first time gives a trustworthy means of investigating that unknown major portion of the whole solar energy on which all organic life depends. This is the real purport of the somewhat abstruse, and, at first sight, unattractive investigations upon wave-lengths to which the author has devoted many years. He compares himself in this respect to one who is opening a path into hitherto unexplored country; not undertaking himself to study its natural history, but trying to execute the less attractive but indispensable labor of making the road on which future investigators may travel.

20. *On the Amount of the Atmospheric Absorption.* (Am. J. Sci., III, xxviii, 163, September, 1884.)

In this paper, it is shown, both from theoretical considerations and by experiment, that the absorption of the solar rays by the earth's atmosphere is at least double what it has commonly been supposed to be.

21. *On the Temperature of the Surface of the Moon.* (Mem. Nat. Acad. Sci., III, September, 1884.)

In this memoir, it is stated that it has been found possible to form a heat spectrum from the moon, and to analyze its different parts. The conclusion reached (which differs from that of Lord Rosse) is that the temperature of the sunlit surface of the moon can not be greatly above zero centigrade. Results of interest in connection with solar radiation are also given.

Professor Langley has published numerous other papers upon subjects connected with solar or astral physics, but it is believed that those which have now been mentioned will fully justify the recommendation of the committee.

GEORGE F. BARKER,
Chairman.

WOLCOTT GIBBS.
SIMON NEWCOMB.
ARTHUR W. WRIGHT.
CHARLES A. YOUNG.

WASHINGTON, April 24, 1885.

At a public session of the Academy, held on the evening of April 21, 1886, the first Henry Draper medal awarded by the Academy was presented to Prof. S. P. Langley by the president, who in a short address gave a résumé of Professor Langley's work in astronomical physics, and the reasons why the Academy had honored him with this medal.

On recommendation of the council, the Academy adopted the following resolution in April, 1885:

Resolved, That the treasurer be authorized to reserve from the income of the Draper fund, \$65 each year, and such further sum as the committee on that fund may authorize, to be invested from time to time until the invested fund is increased to \$6,000, the sum intrusted to the Academy by Mrs. Draper.

PRESENTATION OF SECOND DRAPER MEDAL.

Mr. Barker, chairman of the committee on the Henry Draper medal, reported, in April, 1887, that the committee recommended that the second Henry Draper medal be awarded to Prof. Edward C. Pickering, director of the Harvard Observatory, for his recent work in astronomical photometry and photography. This recommendation was adopted by the Academy.

The report of the committee for the award of this medal is as follows:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

The committee on the Henry Draper medal begs leave herewith to report that it has carefully considered the investigations which have been made in astronomical physics since the award of this medal in 1885; and that, as a result of such consideration, the said committee desires to recommend that the Academy award this medal for the year 1887, to our fellow member, Prof. Edward C. Pickering, the director of the Harvard College Observatory, for his recent work in astronomical photometry and photography.

Professor Pickering was appointed to the position which he now holds in February, 1877. An examination of the annual reports which he has presented to the visiting committee of the observatory will show the

great amount and the great variety of the work which has been done there under his direction. Some of this work is purely astronomical; as an example of which, the excellent meridian circle work of Prof. William A. Rogers may be mentioned. But most of it is in the department of astronomical physics; and this it is to which the committee desires to direct attention.

The work in astronomical physics, which has been done in the observatory of Harvard College under Professor Pickering's immediate supervision, seems readily divisible into three classes: First, stellar photometry; second, stellar photography; and third, stellar spectrum photography.

I. The principal subdivisions of the photometric work are as follows:

(1) Observations of Jupiter's satellites at their disappearances in the shadow of the planet and their reappearances after the eclipse; with the object of determining the times at which these phenomena occur with greater accuracy than had hitherto been practicable.

(2) The determination of the relative brightness of all stars visible to the naked eye in the latitude of Cambridge.

(3) The determination of the relative brightness of several thousand stars of the first nine magnitudes, in order to fix the value of the arbitrary scales usually employed in estimating magnitudes.

(4) Comparisons of various objects at small apparent distances from each other, such as the components of double stars, different satellites of the same planet, etc.

(5) Numerous special investigations on proposed standards of magnitude, stars which have been used for comparison with variable stars, the light of nebulae, etc.

All this photometric work has gone uninterruptedly forward with the aid of special photometers ingeniously devised for the purpose by Professor Pickering.

The observation of the eclipses of Jupiter's satellites has long been regarded as important, not only in determining the motions of the satellites themselves, but also in ascertaining the velocity of light. It is obvious that the observation of the disappearance or reappearance of a satellite is necessarily a photometric observation, and therefore that the subject is one to which improved means of photometric research are peculiarly applicable. But previous to Professor Pickering's undertaking, no one appears to have recognized the advantages resulting from the use of photometric apparatus in the observation of these eclipses. Recently, however, these advantages have been recognized in France, and researches similar in character to those of Professor Pickering have been undertaken there.

It is not expected that the observations of the eclipses made at the Harvard College Observatory will be fully reduced and published until they have been continued through a complete revolution of Jupiter (about 12 years). The first observation of this sort was made on the

23d of June, 1878. Up to the beginning of the present year, the total number of eclipses observed was 358, thirty-nine of which had occurred since October, 1885. The accuracy with which an eclipse of the first satellite can be observed appears, from the preliminary reductions, to be very satisfactory, the probable error seeming to be less than a second of time. The eclipses of the three outer satellites will furnish results nearly as useful, since the greater number of comparisons obtained during each eclipse compensates to a considerable extent for the comparative slowness of the changes in the brightness of the object observed.

The meridian photometer of Professor Pickering was first brought into use in the summer of 1879. The work of determining by the aid of this instrument the relative brightness of the stars which are visible to the naked eye was begun on the 25th of October of that year and was continued through 700 series of observations, 4,260 stars being included in the catalogue. The total number of comparisons made was 94,476, four comparisons constituting a complete observation. These results, together with an extended discussion of the estimated magnitudes obtained for the same stars by careful observers, as well as the results of previous photometric determinations of their relative brightness, were published in Volume XIV of the Annals of the Observatory.

The success of this photometer led Professor Pickering to have a larger instrument constructed, of the same kind, but which could be applied to the measurement of telescopic stars. The new photometer has given perfect satisfaction, and has enabled the brightness of stars to the ninth magnitude to be measured with a deviation from accuracy not exceeding a tenth of a magnitude. Moreover, stars can be measured with this instrument at the rate of forty stars an hour for an entire evening; and under favorable conditions, even one star a minute may be thus measured. During the year 1886, 209 series of measurements were made by Professor Pickering and his assistant, the total number of separate photometric comparisons being 59,800. In 1885, 50,000 such comparisons were made, and in 1884, 27,500. A comparison of the Cambridge results with those obtained at Pulkowa shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed one-tenth of a magnitude. The principal work of the meridian photometer, the revision of the *Durchmusterung* magnitudes, is now approaching completion, nine-tenths of the observations having already been made.

It would seem to be manifest from the facts above enumerated, that practical stellar photometry has now been carried on for the first time by Professor Pickering to that extent and with that completeness which are requisite to give it general interest and importance.

II. The earliest investigations in stellar photography which were undertaken by Professor Pickering were begun in 1882, with the aid of a grant from the Rumford fund of the American Academy. They have

been continued subsequently by an appropriation made in June, 1885, from the Bache fund of the National Academy. The work which has been done in this direction has been summarized as follows:

"The present research was undertaken in 1882 with a lens having an aperture of only $2\frac{1}{2}$ inches. It was shown that photography could be used as a means of forming charts of large portions of the sky, and of determining the light and color of stars in all portions of the heavens. Photographs of the trails of close polar stars no brighter than the eleventh magnitude were obtained without clockwork." "In 1885, the investigation was resumed with a telescope having an aperture of 8 inches. With this, one hundred and seventeen stars within one degree of the pole, one of them no brighter than the fourteenth magnitude, left trails. The average deviation of the measures of the brightness of these stars on different photographs was less than a tenth of a magnitude; a greater accordance than is given by any other photographic method. A similar result was obtained from the Pleiades, of which group over fifty left trails. Similar trails are now being obtained of the stars north of -30° in all right ascensions. This work began in the autumn of 1885, at 23^h, and has already been completed for more than half the sky. By photographing on the same plate polar stars near their upper and lower culminations, material has been accumulated for determining the atmospheric absorption each night of observation.

"A study has been made of the application of photography to the transit instrument. Measurements of the trails show that the time of a transit may be determined from its trail with an average deviation of 0.03 second, which is about half the corresponding deviation of eye observations.

"Charts may be constructed 5° square, having the same dimensions as those of Peters and Chacornac. A single exposure of one hour is required, and it is not necessary that the observer should remain with his eye at the telescope to correct the errors of the clock. Miscellaneous observations have been secured of the Pleiades, of the nebula in Orion, of Jupiter's satellites, and of various other objects."

III. Stellar spectrum photography, in which Professor Pickering has achieved his most marvelous results, was undertaken by him first in 1885, upon a plan entirely novel. Two important features of advantage were possessed by the new arrangement. The first consisted in placing the prism in front of the object glass; a plan already suggested by Fraunhofer, and tried for eye observations by Secchi. The second consisted in placing the refracting edge of the prism parallel to the motion of the star; i. e., if the star was on the meridian, the refracting edge would be horizontal, and the spectrum north and south. The first device gives not only an enormous increase of light, but renders it possible for the stars over the entire field to impress their spectra upon the plate. Hence, while previous observers have been able to photograph but one star at a time, and have not obtained satisfactory

results from stars fainter than the second or third magnitude, Professor Pickering has often obtained more than 100 spectra on a single plate, many of them of stars not brighter than the seventh or eighth magnitude. By means of the second device, the necessary width of the spectrum is secured. If clockwork were employed, the spectrum of a star would be a line too narrow to show any details. Formerly, a cylindrical lens was used to widen the spectrum; but by placing the prism as above, and by suitably varying the rate of the clock, any desired width can be given to the spectrum simply by the motion of the star itself. One millimetre was found to be the best width.

The first experiments were made in May, 1885, by placing a 30° prism in front of a lens of $2\frac{1}{2}$ inches aperture. No clockwork was used, the spectra being formed of the trails of the stars. In the spectrum of the pole star, over a dozen lines could be counted, and in that of α Lyrae, the characteristic lines were shown very clearly with an exposure of only two or three minutes. In the fall of 1885, two prisms were obtained 20 centimetres in clear aperture, and having angles of 5° and 15° , respectively. These could be placed in front of the object glass of the 8-inch photographic telescope. With this apparatus, systematic operations were begun. The research, however, proved too large for the Bache appropriation. Whereupon, Mrs. Henry Draper came forward, early in 1886, and generously offered not only to defray the expenses of the investigation as a memorial to Dr. Draper, but to put at Professor Pickering's disposal the 11-inch refractor, with its photographic corrector, with which Dr. Draper has taken many of his later stellar photographs. The investigation was thereupon extended by Professor Pickering, and divided into three parts. The first included a general survey of stellar spectra, each spectrum being photographed with an exposure of not less than five minutes. These photographs generally exhibited the spectra of all stars brighter than the sixth magnitude with sufficient distinctness for measurement. The second research related to a determination of the spectra of the fainter stars. Each photograph taken received an exposure of one hour, so that the spectra of all the stars not fainter than the eighth or ninth magnitude and included in a region 10° square were represented upon the plate. For both these investigations, the 8-inch Bache photographic telescope was employed. The third research related to a more detailed study of the spectra of the brightest stars. For this work the Henry Draper 11-inch corrected refractor was used, Mrs. Draper having provided a small observatory for it in Cambridge, and also the mounting. Four prisms were constructed, each of 15° , of which three had a clear aperture of nearly 11 inches, the fourth being somewhat smaller, the whole weighing more than 100 pounds and occupying a cubic foot of space.

The results already attained in these three directions have been satisfactory. In the first research, the first cycle, covering the entire sky from zero to 24 hours of right ascension, has been completed. This

cycle contains 257 plates, all of which have been measured, and a large part of the reduction completed. 8,313 spectra have been measured on them, nearly all of which have been identified, and the places of a greater portion of the stars brought forward to the year 1900, and entered in catalogue form. In the second cycle, which will complete the work, 64 plates have been taken, of which 51, including 2,974 spectra, have been measured and identified. In the second research, which has been carried on in the intervals when the telescope was not needed for other purposes, 99 plates, with an exposure of an hour, have been obtained, on which 4,442 spectra have been measured, in one case over 300 spectra being shown on a single plate. In both these researches taken together 15,729 spectra of bright and faint stars have been measured. In the third research, the first results of which were obtained in October last, a considerable number of excellent photographs have been obtained, the results of which can be stated only after a long series of measurements, and a careful reduction and discussion of them. Some points of interest, however, are shown on inspection. A photograph of α Cygni, taken November 26, 1886, shows that the H line is double, its two components having a difference in wave length of about one ten-millionth of a millimetre.* A photograph of Omicron Ceti shows that the lines G and H are bright, as are also four of the ultra-violet lines characteristic of spectra of the first type. The H and K lines in this spectrum are dark, showing that they probably do not belong to that series of lines. The star near X' Orionis, discovered by Gore, in December, 1885, gives a similar spectrum, which affords additional evidence that it is a variable of the same class as O Ceti. Spectra of Sirius show a large number of faint lines beside the well-known broad lines.

Professor Pickering has also devised a new method of enlarging these original photographs, which also removes the inequalities in density in the negatives, appearing as bands parallel to the length of the spectrum. A cylindrical lens is placed close to the enlarging lens, with its axis perpendicular to the spectrum lines. In this way, the length of the spectrum is increased only five times, while its width is increased nearly one hundred; i. e. from 1 millimetre to about 4 inches. This arrangement greatly reduces the difficulty arising from the feeble light of the star. Until very lately, the spectra in the original negatives were made very narrow, since otherwise the intensity of the starlight would have been insufficient to produce the proper decomposition of the silver particles. The enlargement being made by daylight, the vast amount of energy then available is controlled by the original negative, the action of which may be compared to that of a telegraphic relay. The copies, therefore, represent many hundred times the original energy received from the stars.

* It has long been known that the H line is also double (bright) in the spectrum of the solar chromosphere.

The deed of trust under which this committee is acting provides "that the investigation for which it (the Henry Draper medal) is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal." In consequence, the committee recommends the award to Professor Pickering, for the specific investigations in stellar photometry and photography above mentioned, which have been made since the month of April, 1885, the time of the last preceding award and presentation of the said medal. This comprises, it is believed, the whole of the photographic work done at the Harvard College Observatory, and a large and important part of the photometric work.

In the opinion of the committee, Professor Pickering has displayed in these researches a skill, ingenuity, and vigor, which entitle him to an honorable place among the scientific men of our own or of any previous age.

All of which is respectfully submitted.

GEORGE F. BARKER.
WOLCOTT GIBBS.
SIMON NEWCOMB.
CHARLES A. YOUNG.
ARTHUR W. WRIGHT.

Committee on the Henry Draper Medal.

April 21, 1887.

On the evening of April 18, 1888, at a public session of the Academy, the second Henry Draper medal was, in behalf of the Academy, presented by the president to Prof. E. C. Pickering, of the Harvard Observatory, for his work in astronomical photometry and photography.

AWARD OF THIRD DRAPER MEDAL.

At a special session of the Academy, held in Philadelphia, November 13, 1889, Mr. George F. Barker presented the following recommendation of the committee on the Henry Draper medal:

The committee on the Henry Draper medal recommend to the National Academy of Sciences the award of the Henry Draper medal to Prof. Henry A. Rowland, of Baltimore, for his researches on the solar spectrum.

This recommendation was adopted by the Academy.

THE LAWRENCE SMITH FUND.

During the April session, 1884, the president announced that the widow of Prof. J. Lawrence Smith, late an honored member of the Academy, intended to place at the disposal of the National Academy of Sciences the sum of \$8,000, as a memorial fund to promote the study of meteoric bodies.

Upon recommendation of the council, the Academy adopted the following resolution:

Resolved, That the Academy hears with gratification the announcement that Mrs. J. Lawrence Smith intends to intrust to it a fund to promote the study of meteoric bodies, and hereby signifies its readiness to accept the trust.

The Academy also adopted the recommendation of the council, "that the president be authorized to communicate with Mrs. J. Lawrence Smith, and make what arrangements were necessary."

The following is the text of the deed of gift of Mrs. Smith:

DEED OF TRUST OF MRS. J. LAWRENCE SMITH.

Know all men by these presents, that I, Sarah Julia Smith, of the city of Louisville, and county of Jefferson, State of Kentucky, in consideration of the premises, and of the acceptance of the within trust by the National Academy of Sciences, and also in consideration of divers other good and valuable considerations, I, the said Sarah Julia Smith hereto moving, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over, unto the said National Academy of Sciences, and to their successors forever, a certain fund or sum of \$8,000, with the interest and income thereof, to have and to hold the same in trust nevertheless, upon the special trusts and for the uses and purposes following, to wit:

First. In trust, to invest and to reinvest the said sum of \$8,000, and to keep the same invested in good and safe securities, or in such other manner as shall be, in their opinion, best for the preservation and maintenance of such fund.

Second. In trust, to use the interest and income thereof for the purpose of striking a gold medal, which shall be called the "Lawrence Smith Medal," shall be of the value of \$200 in gold, and shall be struck in a die, to be selected and presented to the said National Academy of Sciences by me, the said Sarah Julia Smith. And the said medal shall be awarded and presented from time to time, by the said National Academy of Sciences, to any person in the United States of America or elsewhere, who shall make an original investigation of meteoric bodies, the results of which shall be made known to the public, such results being in the opinion of the said National Academy of Sciences of sufficient importance and benefit to science to merit such recognition; provided, however, that said medal shall not be presented or awarded more frequently than once in 2 years, and provided, also, that the investigation for which it is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust, that if investigations of equal importance shall be made in regard to meteoric bodies at or about the same time in the United States of America and also in some other part of the world, each of which investigations might, in the opinion of the said Academy, entitle the investigator to be considered as a competitor for said medal, preference shall be given in the awarding thereof to investigations made by a citizen of the said United States of America.

Fourth. In trust, that if the said die shall at any time be lost, destroyed, broken, or in any manner rendered unfit for the purpose of striking the said medal, a new die shall be procured exactly similar to the one so selected and presented as aforesaid, and shall be paid for out of the interest and income of the said fund; and such sum or sums of money as shall at any time or times be necessary for the care, custody, and protection of the said die or of the said fund hereby given shall also be taken from and out of the interest and income of the said fund whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust, that if at any time or times the interest and income of said trust fund of \$8,000 shall exceed the amount necessary for the striking of said medal and the care of the said die and of the fund, such surplus over and above the sum or sums

so required for the purposes of the trust, as hereinbefore recited and set forth, shall be used in such manner as shall be selected by the National Academy of Sciences in aid of investigations of meteoric bodies, to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of \$8,000, and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In witness whereof I, the said Sarah Julia Smith, have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be affixed, and these presents to be subscribed by its president, this 6th day of May, in the year 1884.

SARAH JULIA SMITH. [SEAL.]

Sealed and delivered in the presence of—

ANNIE C. NORTON.
J. H. CAPERTON. [SEAL.]

O. C. MARSH,
President of the National Academy of Sciences.

Witnesses to signature:

GEO. J. BRUSH.
E. S. DANA.

At a stated session of the Academy, held in April, 1885, the following resolutions in regard to the Smith fund were adopted upon recommendation of the council:

Resolved, That the National Academy of Sciences gratefully acknowledges the receipt of a fund of \$8,000, presented in trust by Mrs. Sarah Julia Smith to promote the study of meteoric bodies; that the Academy adopts and confirms the action of its president in accepting such trust, and promises the faithful execution of the same.

Resolved, That the Academy appreciates the confidence reposed by the donor in selecting it as the trustee for executing her purpose, and her further liberality in providing dies for a suitable medal.

Resolved, That a committee of 5 members be appointed by the president to recommend to the Academy such measures as may be necessary to the proper execution of the trust.

Resolved, That the said committee be charged with the duty of preparing an expression of appreciation by the Academy of the munificence of Mrs. Smith, and of having such expression suitably engrossed and signed by the proper officers for transmission to the donor.

Resolved, That the treasurer be authorized to reserve from the income of the J. Lawrence Smith fund, \$133 each year, to be invested from time to time until the invested fund is increased to \$8,000, the amount intrusted to the Academy by Mrs. Smith.

COMMITTEE ON THE SMITH FUND.

The president appointed as permanent committee on the Smith fund the following members:

Wolcott Gibbs, *Chairman.*

G. J. Brush.

R. Pumpelly.

A. Hall.

L. M. Rutherford.

ACKNOWLEDGMENT TO MRS. SMITH.

Mrs. SARAH JULIA SMITH:

MADAM: It is our duty as a committee of the National Academy of Sciences to tender to you the thanks of the Academy for the munificent donation which you have intrusted to it. With the most sincere appreciation of the spirit which dictated your gift, and with profound respect and sympathy, we now discharge the duty which has devolved upon us.

The noble and unselfish life of our lamented fellow member, Dr. J. Lawrence Smith, was devoted to science; and of the work which he did, and which confers eternal honor upon his name, no part is more deeply interesting or more permanently valuable than his researches on the chemical constitution of meteorites, research in which he first established in these bodies the existence of hydrocarbon. His beautiful collection has become the property of one of our most prominent colleges. His name and fame are national possessions. The income of the fund which you have intrusted to the Academy, worthily bestowed, can not fail to assist materially in extending our knowledge of meteoric phenomena.

The Academy accepts the trust, which honors the giver, which recalls the lifelong services of one of its most honored members, and which promises to extend the boundaries of the science to which he was devoted. We tender to you, madam, in the name of the Academy, our grateful acknowledgments.

WOLCOTT GIBBS, *Chairman.*

G. J. BRUSH.

A. HALL.

R. PUMPELLY.

L. M. RUTHERFORD.

Committee.

July 27, 1885.

PRESENTATION OF FIRST LAWRENCE SMITH MEDAL.

In December, 1887, the committee on the Smith fund unanimously recommended that the first J. Lawrence Smith medal be awarded to Prof. Hubert A. Newton, of New Haven, Connecticut, in recognition of his eminent services in the investigation of the orbits of meteors. This recommendation was adopted by the Academy at the April meeting, 1888, and at a public session, held on the evening of April 18, 1888, the first Smith medal given by the Academy was presented to Professor Newton by the president, who, in a short address, gave the reasons for its award.

The report of the committee is as follows:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

Professor Newton's study of the subject extends over a long series of years, and has led to results of very great popular interest as well as scientific importance. Meteors in the sense in which the word is now used have from the remotest ages attracted the attention of mankind. Observations of greater or less value have long been accumulating. Chemistry had shown that meteoric bodies which fall upon the earth contain no element not already known as a constituent of the

crust of the earth, but astronomy had not yet brought the wanderers of the heavens into a system and shown that they are moving in definite orbits, and are not distributed by chance in the celestial spaces. Professor Newton's first paper was published in 1860, and was succeeded by a number of others, the last having been read to the National Academy, in April of the present year.

From a careful analysis of the early observations of the archives, going back to the year 902, as well as of modern observations, Professor Newton showed that the connection between the November star showers of 1799 and 1833 had been concealed by the fact, that the day of the shower was moving from October 12, A. D. 902 to November 13, 1833. The shower was thus traced back over 900 years, and the persistence of this 33-year period was distinctly shown. It was also proved that the paths in which the meteors are moving about the sun must be one of five sharply defined orbits. A method of deciding which one of these orbits was the true one was suggested. Professor Adams of Cambridge (England) then showed in the manner indicated which orbit was the correct one, and so prepared the way for proving beyond question, as soon as Oppolzer published the orbit of the comet of 1886, that this comet and the November meteors belong to one system. Schiaparelli had just shown that the August meteors belonged to the same system as another comet.

In a memoir on shooting stars, published in the memoirs of the National Academy (read August 6, 1864), Professor Newton for the first time proved that the orbits of these bodies are not approximately circular like those of the planets, but that they resemble more the parabolic orbits of comets. This was the first step towards the establishment of a relationship between comets and meteors. In the same memoir, Professor Newton undertook to show how many shooting stars enter the air each day. The result of the discussion was the number 7,500,000, but later observations increase this number materially, and perhaps even double it. Another interesting and suggestive question also considered was this: As the earth moves round the sun, how thickly filled with meteorites is the space which it traverses? To this question, the answer given is, as a first approximation, 13,000 in each unit of space of the size of the earth itself.

In a subsequent paper, Professor Newton made an attempt to determine whether comets come originally from the solar system or from outside of it. The investigation was based upon the observed facts, and the results obtained are still under consideration by astronomers. The argument that the meteoric stones of our cabinets were all fragments of comets was again brought out in a lecture delivered at the Sheffield Scientific School. This again was followed by a paper on the effect upon the earth's velocity produced by small bodies passing near the earth. In this paper, it is shown that while small bodies which pass

near the earth, but do not meet it, have a real effect in stopping the earth or the moon, this effect is much too small to be sensible.

In a discussion of the Biela meteors of November 27, 1885, Professor Newton, among other facts, brought out the very interesting and important one, that the meteors left the comet since 1840, and that the disintegration of the comets furnishing meteor streams is a more rapid process than has been usually supposed.

Finally, in a paper read before the National Academy of Sciences, April 19, 1888, Professor Newton has established the following propositions:

(1) The meteorites which we have in our cabinets, and which were seen to fall, were originally (as a class, and with a very small number of exceptions) moving about the sun in orbits that had inclinations less than 90° ; that is, their motions were direct and not retrograde.

(2) The reason why we have only this class of stones in our collections is not one wholly or even mainly dependent on the habits of men, nor on the times when men are out of doors, nor on the places where men live, nor on any other principle of selection acting at or after the arrival of the stones at the ground. Either the stones which are moving in the solar system across the earth's orbit move, in general, in direct orbits, or else, for some reason, the stones which move in retrograde orbits do not in general come through the air to the ground in solid form.

(3) The perihelion distances of nearly all the orbits in which these stones moved were not less than 0.5 nor more than 1.0, the earth's radius vector being unity.

In the judgment of the committee, these researches are of a very high order of merit and of interest.

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