Elias Loomis

PROFESSOR OF NATURAL PHILOSOPHY AND ASTRONOMY
IN YALE COLLEGE.

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PROFESSOR ELIAS LOOMIS.*

Elias Loomis was born in the little hamlet of Willington, Conn., August 7th, 1811. His father, the Rev. Hubbell Loomis, was pastor in that country parish from 1804 to 1828. He was a man possessed of considerable scholarship, of positive convictions, and of a willingness to follow at all hazards wherever truth and duty, as he conceived them, might lead. He had studied at Union College, in the class of 1799, though apparently he did not finish the college course with his class. He is enrolled with that class in Union College, and he also received, in 1812, the honorary degree of Master of Arts from Yale College. At a later date he went to Illinois, and there was instrumental in founding the institution which afterwards became Shurtleff College.

Although the boy inherited from his father a mathematical taste, yet his love for the languages also was shown at a very early age. At an age at which many bright boys are still struggling with the reading of English, he is reported to have been reading with ease the New Testament in the original Greek. He prepared for college almost entirely under the instruction of his father. He was, for a single winter only, at the Academy at Monson, Mass. Owing in part to feeble health he was more disposed, in those early years, to keep to his books than to roam with other boys over the Willington hills. In his later life he frequently said that in his early days he never had a thought of asking what subjects he was most fond of, but studied what he was told to study.

At the age of fourteen he was examined and was admitted to Yale College, but owing to feeble health he waited an-

* An extract from a memorial address prepared by Professor H. A. Newton and delivered in Osborne Hall April 11, 1890, at the request of the President and Fellows of Yale University.

other year before actually entering a class. In college he appears to have been about equally proficient in all of the studies, taking good rank as a scholar, and maintaining it through his college course. President Porter remembers well the retiring demeanor of the young student, and his concise and often monosyllabic expressions, peculiarities which he retained through life. During his Junior and Senior years he roomed with Alfred E. Perkins, whose bequest was the first large endowment of the College Library. He graduated in 1830.

A few weeks before graduation he left New Haven and entered a school, Mount Hope Institute near Baltimore, to teach mathematics, and he remained there for a year and a term. One of his classmates, the late Mr. Cone of Hartford, said that Mr. Loomis had intended to spend his life in teaching, and that it surprised him when he heard that this purpose was abandoned and that Mr. Loomis had gone, in the Autumn of 1831, to the Andover Theological Seminary with the distinct expectation of becoming a preacher. This new purpose was, however, again changed when a year later he was appointed Tutor in Yale College. A vacancy in the Tutorship occurred in the May following (1833) and while not yet twenty-two years of age he returned to New Haven and entered upon the duties of the office. Here he remained for three years and one term. In the spring of 1836 he received the appointment to the chair of Mathematics and Natural Philosophy in Western Reserve College, at Hudson, Ohio. He was allowed to spend the first year in Europe. He was therefore, during the larger part of the year 1836-7, in Paris attending the lectures of Biot, Poisson, Arago, Dulong, Pouillet and others. He did not visit Germany because of want of money. A long series of letters written by him at this time appeared in the Ohio Observer, and the contrast between England and France as he saw them, and the same places as seen by the tourist to-day is decidedly interesting.

He purchased in London and Paris apparatus for his professorship, and the outfit for a small Observatory, and in the Autumn of 1837 began his labors at Hudson. Here he remained for seven years, maintaining with unflagging perseverance both his work in teaching and his scientific labors. In judging of this work at Hudson we must remember that

he was not with perfect surroundings. He was without an assistant and without the counsel and encouragement of associates in his own branches of science. The financial troubles which culminated in this country in 1837 were peculiarly severe upon the young and struggling College. Money was almost unknown in business circles in Ohio, trade being almost entirely in barter. In this way principally was paid so much of the promised salary of $600 per annum as was not in arrears. In one of his letters he congratulates himself that all of his bills that were more than two years old had been paid. In another he says that there was not enough money in the College treasury to take him out of the state. When he left Hudson the College offered to pay at once the arrears of his salary by deeding to him some of its unimproved lands.

In 1844 he was offered, and he accepted, the office of Professor of Mathematics and Natural Philosophy in the University of New York. In this new position he undertook the preparation of a series of text books in the Mathematics, and for some years a large part of the time which he could spare from his regular college work was given to the the preparation of these books.

When Professor Henry resigned his professorship at Princeton in order to accept the office of Secretary of the Smithsonian Institution, Professor Loomis was offered the vacant chair. He went to Princeton and remained there during one year, at the end of which he was induced to return again to his old place in the University of New York. Here he continued until 1860, when he was elected to the Professorship in Yale College made vacant by the death of Professor Olmsted. For the last twenty-nine years of his life, he here labored for the College and for science, passing away on the 15th of August, 1889.

Let us look now in succession at the different lines of his activity during these fifty-six years,—four here in the tutorship and in Europe; seven at Hudson, Ohio; sixteen in New York City and Princeton, and twenty-nine in New Haven.

For the first year on returning from Andover to New Haven, he was tutor in Latin, although it seems that he might, had he chosen it, have been tutor of Mathematics. I believe that at the beginning his mind was not yet definite-

ly turned towards the exact sciences. In his childhood he had taken specially to Greek. In college he was equally proficient in all of his studies. He is represented to have led his class at Andover in Hebrew, and now on entering the tutorship he chose to teach the Latin language and literature. During the second year he taught Mathematics, and the third year Natural Philosophy. His later success in scientific work was, I believe, in no small measure due to his earlier broad and thorough study of language.

I have made some inquiry in order to learn what it was that turned his attention and tastes towards science. One of his colleagues in the tutorship, the Rev. Dr. Davenport, says that he recollects very distinctly the first indication to his own mind that Tutor Loomis was turning his thoughts in this direction. The great meteoric shower of 1833 came early in the period of his tutorship, and the views of Professor Twining and Professor Olmstead about the astronomical character and origin of these interesting and mysterious bodies were a common topic of conversation among scientific men in the College, especially wherever Professor Olmsted was present. The tutors were accustomed to meet as a club from time to time in the tutors' rooms in turn, and Dr. Davenport well recollects the occasion when Tutor Loomis brought in a globe and discussed before the club the new theories about these bodies. Up to this time Tutor Loomis had seemed to him to have given his thoughts and study to language rather than to science.

In January, 1834, there were constituted in the Connecticut Academy of Arts and Sciences twelve committees representing the several departments of knowledge, and Tutor Loomis was put on the Committee on Mathematics and Natural Philosophy. These are the only signs of scientific taste or activity which I have detected earlier than the autumn of 1834, after he had been a year and a term in the tutorship. From this time on to the end of his life, he gave his time and energies to several subjects that are enough distinct one from the other to make it convenient to disregard a strictly chronological account of his labors, and consider his work in each subject by itself.

A subject of which he early undertook the investigation was *Terrestrial Magnetism.* We often use the rhetorical

phrase, "True as the needle to the pole," but looked at carefully, the magnetic needle is anything but constant in direction; like the weather vane on the steeple, it is ever in motion, swinging back and forth, in motions minute and slow, it is true, but still always swinging. It has fitfully irregular motions;—it has motions with a daily period;—motions with an annual period; and motions whose oscillations require centuries for completion.

The *daily* motions of the magnetic needle were those which Tutor Loomis first studied. At the beginning of the second year of his tutorship he set up by the north window of his room in North College a heavy wooden block, and on it the variation compass that belongs to the College. Here for over thirteen months he observed the position of the needle at hourly intervals in the daytime, his observations usually being for seventeen successive hours of each day.

The results of these observations, together with a special discussion of the extraordinary cases of disturbance, were published in the American Journal of Science in 1836. No similar observations of the kind made in this country had at that time been published. So far as I am aware none made before 1834 have since been published, except ten days' observations made by Professor Bache in 1832. In fact, I know of only two like series of hourly observations made in Europe earlier than those by Tutor Loomis. He also at this time formed the purpose of collecting all the observations of magnetic declination that had been hitherto made in the United States, and of constructing from them a magnetic chart of the country. He appealed successfully to the Connecticut Academy of Arts and Sciences for its sympathy and aid. The work of collecting facts was so far advanced before leaving New Haven that when he had been a few months Professor at Hudson he forwarded to the American Journal of Science a discussion of the observations thus far obtained, and with them a map of the United States, with the lines of equal deviation of the needle drawn upon it. Two years later he published additional observations and a revised edition of this map.

These were the first published magnetic charts of the United States, and though the materials for their construction were not numerous, and in many cases those obtainable

were not entirely trustworthy, yet sixteen years later, when a map was made by the United States Coast survey from later and more numerous data Professor Bache declared that between his own new map and that of Professor Loomis, when proper allowance had been made for the secular changes, the "*agreement was remarkable.*"

The northern end of a perfectly balanced magnetic needle turns downward, and the angle it makes with the horizon is called the magnetic *dip*. This angle is an important one, and is observed with accuracy only by using an expensive instrument, and taking unusual pains in observing. Hence only a few observations of this element were found by Professor Loomis. From these, however, he ventured to put on his first magnet map a few lines that exhibited the amount of the *dip*.

While he was in Europe he purchased a first class dipping needle, for Western Reserve College, and at Hudson and the neighborhood in term time, and at other places in vacation, he made observations with this needle. Some of these observations were made before his second magnetic chart was published, and upon this map were now given tolerably good positions of the lines of equal magnetic dip. But he continued his observations for several years, determining the dip at over seventy stations, spread over thirteen states, each determination being the mean of from 160 to over 4,000 readings. These observations were published in several successive papers in the transactions of the American Philosophical Society at Philadelphia.

Various papers on terrestrial magnetism, in continuation of his earlier investigations, appeared in 1842, in 1844, in 1847, and in 1859, but movements in Germany, England and Russia had meanwhile been inaugurated which led to the establishment by governments of a score of well equipped magnetic observatories, and this subject passed largely out of private hands.

Closely connected with terrestrial magnetism, and to be considered with it, is the *Aurora Borealis*. In the week that covered the end of August and the beginning of September, 1859, there occurred an exceedingly brilliant display of the Northern lights. Believing that an exhaustive discussion of a single aurora promised to do more for the promotion of

science than an imperfect study of an indefinite number of them, Professor Loomis undertook at once to collect and to collate accounts of this display. A large number of such accounts were secured from North America, from Europe, from Asia, and from places in the Southern Hemisphere; especially all the reports from the Smithsonian observers and correspondents, were placed in his hands by the Secretary, Professor Henry.

These observations and the discussions of them were given to the public during the following two years, in a series of nine papers in the American Journal of Science.

Few, if any, displays on record were as remarkable as was this one for brilliancy or for geographical extent. Certainly about no aurora have there been collected so many facts. The display continued for a week. The luminous region entirely encircled the North Pole of the earth. It extended on this continent on the 2d of September as far south as Cuba, and to an unknown distance to the north. In altitude the bases of the columns of light were about fifty miles above the earth's surface, and the streamers shot up at times to a height of five hundred miles. Thus over a broad belt on both continents this large region above the lower atmosphere was filled with masses of luminous material. A display similar to this, and possibly of equal brilliancy, was at the same time witnessed in the Southern Hemisphere.

The nine papers were mainly devoted to the statements of observers. Professor Loomis, however, went on to collect facts about other auroras, and to make inductinos from the whole of the material thus brought together. He showed that there was good reason for believing that not only was this display represented by a corresponding one in the Southern Hemisphere, but that all remarkable displays in either hemisphere are accompanied by corresponding ones in the other.

He showed also that all the principal phenomena of electricity were developed during the auroral display of 1859; that light was developed in passing from one conductor to another, that heat in poor conductors, that the peculiar electric shock to the animal system, the excitement of magnetism in irons, the deflection of the magnetic needle, the decomposition of chemical solutions, each and all were produced

during the Auroral storm, and evidently by its agency. There were also in America effects upon the telegraph that were entirely consistent with the assumption previously made by Walker for England, that currents of electricity moved from northeast to southwest across the country. From the observations of the motion of auroral beams, he showed that they also moved from north-northeast to south-southwest, there being thus a general correspondence in motion between the electrical currents and the motion of the beams.

When there is a special magnetic disturbance at any place, there is usually a similar one at all other neighboring places. But these disturbances do not occur at the several places at the same instant of time. Professor Loomis showed that in the United States they take place in succession as we go from northeast to southwest, the velocity of the wave of disturbance being over one hundred miles per minute. The waves of magnetic irregularities were thus connected with the electrical current and with the drifting motions of the streamers in the auroral display.

As incident to this discussion, he collected all available observations of auroras, and he deduced from them the annual number of auroras visible at each place of observation. These numbers, when written upon a chart of the Northern Hemisphere, showed that auroras were by no means equally distributed over the earth's surface. It was found that the region in which they occurred most frequently was a belt or zone of moderate breadth and of oval form, enclosing the North Pole of the earth, and also the North Magnetic Pole. It was therefore much farther south in the Western hemisphere than in the Eastern. Along the central line of this belt there are more than eighty auroras annually, but on going either north or south from the central line of that belt the number diminishes.

In 1870 Professor Loomis published a paper of importance relating to terrestrial magnetism, in which he showed its connection and that of the aurora with spots on the sun. That the spots on the sun had periods of maxima and minima development had long been known. Lamont had noticed a periodicity in the magnetic diurnal variations. Sabine and Wolf and Gauthier had noticed that the two peri-

odicities were allied. The connection of the period of solar spots with conjunction and opposition of certain planets had been shown by De La Rue and Stewart. Professor Loomis undertook an exhaustive examination of the facts that tended to confirm or refute the propositions that had been advanced. He confirmed and added to the conclusions of Messrs. De La Rue and Stewart. He also brought together such facts as were relevant to the question, and he showed that the regular diurnal variations of the magnetic needle were entirely independent of the solar spots, but that those disturbances that were excessive in amount were almost exactly proportional to the spotted surface of the sun. He also showed that great disturbances of the earth's magnetism are accompanied by unusual disturbances on the sun's surface on the very day of the storm.

Various forms of periodicity in the aurora have frequently been suggested. Professor Loomis, from all available accounts of the aurora, was able to show that while in the center of the zone of greatest auroral frequency auroras might be visible nearly every night, and hence that periodicity could not easily be shown by means of numbers of anroras recorded in such places, yet that such periodicity was distinctly traceable at places where the average number seen was about twenty or twenty-five a year. The times of maxima and minima of the solar spots were seen to correspond in a remarkable manner with the maxima and minima in the frequency of auroral displays in these middle latitudes. Also from the daily observations made by Messrs. Herrick and Bradley at New Haven during seventeen years, he concluded that auroral displays in the middle latitudes of America are generally accompanied by an unusual disturbance of the sun's surface on the very day of the aurora. The magnetism of the earth, the Aurora Borealis, and the spots on the sun, have thus all three a causal connection, and apparently that connection is closely related to the conjunctions and oppositions of certain planets.

Shortly after the publication of this memoir, Professor Lovering published his extensive catalogue of auroras. A further discussion of the periodicity of the auroras was undertaken by Professor Loomis and published in 1873. In this he made use of all the auroras recorded in Professor

Lovering's catalogue. They confirmed his previous conclusions, only slight modifications being required by the new facts presented, and by their more systematic collation.

In these papers, as in most of his papers upon other subjects, Professor Loomis was ever intent upon answering the questions: What are the laws of nature? What do the phenomena teach us? To establish laws which had been already formulated by others, but which still needed confirmation, was to him equally important with the formulation and proof of laws entirely new.

Let us now turn to another important line of Professor Loomis' work,—*Astronomy*. As I have said, he was early interested in the shooting stars. In October, 1834, he read a paper before the Connecticut Academy of Arts and Sciences upon this subject, probably in substance that which was shortly afterward published in this Journal.* The published paper is principally a restatement of the observations made in Germany in 1823 by Brandes in concert with his pupils for determining the path of the stars through the atmosphere, together with methods of computation. From the results of Brandes' observations, however, he deduces an argument for the cosmic character of the shooting stars. One month after reading this paper to the Connecticut Academy he engaged in similar concerted observations with Professor Twining, who was then residing near West Point, N. Y. These were only moderately successful, but they were the first observations of the kind undertaken in America.

During the senior year of his college course there arrived at New Haven the five-inch telescope, given to the college by Mr. Sheldon Clark, constructed by Dolland. This instrument was much larger than any telescope then in the country. It was temporarily placed in the Athenæum tower, where it was mounted on castors and wheeled to the windows for use. This temporary abode it occupied, however, for over thirty years. In spite of its miserable location it was, in the decade following its installment, a power in the development of the study of Astronomy in the college. The lives and works of Barnard, and Loomis, and Mason, and Herrick, and Lyman, and Chauvenet, and Hubbard, and of other graduates of the college prove this. What rich returns for Mr. Sheldon Clark's twelve-hundred-dollar investment!

* American Journal of Science and Arts.

In 1835 the return of Halley's comet had been predicted, and its appearance was eagerly expected by astronomers and the public: Professor Olmstead and Tutor Loomis first in this country caught sight of the stranger, and throughout its course they noted its physical appearances. With such means as he had at command Mr. Loomis observed the body's place, and computed from his observations the orbit.

The latitude and longitude of an Observatory are constants to be early determined. These were measured by President Day for Yale College in 1811. In the summer of 1835 Tutor Loomis, with such instruments as the College possessed, a sextant and a small portable transit, made numerous observations of Polaris for latitude, and several moon culminations for longitude. From these he computed the latitude and longitude of the Athenæum tower. The longitude from Greenwich, though obtained from a small number of observations, differs less than two seconds of time from our best determinations to-day. While in Europe in 1836–37 Professor Loomis, as I have said, bought for Western Reserve College the instruments for an Observatory. These were a four-inch equatorial, a transit instrument, and an astronomical clock. On his return he erected, in 1837, a small Observatory at Hudson, and in September, 1838, began to use the instruments. He had no assistant, and by day had a full allotment of college work. Two hundred and sixty moon culminations and sixteen occultations observed for longitude, sixty-nine culminations of Polaris for latitude, along with observations on five comets, sufficiently extended for a computation of their orbits; these attested his activity outside of his required duties. Some years later, when the corresponding European observations were made public, he prepared an elaborate discussion of these longitude observations, and published it in *Gould's Astronomical Journal.* A sixth comet was observed by him at Hudson in 1850.

It may not seem a very large output of work in six years' time to have determined the location of the observatory, and to have observed five comets. But we must recollect that the telegraph had not then been invented, that the exact determination of the longitude of a single point in the Western country had a higher value then than it can have now, and that it could be obtained only by slow and tedious

methods. These were, moreover, days of small things in astronomy in this country. At Yale College we had a telescope but not an Observatory. At Williamstown an Observatory had been constructed, but it was used for instruction, not for original work. At Washington Lieutenant Gilliss, and at Dorchester Mr. Bond, were commissioned by the government in 1838 to observe moon culminations in correspondence with the observers in the Wilkes exploring expedition for determining their longitude. These two prospective sets of observations, both of them under government auspices and pay, were the only signs of systematic astronomical activity in the United States outside of Hudson, when in 1838 Professor Loomis began his observing there.

In his Inaugural Address he asks: "Where now is our American Observatory? Where throughout this rich and powerful nation do you find a single spot where astronomical observations are regularly and systematically made? There is no such spot." When he left Hudson in 1844 the situation was not largely changed. Mr. Bond had removed his instruments and work to Cambridge. The High School Observatory at Philadelphia had been erected and Messrs. Walker and Kendall were using its instruments. Professor Bartlett had built the Observatory at West Point, and had begun to observe there. Lieut. Gilliss, after years of excellent work in the little establishment on Capitol Hill, had just finished the present Naval Observatory building at Washington, Professor Mitchel had begun to build the Cincinnati Observatory, and the Georgetown Observatory building had been erected. Professor Loomis's work at Hudson should be measured by what others were doing at the time, rather than by the larger performance of to-day.

In the summer of 1844, the year in which Professor Loomis came to New York, a new method in astronomy had its first beginnings. The telegraph line had just been built between Baltimore and Washington, and Capt. Wilkes at Baltimore compared his chronometer by telegraph with one at Washington, and so determined the difference of longitude of the two places.

Professor Bache was now Superintendent of the Coast Survey, and he determined at once to use the new method for the purposes of the survey. To Mr. Sears C. Walker

was committed the direction of the work, but scarcely less important were the services of Professor Loomis, who for three campaigns had charge of the end of the lines in Jersey City and New York. Their first partially successful efforts were made in 1846, but the practical difficulties were overcome and entire success was obtained by them in 1847 and 1848. In these years the differences of longitude of Washington, Philadelphia, New York and Cambridge were thus determined with an accuracy far greater than any previous similar determination whatsoever.

The next summer, that of 1849, Professor Loomis assisted in a like work to connect Hudson, Ohio, with the eastern stations. His observations of moon culminations at Hudson were thus available equally with those made at Philadelphia, Washington, Dorchester and Cambridge for determining the absolute longitudes of Atlantic stations from Greenwich. It was not until 1852 that European astronomers began to use these telegraphic measuring longitudes.

In 1850 Professor Loomis published a volume on the *Recent Progress of Astronomy, especially in the United States.* A first and a second edition were soon exhausted, and in 1856 the volume was entirely rewritten and very much enlarged. Some of the topics in these volumes were the subjects of articles communicated from time to time to the public in this Journal, *Harper's Magazine*, and other periodicals. Another important contribution to astronomy appeared in 1856, that is, his *Introduction to Practical Astronomy*. Eminent astronomers in England and America have expressed in the highest terms their praise of this book. Though it is now thirty-five years since its first appearance, and many treatises on the same subject, some elaborate and some elementary, have since been published, yet for an introduction to practical work I believe that a student will find this volume better than any other for his uses at the beginning of his course.

The increase of our knowledge in Astronomy was, from first to last, an object of special interest to Professor Loomis. Before he left New York the income from his text-books enabled him to make to Yale College the generous offer of coming to New Haven and working in an Observatory at his own charges, provided a suitable Observatory should be con-

structed and equipped for him. Unfortunately, the college was not able, although it was greatly desirous of doing it, to avail itself of his generous offer. Near the same time he joined with public-spirited citizens of New York in an effort to establish an astronomical Observatory in or near that city, and for that purpose an act of incorporation was obtained from the New York State Legislature. After coming to New Haven, he always took the warmest interest in the plans of Mr. Winchester for the establishment of an Observatory in connection with Yale University. His counsel and assistance have been instrumental, more than the public could know, in producing and preserving whatever of value has been developed in that Observatory.

PHOTOGRAPHS OF THE SURFACE OF MARS.

WM. H. PICKERING.

For THE MESSENGER.

A box of photographs has recently been received from Mr. Wilson, and contains among other things a number of negatives of the planet Mars. Seven views were taken April 9, between $22^h\ 56^m$ and $23^h\ 41^m$, Greenwich mean time. Seven more were taken April 10, between $23^h\ 20^m$ and $23^h\ 32^m$. Thus the same face of the planet was presented in both cases. Distinct and identifiable spots and markings are well shown in all the pictures, but in those taken on the latter date a considerable accession is shown to the white spot surrounding the south pole. It has been known for years that the size of these polar spots varied gradually from time to time, apparently diminishing in the summer, and increasing in the winter of their respective hemispheres. But I believe that this is the first time that the precise date, and approximate extent of one of these accessions has been observed. The area affected stretches from the terminator, which at this time was in long. 70°, along parallel — 30° to longitude 110°, thence to longitude 145°, latitude — 45°; thence to the limb which was in latitude —85° an the 120° meridian, and thence back to the point of starting. It may thus extend also over an unknown area on what was at that time the invisible hemisphere of the planet. The visible area included