MEMOIR

OF

JOSEPH WINLOCK.

1826–1875.

BY

JOSEPH LOVERING.

READ BEFORE THE NATIONAL ACADEMY, APRIL 19, 1876.

BIOGRAPHICAL MEMOIR OF JOSEPH WINLOCK.

PROFESSOR JOSEPH WINLOCK was born in Shelby County, Kentucky, on February 6, 1826. He died, suddenly, at Cambridge, Mass., in all the strength of his manhood, and at the height of his usefulness, on June 11, 1875. The day before that of his death, he was at his usual work, with no warning of his impending fate except from a sense of increasing lassitude which he had felt for several weeks.

His grandfather, a Virginian by birth, was General Joseph Winlock, who joined the American army, at the outbreak of the Revolution, when he was only eighteen years of age. He served at first as a private, and was afterwards promoted to the rank of ensign, lieutenant, and captain. He was engaged in the battles of Germantown, Brandywine, Monmouth, etc., and was with Washington at Valley Forge. In 1787, he married Miss Stephenson of Virginia, and settled in Kentucky, where he was employed in surveying and entering land. He was sent to the Convention which framed the Constitution of Kentucky, and, afterwards, for some years to the State Senate. He commanded the troops of the State which were ordered out to intercept the expedition of Aaron Burr in 1806. In the war of 1812, he held the rank of Brigadier-General, and went with three regiments to Vincennes.

His son, Fielding Winlock, the father of Professor Winlock, was born in Kentucky on May 4, 1787. He studied law, at first in the office of Felix Grundy, and, after Mr. Grundy's removal to Nashville, in the office of Henry Clay. During the preparations for the War of 1812, he was clerk of the committee of the State Senate on military affairs, performing also many of the duties of Adjutant-General. He left this position to serve in the army as aid to his father, and, in the campaign which ended with the defeat of Proctor and Tecumseh, on General Shelby's staff. After the war he held, at different times, various places of honor and trust, and died at the advanced age of eighty-five.

Professor Winlock was educated at Shelby College, Kentucky, where he graduated in 1845. At this early age his tastes and acquirements were conspicuous; and he received immediately the appointment of Professor of Mathematics and Astronomy in that institution. He devoted his first savings to the purchase of a set of the *Astronomische Nachrichten;* and, in order to be able to read it, he rose early in the morning to talk German with a rude laborer upon his father's farm, before the day's work began. Fortunately for himself and for science, he attended the fifth meeting of the American Association for the Advancement of Science, which was held at Cincinnati in the spring of 1851. It is not among the least of the advantages of this association that it brings into notice young men of promise who might otherwise live and die in obscurity, revealing to themselves as well as to others, by comparison, their rare intellectual endowments. In this case, the chief of American mathematicians recognized, in the Kentucky professor, one who had mastered and enjoyed his own highly condensed treatises, however distasteful they may have been to commonplace students and teachers. This happy conjunction of kindred minds resulted in bringing Mr. Winlock to Cambridge in 1852. Cambridge was, at that time, the headquarters of the American Ephemeris and Nautical Almanac; a great work, ordered by Congress in the Act of March 3, 1849, and placed under the superintendence of Lieutenant (now Admiral) C. H. Davis. Mr. Winlock joined the able corps of computers, on whose ability and fidelity the life of the Almanac depended, and remained in this service until 1857, when he was appointed Professor of Mathematics in the United States Naval Observatory at Washington. He had been in this new position for only a short time when he was made Superintendent of the Ephemeris and Almanac, and returned to Cambridge.

He vacated this post in 1859, and removed to Annapolis, where he had charge of the mathematical department in the United States Naval Academy. Soon after the removal of the Academy to Newport, in consequence of the war of secession, he was again made Superintendent of the Ephemeris and Almanac, and lived in Cambridge. During his long though interrupted connection with this national work, which has contributed largely to the cultivation as well as to the credit of mathematics and astronomy in this country, he made many valuable contributions to it, among

which that of his carefully prepared Tables of Mercury was the most important.

In 1866, with no effort on his part, he received the appointment of Phillips Professor of Astronomy in Harvard College, and Director of the Observatory. To his titles was afterwards added that of Professor of Geodesy in the Lawrence and Mining Schools of the College. While he was Professor at Shelby College, he had made himself familiar with the construction and manipulation of the equatorial telescope. An excellent Merz instrument of this description, having a focal length of $9\frac{1}{2}$ feet and an aperture of $7\frac{1}{2}$ inches, was the property of that institution, and was afterwards borrowed by Mr. Winlock, and mounted at Cambridge, for a time, for his private use. With this exception, his scientific labors had been exclusively in the way of the higher mathematics, either as teacher or computer. It was not until he was relieved from the work of routine, and became Director of the Observatory at Harvard College, that he had an opportunity to develop and manifest his remarkable mechanical ingenuity and genius for invention. An ample and deserved tribute is paid to the memory and the services of the two lamented Bonds (the father and the son), when it is remembered that their lives, consecrated to astronomy, founded the Observatory, and won for it the sympathy and support of the community. Affection for them, and respect for their disinterested zeal, inspired the liberal endowments which strengthened its early growth. Because the men were there, the institution was born and lived. The buildings and equipments of the Observatory, under its first directors, put to shame many similar establishments in Europe. The possession of a magnificent refractor, equatorially mounted, approached by a skilfully devised observer's chair, and accommodated under an immense dome which was moved with marvellous ease, contrasted favorably with deficiencies in instruments and machinery at older observatories, and gave to the one at Cambridge, at once, a name and a rank among the best in the world. With delicacy and disinterestedness of feeling, eminently characteristic of Mr. Winlock, his first thought, on assuming the duties of Director, was for the reputation of his predecessors, with which the reputation of the Observatory was intimately associated. As rapidly as the resources of the Observatory permitted, he provided for the reduction and publication of their unfinished work. Thus

the Annals of the Observatory have been enriched by a volume on Sun-Spots, and others on a catalogue of Zone-Stars. Another is yet to appear containing a catalogue of Polar and Clock Stars.

But it was impossible for the Observatory to maintain its high standing and remain stationary, while the old observatories elsewhere were remodelled, refurnished, and prepared to start upon a new career; and young observatories, richly appointed, were springing up in both hemispheres. The inventory of instruments, at the disposal of the Bonds, comprised the large equatorial, a five-foot equatorial, a four-foot transit-circle, a Bond clock and chronograph, two chronometers, and a set of Lloyd magnetometers for obtaining the elements of the earth's magnetism. During the nine years of Mr. Winlock's vigorous administration, the instrumental appliances of the Observatory were strengthened in all directions. A seven-foot equatorial by Clark, another Bond chronograph, a Bond standard-clock with break-circuit attachment for transmitting time-signals, a Frodsham sidereal clock, a Frodsham *break-circuit* sidereal chronometer (the original device of Mr. Winlock), a mean-time chronometer, a thermometric chronometer, a photographic telescope of long focus, a Russian transit, made in the workshop of the Pulkowa Observatory, a Zöllner astrophotometer, a large Ruhmkorff coil, various spectroscopes and self-recording meteorological instruments; all this rapid increase of resources, while it added to the power, greatly multiplied the responsibilities of the Director. The costly transit-circle, though constructed upon the best models and by the most excellent artists, had always proved a failure and a disappointment; as Mr. Bond supposed, from fatal injuries which it received in its transportation. Though it was useful as a transit-instrument, implicit reliance could not be placed in it as a circle. The consequence was, that the great equatorial was too frequently called away from its legitimate work to do the duties which belonged properly to the circle. Mr. Winlock was not long in inspiring the friends of the Observatory with that large measure of confidence in his capacities and his sound judgment which prompted them to contribute over $12,000 for the purchase of a new meridian circle. In the autumn of 1867, Mr. Winlock went to Europe, and spent four months in visiting the principal observatories, and acquainting himself with the latest improvements in instruments, and especially in circles. Having studied the

advantages and the defects in the highest class of meridian instruments, he blindly copied no one of them; but suggested valuable modifications, with the view of securing greater stability, increased precision of movement, and the most complete facility of observation. The improvements which he suggested were warmly approved and promptly adopted by the artists whom he preferred, Troughton and Simms of London; his modifications of the old construction have been fully justified by the results since the new circle has been put to work, and other astronomers have given the best indorsement by copying them. The eminent astronomer and mathematician, J. C. Adams, now President of the Royal Astronomical Society, ordered a circle from the same artists and of the same pattern for Cambridge, in England. In November, 1870, when the new instrument was ready for use, Mr. Winlock turned it upon the zone of stars between 50° and 55° of north declination. When the whole field of observation was divided between the different members of the *Astronomische Gesellschaft*, this was the share which fell to the Observatory of Harvard College. Already 15,000 observations have been made upon the zone-stars, and in two years more the great work will be completed. In 1867, Mr. Winlock had directed a series of observations with the old meridian circle for the purpose of obtaining an extended list of accurately placed time-stars. The utility of a larger catalogue of time-stars had been evidenced in the operations for the determination of longitude conducted by the United States Coast Survey, of which Mr. Winlock was consulting astronomer. These observations, which assigned exact places to stars only two minutes apart in right-ascension, but differing widely in declination, were finished in December, 1868, and have been reduced and printed. In 1871–72, the same stars were reobserved with the new circle, and again for the third and fourth times in 1874 and 1875. An additional set of stars is required for the instrumental constants, expressing errors in azimuth, collimation, level, etc. For this purpose 5000 observations were made with the new circle in 1873 and 1874, intended to serve as the basis of an improved catalogue of polar stars, and they are now ready for publication. Therefore, no time has been wasted in reaping the full benefits of the new instrument, although the 30,000 observations already made with it are only the first-fruits of the happy devices of Mr. Winlock. These materials, to

which must be added a catalogue of new double-stars, dissected by the great refractor, and a most laborious and exhaustive work upon stellar photometry, will magnify the forthcoming volumes of the Annals of the Observatory, and be a worthy monument to the skill and perseverance of the Director and his gifted and faithful coadjutors.

In 1869, Mr. Winlock was instructed by Professor Benjamin Peirce, then Superintendent of the United States Coast Survey, to proceed to Kentucky at the head of a party destined to co-operate with officers of the survey in observing the total eclipse of the sun, on the 7th of August. Mr. Winlock gave his attention, particularly, to the physical aspects of the eclipse, examining the photosphere and the chromosphere with the spectroscope, and taking eighty photographs of the eclipse, in all its phases, seven of them during totality. It was his habit to think out every subject which engaged him for himself; and, when he acted, he seldom followed in the wake of other men. He found good reasons for rejecting the method of photographing which had been tried in Spain on occasion of the total eclipse of 1860, and which other American astronomers were preparing to imitate in 1869. As he wished, most of all, to secure a good picture of the corona, he placed the sensitive plates at the focus of the object-glass, thereby economizing the light, and avoiding the distortion by the eye-piece. His success was highly satisfactory. In the best of the pictures, he immediately recognized the fact that the corona was broader in the direction of the sun's equator than along the axis. He had arranged for obtaining numerous views of the partial phases of the eclipse, in the hope of extracting from them valuable information as to the use of photography in observing the transits of Venus. To this end, he was afterwards authorized by the Superintendent of the Coast Survey to engage Messrs. Alvan Clark and Sons to construct a micrometer, adapted to the nice measurement of distances and positions on the photographic plates. The Annals of the Observatory will contain a description and engraving of this micrometer, and an account of the measures made with it, with various representations of the eclipse copied from the photographs.

At this time, no one except Mr. Winlock had succeeded in obtaining a photograph of the corona during any solar eclipse. Although his photographs were only $\frac{3}{4}$ of an inch in diameter,

they seemed to promise measurements, made under a microscope, which would compare favorably with the best that could be furnished by meridian instruments. A larger image would be still better; but this required a telescope of formidable length, and difficult to manipulate. To surmount this obstacle, Mr. Winlock conceived the idea of a horizontal telescope, to be fed by the light from a heliostat. He was convinced that a transparent reflector would be better than a silvered mirror, as it would weaken the light, and supersede the necessity of making the time of exposure inconveniently short. Moreover, as the instantaneous action of the light was often sufficient, the heliostat was unnecessary. Soon after his return from Kentucky he gave an order to the Messrs. Clark and Sons for a lens of four inches in aperture and forty feet in focal length, which, after some preliminary trials at their shop, was ready for use at the Observatory in July, 1870; and, since then, has been in constant employment for procuring photographs of the sun. The lens is mounted upon one pier, the reflector upon another, and the camera upon a third pier. The tube used for excluding the daylight is disconnected from the essential parts, so as not to disturb their stability.

At the request of the Superintendent of the United States Coast Survey, Mr. Winlock organized and directed one of the parties sent to the south of Europe to observe the total eclipse of the sun on December 22, 1870. He selected Jerez de la Frontera, near Cadiz, as a favorable station, and was assisted by one experienced officer of the survey, by several eminent astronomers and physicists, and by one of his own staff at the Observatory. Among the physical and astronomical instruments which he prepared for this expedition was a lens of 32½ feet in focal length, to be used in the manner just described for instantaneous photographs. At this time, Mr. Winlock's method was widely known and highly appreciated, and every party which went into the field to observe this eclipse had decided to dispense with an eye-piece, and photograph in the focus of the object-glass. Unfortunately all the parties, European and American, failed, by reason of bad weather, in obtaining a picture of the corona, except the party in Spain; and there, also, the sky was not favorable for the best results. All the observers who went to India to photograph the total eclipse of 1871 preferred the same method, and were successful. Lord Lindsay applied it at

the Mauritius in connection with the horizontal telescope. A telescope of long focus is not a new thing; a telescope placed upon the ground is not a new thing; there is no novelty about the heliostat; more than one person may have discovered the advantage in photographing which belongs to telescopes of great focal length. Nevertheless, the adaptation to photographic purposes of a telescope of long focus, fixed horizontally, and used without an eye-piece or a heliostat, is original, and whatever merit there is in it belongs to Mr. Winlock.

In a former generation, an eclipse of the sun excited the interest of astronomers, as furnishing the means of verifying or correcting the dynamical theory, or giving differences of geographical longitude. It is the consolation of science, that as fast as old fields are exhausted new ones call loudly for cultivation. As soon as one question is settled and curiosity flags, another problem springs into life and a fresh interest is born. The old ambition to fit out a comet with its orbit has yielded to the passion for knowing more about its physical changes and constitution. Now that the law of gravitation asserts an unchallenged supremacy in the solar system, the complex structure of the sun and the origin of the solar radiations claim a share of the astronomer's attention. In this way physical astronomy has acquired a new meaning; and a physical as distinguished from an astronomical observatory, either under the same or an independent superintendence, is one of the necessities of to-day's astronomy. It has been largely in the interest of physical astronomy, in this new sense, that observers have traversed continents, crossed oceans, and taken up their quarters in desolate islands, wherever a total eclipse of the sun or the transit of Venus has invited them. Where special physical observatories have not been started, the old observatories must assume their work, but not to the prejudice of the preferred duties of an astronomical observatory. Mr. Winlock gave a liberal portion of his time to celestial spectroscopy, and stocked the Observatory with the requisite instruments, and of the best class. These little instruments divided with the larger ones the benefits of his inventive spirit. In his two eclipse expeditions, he provided abundantly for the spectroscopic examination of the sun's surroundings, catching the sun itself in the reversal of the lines, and witnessing other interesting transformations. The secret of his success lies in the direction of his rule

of having a definite idea of what he wished to do, and the best way of doing it, before going into the field. He went to Spain with the purpose of studying especially that fainter portion of the sun's corona which is outside the limits of the best photography. His experience in the Kentucky expedition had taught him that much valuable time is lost in the brief duration of totality, when the position of the dark or bright lines is registered by means of a scale which must be read and recorded at the time. To meet this difficulty, he invented the simple expedient of graving corresponding lines upon a silver plate, previously graduated by a few standard spectral lines. The differences could be leisurely measured at some future time. This improvement was promptly adopted by the English astronomers, and applied by them to the eclipse of 1870. Mr. Winlock was of opinion that his contrivance would be useful in observing the spectra of comets and nebulæ, and wherever the lines were faint. It might also be convenient for finding declination with meridian instruments. Another device was the use of a mirror to reflect the slit, and enable the observer to place it upon any part of the sun's image without the help of an assistant.

In January, 1854, the Hon. R. C. Winthrop, Chairman of the Committee of the Board of Overseers of Harvard College, appointed to visit the Observatory, reported that the Observatory time was sent to Boston for the regulation of marine chronometers, for the arrangement of railroads, and for the general convenience of the people through a large part of New England. He adds: "The importance of such a system to the business operations of the community can hardly be over-estimated." At this time the signals were sent to Boston by way of Watertown, Brighton, and Roxbury, a circuitous line of twelve miles in length, and the wires were often broken. In 1856, a loop connected the Observatory with the Fitchburg line, and was owned by it until 1862. This has, of course, been available for the occasional transmission of time; but it was designed for the determination of differences of geographical longitude, in connection with the United States Coast Survey; a service which began under the administration of the first Director, and has been continually expanding, until it has taken into its embrace the Pacific coast and the western shore of Europe. In 1866, the necessities of the Coast Survey demanded that the loop should be renewed between

the Observatory and the main lines of the country; and this was done at the expense of the survey. From its foundation, the Observatory, in one way or another, had furnished exact time to the community gratuitously; for which, elsewhere, observatories receive a liberal compensation. In 1872, Mr. Winlock introduced improvements which have made this service more widely and constantly useful, and at the same time remunerative. A contract was made for a special wire between Cambridge and Boston, which should not be diverted to any other business. An attachment to the mean-time clock of the Observatory interrupts the voltaic current once in each two seconds, omitting the last break of every minute, and the last thirteen breaks of every five minutes, so that there can be no mistake as to the identity of any second or minute. Branch wires unite the City Hall of Boston, the telegraph offices and railroad depots, and the principal clock and watch factories and warehouses with the first wire. In some places, an electro-magnetic clock is used, controlled by the Observatory clock; but a cheap vibrating armature is all which is necessary, and is generally employed. The superiority of the new system is here: clocks, watches, and chronometers can be compared with the best standard time, not merely once a day, but at any moment; and the public have appreciated and rewarded it. In one sense, it may be always said that time is money. In this instance, the Observatory time has opened so good a market that it has yielded a yearly income of $2000.

In 1872, Mr. Winlock began to prepare a series of astronomical engravings, which should represent, with sufficient accuracy, the most interesting objects in the heavens, as they appear in the powerful instruments of the Observatory. This work was intended for the benefit, not of astronomers, to whom the "Annals" are accessible, and precise measurements are indispensable, but of a larger class of readers, who, without pursuing astronomy as a specialty, are interested in following its progress and achievements. Thirty-five large plates, beautifully executed from the most carefully prepared drawings and photographs, were completed at the time of Mr. Winlock's death, and wait only for a few pages of letter-press to be ready for publication. They will gratify the scientific public with admirable representations of the planets, Mars, Jupiter, and the ring-encompassed Saturn; of the sun's spots, protuberances, and corona; of the moon's

craters and geography; of seven of the most famous clusters and nebulæ; of Donati's comet of 1858, and Coggia's comet of 1874, in some of their wonderful transformations.

In August, 1874, Mr. Winlock was appointed by Secretary Bristow chairman of the commission established by Act of Congress for making inquiries into the causes of steam-boiler explosions. He entered into this investigation with remarkable energy; carefully analyzed the various theories which had been suggested to explain this class of accidents; and ended with devising a number of ingenious experiments calculated either to confirm or refute them in detail. The arrangements were nearly completed for making these experiments at Sandy Hook and at Pittsburgh, when death put an end to his labors.

In the early part of his active career, Mr. Winlock was known and trusted as an accomplished teacher and an excellent mathematician; well versed in theoretical astronomy, and capable of applying it in laborious and responsible calculations. These qualifications pointed him out as a proper person to be made director of an observatory. With his new opportunity, he developed other talents, which, if not indispensable, were none the less valuable in his changed condition. It might have been expected that his clear mathematical mind would easily comprehend the physics and the geometry of the instruments whose usefulness he was to guide, and seize upon any defects which might exist in their construction. In devising remedies for these defects, as simple as they were sufficient, he displayed an originality in his mechanical ideas, and a spirit of invention, which left nothing wanting to fill out the measure of a consummate director. Without any passion for innovation, or any conceit of his own methods, he was not afraid to leave an easy and well-worn path, or disturb the most time-hallowed routine, if he could give good reasons for the change. The life of an assistant at an observatory, obliged to work while other men sleep, exposed to the caprices of the clouds, made nervous by the irregularity of his hours, the nice handling of his instruments, and the delicacy of the work expected of him; disappointed at the critical moment in realizing the fruits of anxious days of preparation: such a life is dependent, in no small degree, not only for its happiness, but its endurance even, upon innumerable and indescribable little facilities for observation, which individually are not worth the

mention, but which in the aggregate tell distinctly upon the success and the comfort of the profession. In his many innovations, of which every room and each instrument in the Observatory is a witness, Mr. Winlock was not misled by any theoretical abstractions, but moved always within the limits of practical good sense.

In his administrative capacity, which was tested in the Nautical Almanac, at the Observatory, and on two eclipse expeditions, Mr. Winlock evinced a disinterestedness, a strength, and a tranquillity of mind, which commanded the respect and won the affection of his associates. His leadership was nowhere asserted, but everywhere acknowledged. A man of few words, but of much thought; of no pretensions, but of great performance; he did his own part patiently and well, and by his example inspired others to do theirs. The magnitude and the variety of work embraced in his programme, none of which suffered by default, certify to the prudence and the vigor with which his forces were selected and marshalled.

In his private life, Mr. Winlock was exceptionally quiet and retiring. But little inclined to general society, he was full of hospitality. His happiness was not complete without a few very intimate friends; and he had no enemies. He was remarkably silent before strangers; but no one talked more or better in the circles which he loved. Indisposed as he was to take up his pen, when he wrote his words were as transparent as his thoughts. Modest and without self-assertion, he had as much as any other man the courage of his own opinions. Slow to put himself forward, he was genial and accessible; giving his time and his instruction freely to all who asked; never hoarding up a discovery for his own exclusive benefit, but sharing with all his last thought and his newest invention. He was keenly alive to the ridiculous; but there was no ill-nature in his criticisms. Pretence and charlatanism in science amused him; but they did not destroy his equanimity. Without any selfish aims, he took no security for his own discoveries and inventions; so that others, less scrupulous than he was, too often entered into his labors. His friends sometimes wished that his ambition had been more aggressive; but perhaps he was wiser, in the simplicity of his character and the purity of his motives, than the men of this

generation. The discoveries and inventions which he did not claim for himself will be vindicated for him.

In an age of bribery and corruption, every example of honor and fidelity in the execution of a public trust is to be cherished. In an age, when superficiality is preferred to depth, when the aspirants for scientific distinction sometimes forget to be just, and even the stars of heaven are obscured by the dust of earth, every life consecrated to honest study, not deflected from its high path by the love of popular applause, silent in its own strength, as the planets whose courses it follows, is a blessing and a legacy to mankind. In an age, when priority of discovery often counts for more than the advancement of human knowledge, and the value of inventions is read only on the patent-rolls, the seeds which are scattered broadcast by the roadside and not selfishly garnered in some private granary, though the sower may have no sense of his own merits, will make the harvest of future science. The deep impression which a quiet, unobtrusive, self-poised career, like that of Mr. Winlock, makes upon the community, can never be known until it is finished. And then we see the beautiful spectacle of all—friends and strangers, those who knew him best, and those who seemed to know him but little—spontaneously offering the tributes of gratitude and affection which they would have refused to the noisy claimant. This is the best hope and the highest reward of science.

Shy soul and stalwart, man of patient will
Through years one hair's-breadth on our Dark to gain,
Who, from the stars he studied not in vain,
Had learned their secret to be strong and still,
Careless of fames that earth's tin trumpets fill;
Born under Leo, broad of build and brain,
He watched while others slept, in that hushed fane
Of Science, only witness of his skill;
Sudden as falls a shooting-star he fell,
But inextinguishable his luminous trace
In mind and heart of all that knew him well.
Happy man's doom! To him the fates were known
Of orbs dim-hovering on the skirts of space,
Unprescient, through God's mercy, of his own![1]

---

[1] J. R. L.