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THE ALLEGHENY OBSERVATORY DURING THE ERA OF THE TELESCOPE ASSOCIATION, 1859-1867

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NIGHT has closed in on a sleepy Allegheny City in the late 1850s. It is clear, few city lights are evident, and the stars shine down in full brilliance. On a darkened street corner perhaps, or in a garden, vacant field, or a rooftop, even the Allegheny Commons, a shadowy figure of a man points his small telescope to the heavens and peers intently through it. Now and then he permits others to look also as he offers explanations to a small group of the curious gathered about him. This man was Lewis Bradley, a teacher and proprietor of the Allegheny Institute, a preparatory school in the classics located on the corner of Federal and Robinson streets. Small beginnings indeed, for from out of such quiet gatherings grew one of the world's most renowned astronomical institutions — the Allegheny Observatory.

Professor Bradley was a man of more than ordinary intelligence, possessed also of an eccentric character.¹ Little is known of his life.

Dr. Beardsley has been an astronomer at the Allegheny Observatory, University of Pittsburgh, for twenty-seven years. He has an M.S. in astrophysics from the University of Chicago and a Ph.D. in higher education administration from the University of Pittsburgh. This article is a synopsis of a book-length manuscript on the subject, which in turn has led to research on a biography of Samuel Pierpont Langley.—Editor

1 Based upon the recollection of John A. Brashear as related to him by William Thaw. From a newspaper clipping undated and unidentified in the Allegheny Observatory Documents, probably about March 1909. A full quota-

The 1860 census lists him as having been born about 1820 in the state of New York. He evidently was well educated there not only in the classics but in mathematics and astronomy as well. His name first appears in the 1844 *Harris's City Directory for Pittsburgh and Allegheny* as a teacher, a profession which he pursued for more than twenty-five years in the city of Allegheny. What is known is that at some time in these early years he put his knowledge of astronomy to a better use through the acquisition of a small telescope,² and this instrument led ultimately to the formation in Allegheny of the Telescope Association.

The original minute book of the Telescope Association still exists.³ In it the initial entry is curiously entitled, "Skeleton History of the Origin of the Allegheny Observatory." Evidently, this book did not begin with the original meetings, and the early entries are reconstructions. Written in what appears to be the hand of Bradley, the beginning of the Telescope Association is stated to have been a clear evening in February 1859. Subsequent entries suggest that three informal meetings were held that February, all on Tuesday evenings. Weather reporting in the newspapers of that day was far from satisfactory, but a careful study of the available papers suggests that February 8 was in fact a "pleasant day" (leading to a starry evening?) while February 2 was "gloomy and snowy." That first informal meeting, in all probability, occurred on February 8, 1859, followed by meetings on February 15 and 22. The minute book entries, in addition to information gleaned from newspaper articles, permit a construction of those events that led up to the origin of the Allegheny Observatory.

For more than one hundred years, a story has persisted that the appearance of Donati's Comet in 1858 so impressed the citizens of Allegheny and Pittsburgh that they banded together to found an astronomical association from which the Allegheny Observatory evolved. It is a beautiful story; one that has become a legend. It is, unfortunately, at complete variance with an account in the *Pittsburgh Dispatch* of November 4, 1861, for there one finds an emphatic statement that the initial formation of the Telescope Association occurred

tion appears in footnote 39. (The designation Allegheny Observatory Documents hereafter refers to manuscript reference materials still housed at the Allegheny Observatory.)

² *Pittsburgh Dispatch*, Nov. 4, 1861. See also *ibid.*, Nov. 15, 1859.

³ Minute Book, The Telescope Association — 1859-1867, kept with the Records of the Board of Trustees, University of Pittsburgh (hereafter cited as Minute Book).

some two years prior to the date of an earlier article (November 15, 1859), that is, approximately November 1857, which was fully ten months before the appearance of Donati's Comet. This is perhaps somewhat of an overstatement, for there was no formal organization as early as 1857, only the interest that must have arisen from Professor Bradley and his small telescope, an instrument described as possessing an excellent construction and very good defining power. This instrument can be conceived as having served a double purpose. It would have furthered Bradley's interest in astronomy and it would have attracted the attention of other persons in the neighborhood, thus serving to publicize himself and his school. One can imagine Bradley setting up his telescope in the evenings and showing the wonders of the heavens to all who gathered around, or perhaps attending lawn or porch fetes of some of Allegheny's most influential citizens with his instrument being the center of interest.

In any case, Bradley's instrument did arouse the interest of several wealthy and influential gentlemen of Allegheny City who began to discuss with Bradley and among themselves the prospect of acquiring an even larger and better telescope. There was nothing formal then about such discussions and they probably occurred on the occasion of chance meetings or at other get-togethers. The idea of a larger telescope would have been a great stimulus to Lewis Bradley, for he certainly must have been familiar from his astronomical readings with the story of the founding of the Cincinnati Observatory. Many years earlier Professor Ormsby McKnight Mitchel had invited the citizens of Cincinnati to form a stockholder corporation for the purpose of building an observatory. They did so, and the money subscribed from the sale of shares was used to build the famous Cincinnati Observatory, with Professor Mitchel its director. The shareholders, as owners, had the privilege of viewing the wonders of the heavens whenever they wished. The story of the Cincinnati Observatory had been well publicized in Mitchel's writings; furthermore, he had lectured far and wide through the nation advocating construction of similar observatories in all large cities. But it would not be until April 1859 that Mitchel himself would lecture in Pittsburgh. The concept of a similar stockholder arrangement in Allegheny must have gradually fixed itself in Bradley's mind, for the *Dispatch* of November 4, 1861, stated: "and at length he [Bradley] conceived the design of securing an association of these gentlemen, for the purchase of an instrument of larger size than would be desirable for any one, singly, to supply himself with." From time to time as this idea matured he discussed

the possibility of a telescope association with his potential backers and received their hearty endorsement. Such discussions, still on an informal basis, would have occurred occasionally during the years 1857 and 1858. Real accomplishment perhaps lagged until the spectacular appearance of Donati's Comet in late 1858. Attended by much excitement among the world's populace, the comet acted as a catalyst for the creation of the Telescope Association and, coupled with the personal ambition of Bradley, led him at last to call for formal discussions toward forming the organization.

On February 8, 1859, Bradley called upon several prominent Alleghenians and invited them to his place to discuss the matter of procuring a telescope, "the magnifying power of which would bring the Heavenly Bodies near enough to be viewed with greater interest and satisfaction than with the unaided eye."⁴ Four men received his invitation that first night: one was Josiah King, proprietor of the large Eagle Cotton Mill in Allegheny and later a publisher of the *Pittsburgh Gazette*; another was Harvey Childs, a wholesale shoe merchant, whose firm is still engaged in that business today; still another was Edward Rahm, a leading banker; and the fourth was Thomas M. Howe, a bank president at the time and later United States congressman and a trustee manager of the observatory. Of these only King, Childs, and Bradley met on that occasion and their discussion focused on the importance of purchasing a good telescope and placing it in Bradley's schoolroom. This meeting was followed by informal discussion meetings on February 15 and 22 to which a number of additional gentlemen were invited. The telescope would be for the common use of the individuals interested in its purchase.

Enthusiasm, however, had to be translated into commitment, and at that first meeting and at the two succeeding February meetings discussion shifted to the feasibility of purchasing an instrument worth several hundred dollars and of fitting up a special observing room in some building in the central part of the city for its use. It would seem likely that Bradley at that time possessed a refractor of about two or three inches aperture (lens diameter) and that the association initially had considered an instrument of perhaps four or five inches aperture. Now their enthusiasm was leading them to a larger instrument, of about eight inches aperture. Such an ambitious enlargement of the plan warranted an increase in the number of subscribers and discussion in turn centered upon a formal organization. Finally, at a meeting on March 1 the Telescope Association became actuality. Josiah

⁴ *Ibid.*

King proposed that Thomas M. Howe prepare a subscription book and that Professor Bradley "wait" upon the gentlemen whose names were agreed upon as being *acceptable* parties to compose the Telescope Association. Rising to the task given him, Howe procured a subscription book and in it entered this preamble:

Allegheny March 2nd 1859

The undersigned hereby agree, severally, to pay the sum of *One hundred dollars* for the purpose of purchasing *A Telescope* to be equatorially mounted and of a focal length of about ten feet, and an Object Glass of about 8 inches in diameter and placing the same in some convenient and suitable position in the City of Allegheny or neighborhood, for the use of themselves, their families, and the community at large, under such rules and regulations as the subscribers may adopt. Payment to be made to, and the funds expended by such three persons as may be selected from among the undersigned by a majority thereof to act as a Board of Trustees whenever twenty five subscribers of one hundred dollars each shall be obtained thereto.⁵

Underneath appear the signatures of twenty of Allegheny's more prominent citizens.

Thos. M. Howe
Harvey Childs
L. Bradley
Thompson Bell
R. S. Hays
Henry Irwin
Wm. S. Bissel
F. R. Brunot
John A. Wilson
James Park Jr.

Josiah King
C. G. Hussey
Edward Rahm
James Marshall
John Dean
David Campbell
Wm. Bagaley
G. W. Cass
H. Hepburn
Henry Bollman⁶

The pledge-securing committee headed personally by Bradley made rapid progress. As described in the *Dispatch*, "the indicated amount had been raised without difficulty, the only complaints reaching the committee being in regard to the limited and seemingly exclusive character of the project." Others were also becoming interested.

⁵ Minute Book, Mar. 1, 1859, 2.

⁶ Another Minute Book (apparently a later copy of the original), hereafter designated Large Minute Book, contains the name Allen Kramer in place of Henry Bollman. Also kept with the Records of the Board of Trustees, University of Pittsburgh.

On March 15 a board of trustees was elected with authority to act in the name of the association.⁷ Although little realized at the moment, this was a momentous event which would provide leadership and support for the Allegheny Observatory for the next thirty years. Those elected were Thomas M. Howe, Dr. C. G. Hussey, and Josiah King. Their first duty was to investigate the selection of a site. By now the members realized that a housetop in the city would not be appropriate for such a large telescope, so attention turned to the many hills in the vicinity. Shortly thereafter, Bradley journeyed to New York City, evidently to seek advice from an eminent astronomer, Lewis Rutherfurd, concerning what sort of telescope would best serve the association.

The Telescope Association was now a going concern. Swept up in the pervading confidence of the moment, the subscribers eagerly pressed forward in the early spring of 1859. At this time there was a further assurance of success which excited everyone — not just the subscribers but the general public. Those responsible for arranging for the Young Men's Library Association lecture series, headed by the noted Felix R. Brunot, had secured the services of Professor Ormsby Mitchel for a series of five public lectures. The local press shared the excitement, printing an excerpt from Mitchel's New York City address which he had delivered on January 29, exclaiming, "Prof. M. is perhaps the leading astronomical mind of our country, and one of the most pleasing lecturers living."⁸

Mitchel's lectures were scheduled to begin Monday, April 11, with the remaining lectures on Tuesday, Thursday, Friday, and Saturday. Wednesday was apparently left open for consultations between Mitchel and the Telescope Association. But tragedy dictated that only two of those five lectures would occur, and if there were consultations no record of them exists. To begin with, Mitchel was delayed by a railroad accident and did not arrive in time to deliver the Monday lecture.⁹ This lecture had to be delivered on Tuesday, and his next lecture occurred on Thursday as scheduled. Soon after the Thursday lecture, however, a telegram arrived for Mitchel from his family in Cincinnati. His wife had suffered another severe paralytic stroke and was again near death. Frederick A. Mitchel, in his father's biography,¹⁰ mentions that his mother suffered three serious strokes; the

⁷ Minute Book, Mar. 15, 1859, 4.

⁸ *Pittsburgh Dispatch*, Apr. 4, 1859.

⁹ *Ibid.*, Apr. 12, 1859.

¹⁰ Frederick A. Mitchel, *Life of Ormsby McKnight Mitchel* (Boston, 1887), 208.

first in 1857 and the last and fatal one in 1861. The one in 1859 was thus the second — for which her son mentions no date. Mitchel and his wife were extremely devoted; on many a night she had worked alongside him at the telescope as his assistant, and, upon receiving this telegram, he left immediately for Cincinnati. All hope of his returning to complete the lecture series was soon dashed by the now frail health of his wife as well as the impending threat of civil war. Mitchel never returned to Pittsburgh, and on May 6 the *Pittsburgh Dispatch*, as a summary, printed the concluding remarks of his January 29 New York City lecture.

On April 19, the Telescope Association met to hear committee reports.¹¹ The trustees reported much activity over the past month in visiting several potential sites for the telescope on the hills surrounding Allegheny. They were most interested in the top of Seminary Hill, but they also considered the property of subscriber Henry Irwin on the west slope of Seminary Hill and a third site owned by subscriber Thompson Bell on Quarry Hill in Pittsburgh.

At this meeting, also, Professor Bradley reported what must have been the most exciting news of all, in regard to his trip to New York City. In the preliminary meetings Bradley had suggested they might secure a medium-sized telescope valued at \$1,700.¹² It was estimated that the expense of mounting it upon a rooftop might amount to no more than \$600. Accordingly, it had been decided that this entire amount could be raised by subscriptions amounting to \$100 apiece, thus fixing the size of the association at about twenty to twenty-five subscribers. As a result of newspaper publicity, many more persons desired membership, were admitted to the subscribers roll, and now there was promise of a surplus of working capital. What Bradley reported was that he had learned from Rutherford that the celebrated telescope maker, Henry Fitz, was at that moment engaged in finishing an object glass of great focal power, thirteen inches in aperture, to be mounted in Rutherford's private observatory in New York City. Rutherford was wealthy, an active and distinguished astronomer, and had long been one of Fitz's warmest friends and patrons.¹³ In consequence, this instrument was to be furnished to Rutherford for the extremely low cost of \$7,000. But the exciting part of this news was that Rutherford proposed to transfer this instrument to the association

¹¹ Minute Book, Apr. 19, 1859, 5.

¹² *Pittsburgh Dispatch*, Nov. 15, 1859.

¹³ Rutherford's residence and private observatory were just around the corner from Fitz's workshop. Rutherford had purchased several telescopes from Fitz, including an eleven-inch-aperture refractor.

immediately and await the construction of another for his own use. Formal approval was given at the next meeting of the association in May. At this meeting, James Marshall "moved that it was expedient to purchase for the use of the Association a glass of high power, and that the Committee be authorized to contract for a thirteen inch Object Glass."¹⁴ The motion was unanimously carried, few realizing perhaps the seriousness of owning one of the world's largest telescopes. The board of trustees then lost no time informing Rutherford of the acceptance of his offer.

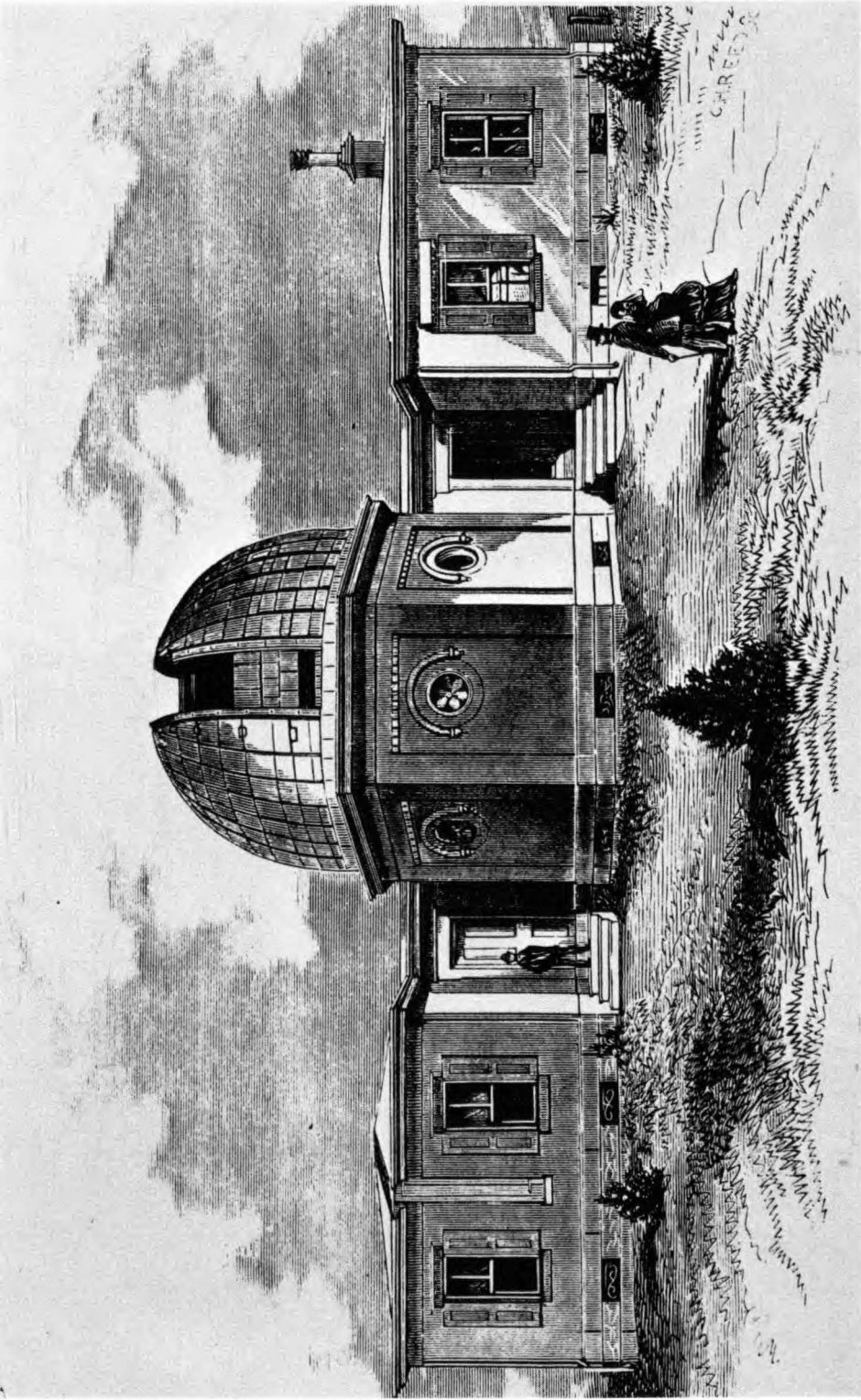
Meanwhile, the committee appointed to confer with the Allegheny City councils had also been active following the April meeting. At the meeting of the councils on May 5, Edward S. Wright of the Committee on City Property for Select Council reported that he "had an interview with a committee of the 'Telescope Association' of the City of Allegheny, — desiring to lease a portion of the 'seminary purchase' for the purpose of erecting an Observatory at the corner of Cliff Street and Irwin's Avenue, for which they would require six lots."¹⁵ The committee recommended that they be authorized to lease to the association the six lots required at the rate of \$1,000 per year with the provision that if and when the association should remove their instrument to any other locality, the lots would revert back to the city. Select council then adopted a resolution to that effect, which was concurred in by common council.

This whole process appears to have been facilitated by one fact — that the president of select council and the chairman of the association's observatory committee to confer with city council were one and the same person, James Marshall. But at the association meeting on May 14 Marshall made a verbal report on behalf of the committee and presented a different or revised version of council action, that is, "the City would donate for purposes of the Association *three quarters* of an acre from the Seminary property or would convey title to the same for sixty dollars per annum ground rent."¹⁶ The association subscribers, after a "free interchange of views," referred the report back to the committee without taking action. The prospect now of such an extremely large telescope dictated that only the best possible site be chosen, therefore this should be at as high an elevation as

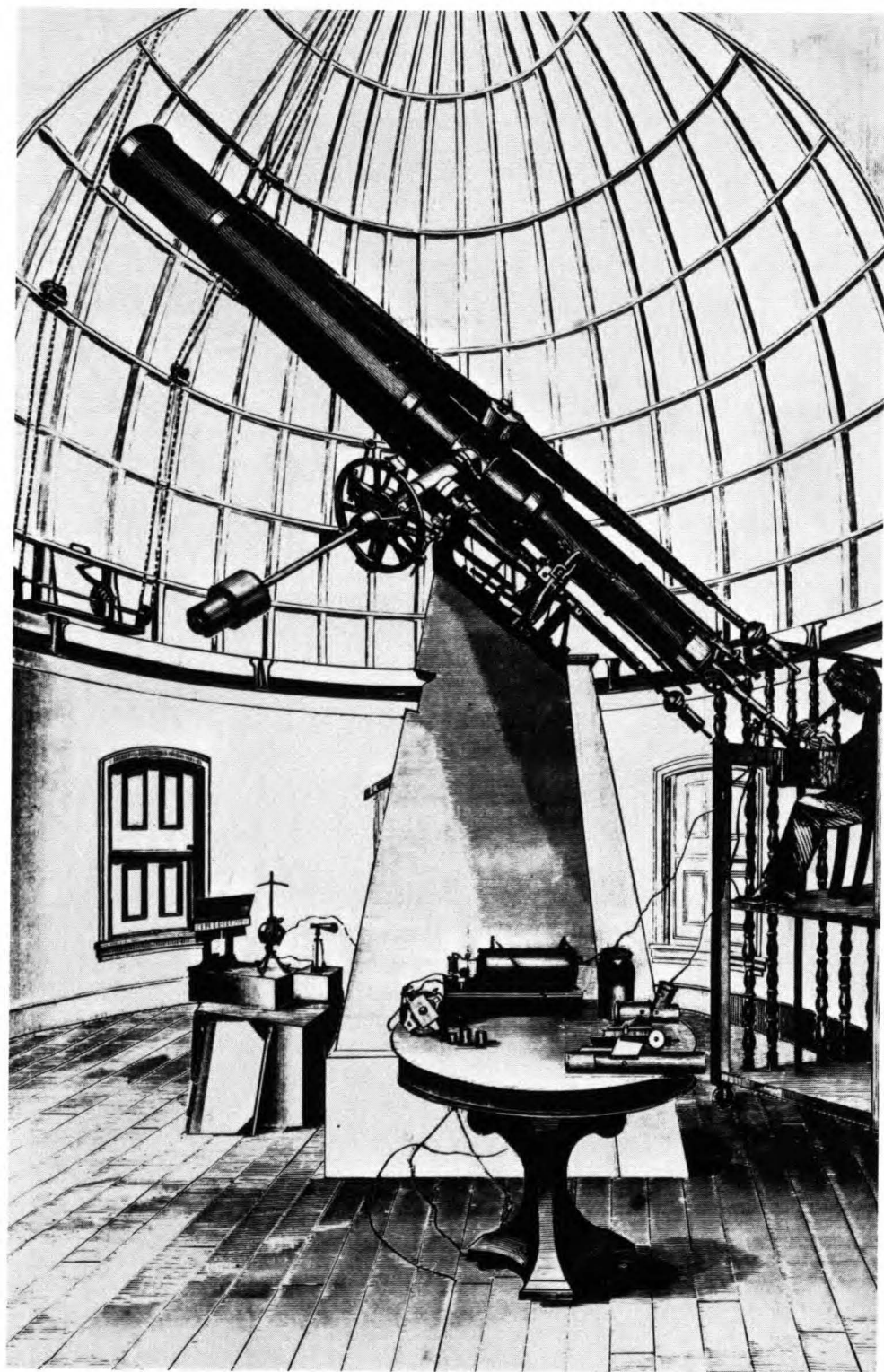
¹⁴ Minute Book, May 14, 1859, 8.

¹⁵ *Pittsburgh Dispatch*, May 6, 1859. These six lots were situated on the east summit of Seminary Hill near where the Community College of Allegheny County is now situated. Henry Irwin's property was on the western slope of the hill.

¹⁶ Minute Book, May 14, 1859, 8.

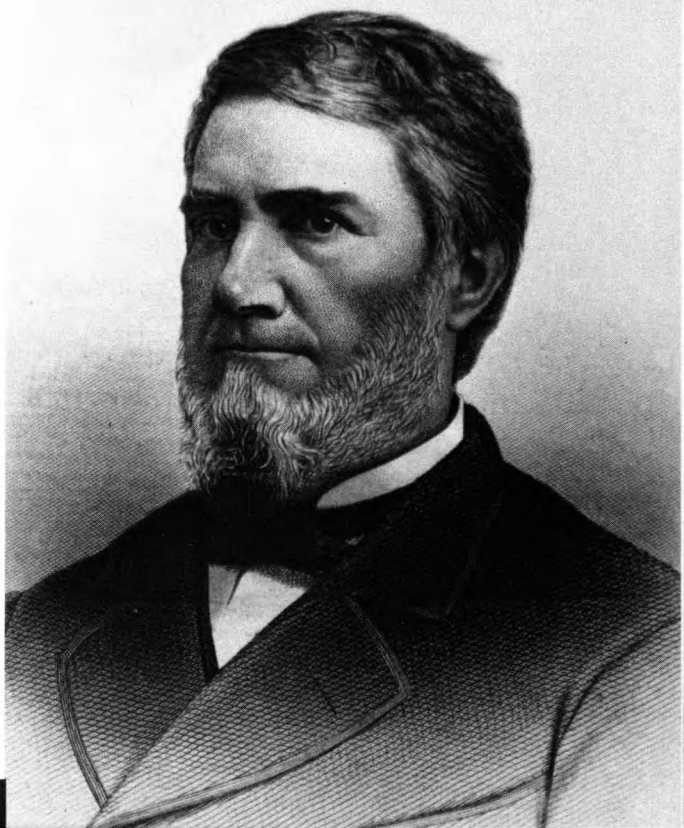


The Allegheny Observatory in 1871 as it appeared originally. (*People's Monthly*, Vol. 1, 1872)

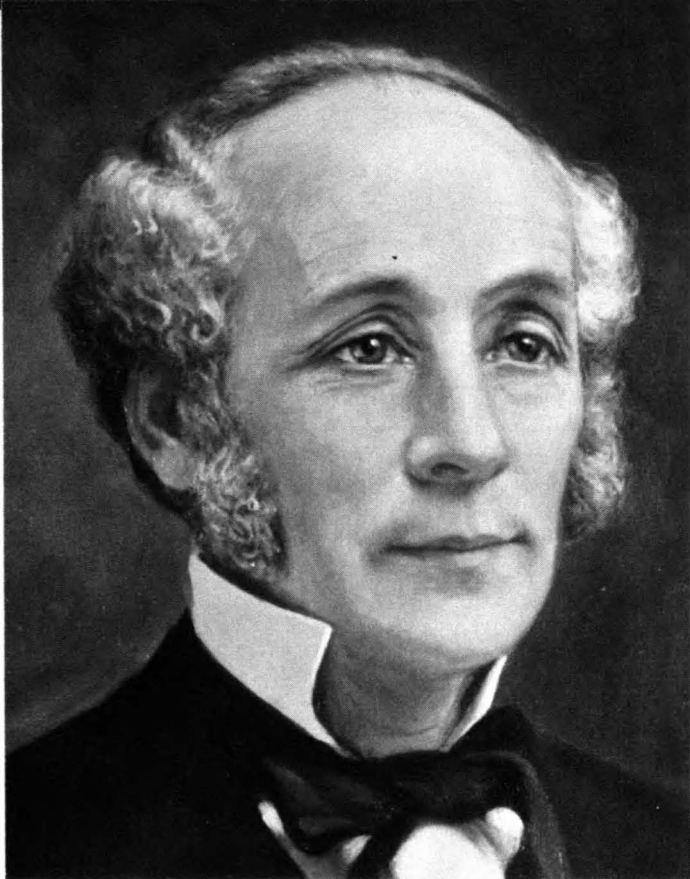


The thirteen-inch Fitz refractor of the Allegheny Observatory in 1871.
(*People's Monthly*, Vol. 1, 1872)

William Thaw (1818-1889),
member of the board of
managers of the Telescope
Association. (*Magazine of
Western History*, Vol. 2,
1885)

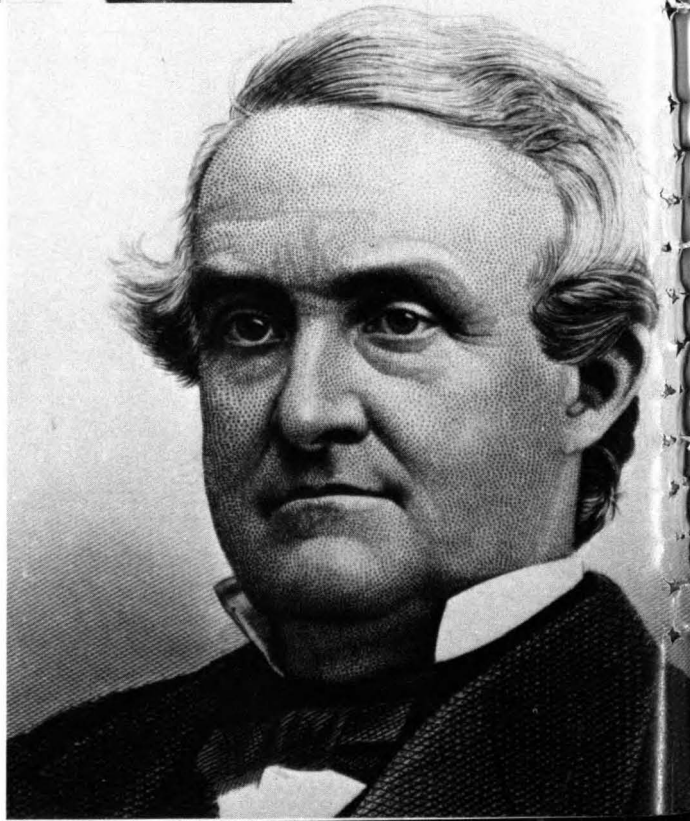


Philotus Dean, A.M. (1822-
1871), first director of the
Allegheny Observatory,
1863-1867. (Courtesy Uni-
versity of Pittsburgh)



George Woods, L.L.D.
(1813-1899), chancellor of
the Western University of
Pennsylvania, 1858-1880.
(Courtesy University of
Pittsburgh)

Hon. Thomas M. Howe
(1808-1877), member of the
board of managers of the
Telescope Association. (*His-
tory of Allegheny County,
Pennsylvania*, Vol. 2, 1889)



possible. Both Seminary Hill sites were objected to because the hills immediately to the north were much higher in elevation.

Following this meeting, a long summer dragged by, for the association did not meet again until November 3. But it was a busy summer for the committees and the board of trustees. The subscription committee, now headed by Josiah King, had the task of raising funds to secure the purchase of Rutherford's thirteen-inch refractor. Fund raising is never easy, nevertheless the task was accomplished over the summer, probably much helped by the publicity attendant with Professor Mitchel's lectures and the promise of an instrument exceeded in size only by the Harvard fifteen-inch, the world's largest telescope. At the same time, the committee was busily occupied concerning a new development which had apparently surfaced at the May meeting. A nearly ideal site had been offered to the association, and the committee negotiated over the summer with Matthew Ferguson and his neighbors, Washington McClintock and Robert Ashworth, with regard to their properties.¹⁷ Here, just behind the city, the hills had much greater elevation and permitted an unobstructed horizon situated above the pall of city smoke. Ferguson and McClintock were willing to donate their adjoining properties to the association, and the adjoining property of Ashworth, containing a dwelling, was available for purchase.

By now, also, another development occurred in the fortunes of the association, for the Dudley Observatory in Albany, New York, was finished and urgently required a telescope.¹⁸ It was agreed among all the parties that Rutherford's telescope should go immediately to the Dudley Observatory instead of to the Telescope Association which did not yet possess a building, that the telescope which Fitz had promised to build next for Rutherford would then be built for the Telescope Association, and that Rutherford would afterwards have one finally built for himself. In a sense this would be an advantage, for Fitz would construct this new telescope having had the prior experience of constructing what was now the Dudley Observatory's instrument. But it would also necessitate that the association enter into a contractual agreement with Fitz for the new telescope.

At that November 3 meeting of the association a new member, William Thaw, spoke up. He moved that the board of trustees be requested to purchase such a telescope as the members might think best suited to the association, to have Ferguson and McClintock

¹⁷ *Pittsburgh Dispatch*, Nov. 15, 1859.

¹⁸ *Minute Book*, Nov. 3, 1859, 39.

execute the necessary papers conveying their property to the association, and to secure from Ashworth his property and improvements on as favorable terms as possible. The motion was adopted, helped in no small measure by Josiah King's report that the actual amount then subscribed amounted to \$11,800, and that additional pledges had been promised, sufficient to increase the amount to \$14,000.

Of all who now belonged to the association, only Lewis Bradley had a real knowledge of astronomy and of telescope operation. The trustees, though accomplished businessmen and contractees in their own fields, were wholly dependent upon Bradley's expertise. They issued Bradley a letter of authorization to act in their name in contracting with Fitz for the new telescope, and, as compensation, they agreed to allow Bradley charge of the telescope and the use of the existing dwelling on the Ashworth plot for a "School of Astronomy." Bradley left at once for New York and arranged the terms set forth in this letter from Fitz to the trustees:

I hereby propose to furnish and mount upon the pedestal you design to erect in the Allegheny Observatory during the first week of Sept. 1860 for the sum of *seven thousand dollars* payable on delivery, an Equatorial Telescope of the following dimensions, qualities and appendages, submitting the same to Messrs. L. M. Rutherford [sic], Prof. C. W. Hackley, and Dr. F. Brünnow, as umpires on the part of the fulfillment of my engagement in this contract, and furnishing you with their written confirmation of the same, before delivering the Instrument.

First — The Object Glass shall be 13 inches clear aperture, and about 15 feet focal length, pure and unexceptionable in its appearance as that of the Dudley Observatory, and equally efficient in its performance as that one, or any other I have ever furnished.

Second — The declination and Hour Circles shall be respectively 20 inches and 18 inches in diameter, made of brass, graduated on silver, and reading, the former to ten seconds of arc, the latter to seconds of time, and with sufficient accuracy to satisfy the highest demands of the Astronomer.

The whole of the Equatorial, together with the side rods, counterpoises, and all its other parts, shall be equal and similar to Mr. Rutherford's, and the one at Ann Arbor.¹⁹

The trustees quickly responded with a formal acceptance of these terms, to which Fitz, in reply, revealed that construction was already proceeding well; in fact, he had been hard at work on the instrument for the *previous six months*.

Note the interesting condition in the above agreement in which Fitz proposed to deliver the completed instrument during the first week of September 1860. This was but eight months away. Excitement must have been at a fever pitch, for two important steps remained

¹⁹ Henry Fitz to Board of Trustees, Jan. 17, 1860, Minute Book, 12.

which had to be dealt with as expeditiously as possible. First, ownership of a sizeable plot of land, a house, the prospect of owning a large valuable telescope and observatory building, and a school of astronomy obligated the association to seek incorporation. Secondly, in the next eight months an observatory building would need to be contracted for and constructed. There was little time to lose. The board was evidently of the opinion that incorporation under special act of the legislature might in some respects accomplish a stronger charter in less time. Required then was a strong and influential spokesman on the behalf of the association to present its case before the legislature. The eminent Honorable William Wilkins, a gentleman of distinguished attainments, former minister to Russia, former secretary of war, eighty-one years of age, and even then a leading member of the state senate, not only accepted the role of advocate but became a subscriber for five shares.

The committee on organization came to a fair agreement on matters of organizational structure and operating regulations. Guided by this and assisted by the board, it must be presumed that Judge Wilkins wrote and helped sponsor the act incorporating into it the names of sixty-six original subscribers as incorporators. With Wilkins's own name heading the list, speedy legislative action was assured. Entitled, "An act to incorporate the Allegheny Observatory, in Allegheny County," it was passed by the Pennsylvania legislature in final amended form on March 22, 1860, and was signed by the governor on March 24.²⁰

Among the provisions of this act was the specification of an interim board of managers to conduct the business of the corporation; the board was five in number: Thomas M. Howe, Curtis G. Hussey, John H. Shoenberger, Josiah King, and William Thaw. These persons were to serve until bylaws could be ratified by the membership and proper elections held. Furthermore, the corporation was charged with the responsibilities of the "primary and incidental purposes of an astronomical observatory, including, if the same be deemed advisable, a school of English and Classical literature and science." The wisdom of the corporation in seeking a strong charter was to become evident some years later when Walter H. Lowrie, formerly chief justice of Pennsylvania, asked to study the possible merger of the Western University of Pennsylvania and the observatory, concurred that the

20 See W. J. Holland, comp., *Acts of Assembly and other Important Papers Relating to the Western University of Pennsylvania* (Pittsburgh, 1902), 12. The date should read "twenty second day of March."

Allegheny Observatory did have the "power to make."²¹ Incorporation also had the advantage that the board of managers could now make management decisions quickly without the necessity of formal membership ratification, and quick action was indeed a necessity to prepare for the arrival of the telescope. The other item of immediate business still remained: the observatory building. Appointing Lewis Bradley as their secretary, the board began regular meetings. Effective as this procedure would be, it had what might be termed a grave disadvantage in that it removed most of the association subscribers from direct involvement.

The board soon accepted a proposal for the design of the observatory building submitted by the Pittsburgh architectural firm of John U. Barr and Henry Moeser.²² An intriguing aspect concerns the architects' role in this design. Few architects then (or even now) would have had observatory design experience. Nor could the board have provided much help in the issuance of specifications. Credit must be given to the firm of Barr and Moser for achieving a practical and at the same time aesthetically pleasing design by first carefully studying all other observatories throughout the country. Their final plans avoided one of the more prevalent and grosser blunders of early observatory design: that of incorporating the main entrance into the building as part of the dome structure housing the telescope. This design specified three separate structures in a sense.²³ The central one was to be octagonal in form on the exterior, and circular on the interior; twenty-one feet in diameter and thirteen feet in height, to the base of the dome. The dome was to be semicircular in form and movable, giving perfect freedom of observation in all directions. On each side of this building would be erected buildings about the same height; fifteen by eighteen feet in dimension, and connected by corridors with the central building. In one of these there would be, at some future day, a transit instrument and an astronomical clock. The other would be devoted to the purposes of the institution.

With the plans agreed upon, the board decided to assess the incorporators 50 percent on the amount of their subscription to be collected by the treasurer by June 1, the remainder to be collected by August 1860.²⁴ By June, construction was well under way; completion was planned in August, for the telescope was expected in September.

²¹ Records of the Board of Trustees, Western University of Pennsylvania, Apr. 22, 1867.

²² Minute Book, May 7, 1860, 24.

²³ *Pittsburgh Dispatch*, Nov. 4, 1861.

²⁴ Minute Book, May 19, 1860, 26.

It was to be a summer of anticipation for the small group of would-be astronomers as the sun shined down in warmth upon the forming Allegheny Observatory.

September came at last and the building stood ready on the hill-top, but the days passed into October with still no delivery of the telescope. As it would turn out, fourteen more months elapsed before the telescope arrived in Pittsburgh. No clear reason accounts for the delay. A letter to Bradley from Fitz on November 20, 1860, suggested that only final certification by the judges, especially Rutherford, was needed. But two weeks later Rutherford wrote Bradley, saying that the lens was still unfinished although he was confident that only one more week's work would be all that was necessary. Thenceforth an excruciating wait must have ensued for it was not until July 6, 1861, that Fitz at last wrote to Bradley to say that Rutherford had tested the thirteen-inch lens in his own telescope and had given it his full approval.

An interesting feature of Rutherford's testing involved the construction by Fitz of an adapter so the thirteen-inch lens could be fitted to Rutherford's eleven-inch refractor tube. In consequence Rutherford's test was of the thirteen-inch lens diaphragmed to slightly more than eleven inches. Not only did almost 25 percent of the light gathering power remain untested but the focus of the outer zones of the lens, which is critical to good lens performance, remained untested. In today's technology, of course, the mere appearance of double stars²⁵ in a telescope, which constituted Rutherford's testing procedure, would be no match for the precision of a Foucault knife-edge test. Such a test was, of course, unknown at that time. Approval of the other judge, Felix Brünnow, director of the University of Michigan Observatory, still remained (Hackley had died in the meantime). Fitz impatiently fumed because Rutherford, who had agreed to contact Brünnow, could not be reached because he was cruising Long Island Sound in his yacht. Rutherford did finally get around to communicating with Brünnow and provided him a full description of the telescope's performance on certain very close double stars, concluding with a personal invitation to visit him in New York and inspect the instrument himself: "In general, I would say that the disks of stars are round and remarkably small, and with very little stray light for so

²⁵ A double star comprises two stars in close proximity as seen in the telescope. Often they are so close together that only an excellent telescope can resolve them. Such pairs usually are orbiting about each other over very long periods of revolution.

large an aperture and short focal length. Its superiority in light over my 11 inch is very marked, so that on returning afterwards to my own, everything appeared offensively dull and dark." ²⁶ Unfortunately, Brünnow was ill at the time and the journey to New York would have been too arduous an undertaking. Relying on Rutherford's reputation as an excellent judge of telescopes, he replied to Bradley by letter on October 16 that since the instrument was satisfactory to Rutherford he would consider it to be satisfactory also.

A hurried meeting of the association's board of managers took place October 21, the first since June 1860. Josiah King made an acceptance motion, and the board resolved that the instrument be accepted as satisfactory based upon the testimony presented and that Fitz personally erect the telescope in the observatory at his earliest convenience. But surprisingly it was necessary also to authorize the treasurer to *borrow* not more than \$6,000, "and that the faith, funds and property of the Society is hereby pledged to all or any of the managers who may become individually liable as Endorsers or Drawers of the Obligation to be given for said loan — the proceeds of said loan to be applied toward the payment, on delivery of the Telescope contracted for with Henry Fitz of New York." ²⁷ The big day was at last close at hand.

Fourteen months is a long time, although similar delays in telescope manufacture even now are not uncommon. Unfortunately, this delay could not have come at a worse time, for in its very midst the ominous sectional crisis that had been brewing for some time engulfed Pittsburgh and the nation in war; on Saturday, April 12, 1861, the Pittsburgh papers announced solemnly, "The War Has Commenced." During the next four years the energies of Pittsburgh were turned to the war effort. As J. Cutler Andrews, an eminent authority on Pittsburgh and the Civil War, so ably expressed it, "The town which had already undergone so many transformations was destined to be made over yet again. That final change, a speedy change of great magnitude, was the work of two profound upheavals: the Industrial Revolution and the Civil War." ²⁸

Many of the incorporators of the observatory were those most prominent in the manufacture of iron and steel, cotton and woolen goods, and glassware, commodities essential to any war effort. As

²⁶ Rutherford to Brünnow, Sept. 21, 1861, Minute Book, 37.

²⁷ Minute Book, Oct. 21, 1861, 40, and Nov. 23, 1861, 44.

²⁸ J. Cutler Andrews, "The Civil War and its Aftermath," in Stefan Lorant, *Pittsburgh: The Story of an American City* (New York, 1964), 131.

Pittsburgh quickly became the forge of the nation and a major supply link to battle areas along the Mississippi and Tennessee river systems, the incorporators of the observatory were swept up in the surging activity of war effort. Some like Colonel David Campbell were directly involved in the military conflict, and Felix R. Brunot, though a civilian, actually served time in a Confederate prison, captured during his medical relief activities and eventually released through exchange. The others devoted their full energies to providing goods and services. Such wide-sweeping change in priorities was bound to affect the observatory, the result being that only a handful of people still maintained their original enthusiasm for astronomy and remembered their obligation to the observatory.

On November 14 the *Pittsburgh Dispatch* at last announced that the mechanical parts of the telescope had arrived "a few days since" consigned to Clarke and Company (William Thaw). By November 21, Henry Fitz had arrived, carrying the lens in his carpet bag, and the work of unpacking the crates and assembling the telescope on its pier commenced.²⁹

The telescope was completely assembled in less than two days, and then, just as all was in readiness for the initial viewing, heavy clouds rolled in to blot out sun, moon, and stars. For a tiny group of the faithful, standing each day on the observatory hilltop, the entire next week must have been the most frustrating of their lives. Not until Tuesday, November 27, did the sun finally make a brief appearance. The *Dispatch* reported: "The sun having then become partially unveiled, the great instrument was directed upon it by Mr. Fitz, and after a brief inspection was pronounced by him the best which he had ever completed."³⁰

A happy Henry Fitz, convinced of the success of his telescope, quickly departed from Pittsburgh to attend to urgent business in New York with the promise to return in a week or two. That promise was not kept, and Henry Fitz never saw the telescope again.

It was left to Lewis Bradley to continue the testing and the adjustment of the new instrument. On December 5 he rapturously announced in the *Pittsburgh Dispatch* the results of his first observations of the heavens. He marvelled at the beauty of the rings of Saturn, then nearly edge-on. Jupiter appeared "as large as the full moon." His observation of the star Sirius, though, suggests that the telescope driving mechanism was not yet working. It had become Bradley's

²⁹ *Pittsburgh Dispatch*, Nov. 22, 1861.

³⁰ *Ibid.*, Nov. 28, 1861.

responsibility now to adjust the gears and get this essential part of the telescope working so that it might track the stars while he observed them.

The Allegheny Observatory had at last emerged from dream into reality. This occasion called for proper commemoration, and on January 7, 1862, the incorporators assembled proudly at the "rooms of the institution" for a formal dedication of the observatory.³¹ As this was an auspicious moment, interest should have been at a peak. One might reasonably have expected a full complement of incorporators, their families, and many others to be present. In fact, the record shows that only seventeen incorporators were present besides Lewis Bradley, who delivered the dedicatory address. There was no newspaper coverage of the event. Long delay in the arrival of the telescope had obviously taken its toll; interest had declined. Also, by now the Civil War had become a serious threat to the residents of Pittsburgh. William Wilkins, an incorporator, had assumed command of the Home Guard, and fortifications had been constructed on many of the hilltops of the area, where the guards were posted as lookouts. The Confederate troops were only one hundred miles to the south and rumors of their advance persisted. Everyone was tense. It was natural for many at this time to be concerned about themselves more than about the Allegheny Observatory. Also, evidenced by the previously mentioned loan to pay Fitz, subscription money had not been forthcoming; financial trouble was in the offing.

Thus, proud as they might have been on this occasion, the small group assembled for the dedication must have been deeply sobered by such pressing concerns. They did listen to Bradley's address enthusiastically and by unanimous resolution directed it to be registered among the proceedings of the association. Unfortunately, the text of this address no longer exists. Where it occurred in the minute book, a series of page stubs indicate that the address was torn out, preceded by a terse notation, "Note. The following eight pages entertaining Mr. Bradley's address were by the consent of the managers withdrawn from the Minute Book — T. M. Howe — Pittsburg. Feb. 4, 1864."³²

Bradley (as related in the minutes) summarized the history of the observatory and described his observations to date. Then he read a paper making a clear exposition of the purpose (his?) of the observatory, "luculentam atque utilem societate." Certainly, Bradley must have presented a strong plea for a transit telescope and a

³¹ Minute Book, Jan. 7, 1862, 49.

³² *Ibid.* The minutes contain only a brief synopsis of the address.

sidereal clock. As to his purpose for the observatory, he may have advocated the importance of his "school of astronomy," now housed in the director's residence, and of the observatory's public function.

It seems clear that Lewis Bradley, who had been the prime instigator and who had originally established desire for an observatory in the minds of certain influential citizens of Allegheny, now linked it to his concept of an adjunct "School of Astronomy" which would be in fact his Allegheny Institute. Exactly in what manner might his students, who would have been in their early teens at the most, benefit from proximity to one of the world's largest telescopes is not at all clear. Inasmuch as he was the only person in the association skilled in astronomy and the operation of the telescope and was living and conducting his school on the premises as "custodian," it is natural to assume that Bradley had come to regard the institution as "his" observatory and "his" telescope. The observatory and the telescope thus served him as an enrollment drawing card and publicity getter for his Allegheny Institute, and as a personal egoism. The rules and regulations regarding the use and purpose of the observatory as finally adopted by the association at the end of 1862 asserted the right of the association to complete control over the observatory.³³ Bradley must have regarded such rules as restrictive. Also, these regulations authorized a position of "Director." Logically, to Bradley, he was or at least should be the director and the adoption of the rules thus formalized it. It was, however, a dream for Bradley that was never to materialize.

Although he had signed the initial pledge of \$100 for his share as a stockholder, Bradley's name does not appear in the final list of contributors. Evidently, he never paid directly for his share, assuming perhaps he deserved it through contribution of his time, expenses, and expertise. Others in the association may have considered so as well, but in the legal sense he had now been reduced to the status of an employee serving the corporation on a contractual basis. The board of managers, concerned that the observatory and telescope were serving increasingly as embellishment to Bradley's school, as well as Bradley's increasingly possessive attitude, did not consider themselves obligated to appoint Bradley as director. By now also, the board began serious consideration of the goals and mission of an observatory which possessed one of the world's largest telescopes.³⁴

³³ Minute Book, Dec. 15, 1862, 45.

³⁴ "The Allegheny Observatory," *The People's Monthly* (Pittsburgh) 1 (1871) : 57.

In his dedicatory address, Bradley had used the expression "luculentam atque utilem societate" to denote his concept of the mission of the observatory, and the phrase might be loosely translated as "for the edification and benefit of the public." But such a large telescope must play a much broader role than merely benefiting public curiosity. Also bear in mind that at this time most of the managers were also members of the board of trustees of the Western University of Pennsylvania. The principal (chancellor) of the university, George Woods, L.L.D., was aware that a large observatory could serve as a very useful instructional aid and prestige symbol to the university. Those of the board of managers who were trustees of the university were in regular communication with Woods. The matter of the observatory indebtedness still remained unresolved and was becoming of increasing concern to the managers. Since Ashworth had never received payment for his part of the property, a sheriff's sale of the property and the observatory had become increasingly imminent.³⁵

In such a context as this Woods may have suggested that the director should properly be a learned man, preferably with university connections as a member of the faculty. Although nothing was so stated directly, it would seem to be more than mere coincidence that Woods proposed to the university trustees on June 23, 1863, that a professorship in the natural sciences be established and that an endowment be subscribed to ensure the salary of the position.³⁶ Josiah King, an observatory manager, was appointed to raise the requisite funds for this endowment. In addition, William Thaw, also an observatory manager, on September 3 nominated the name of B. C. Jillson, L.L.D. from Yale and a geologist, to fill that chair. Jillson was duly appointed but declined. Thus, pending completion of the endowment of the university chair and the election of a suitable candidate, the observatory board of managers found it necessary to look elsewhere for what they may have considered to be an interim solution to the directorship problem.

On Thursday, November 12, 1863, the board of managers of the observatory held their first formal meeting since that of November 23, 1861.³⁷ The purpose was the "consideration of the propriety of proceeding without further delay to elect a Director." But first they care-

³⁵ *Ibid.*

³⁶ Records of the Board of Trustees, Western University of Pennsylvania, Minute Book No. 1, June 23, 1863. See also for Sept. 3, 1863. For a biography of B. C. Jillson, see George T. Fleming, *My High School Days* (Pittsburgh, 1904), 95.

³⁷ Minute Book, Nov. 12, 1863, 45; Nov. 14, 1863, 46; Nov. 17, 1863, 47.

fully defined the duties and conditions of the office. Initially, no salary would be attached to the position, as use of the house on the premises was to be considered compensation. The director would have to keep the dwelling and the grounds in repair, take charge and custody of the observatory and its instruments, keep them in good repair, and accommodate the stockholders and the public as the bylaws might direct. The managers were prepared to elect a director and they had a specific person in mind. This was Philotus Dean, Jr., who promptly responded to the managers agreeing to the conditions and accepting the position "if elected Director."³⁸ However, the meeting of the managers produced a new development, namely, that Professor Bradley should be entitled to a hearing. A meeting of the managers was set for the following week to hear Bradley, but evidently he did not appear. The board then proceeded immediately to the business of electing a director. William Thaw nominated Philotus Dean, who was then duly elected director for a period of one year and "thereafter during the pleasure of the Board of Managers." The Allegheny Observatory at last had a director, at least in name, for it happened that several weeks elapsed before Philotus Dean could become the director in fact.

Following the election of the director the managers returned to the claims of Bradley. Evidently, Bradley had spent \$150 of his own funds when he visited New York City on business of the corporation. He was requesting, in fact demanding, remuneration. In addition, when Fitz had hurriedly left for New York after mounting the telescope, it was Bradley who was saddled with the task of adjusting the polar axis of the telescope into exact alignment with the earth's rotational axis, adjusting the drive mechanism gear train to permit the telescope to track the stars, and carrying out any other adjustments that might have been necessary. All these adjustments required great skill, and Bradley unquestionably reasoned that this work had properly been the duty of Fitz as part of his contract to construct the telescope. Thus, if he, Bradley, had now to perform these duties then he should be suitably compensated. He demanded \$1,200. On the other hand, the managers reasoned that Bradley had accepted the use of the observatory dwelling as full compensation for his duties as custodian. The duties of custodian included "maintenance and repair," and the adjustments which Bradley performed should be included within that category. A mitigating factor in their decision was, of course, the fact

³⁸ Philotus Dean, Jr., to board of managers, Nov. 12, 1863, Allegheny Observatory Documents.

that the treasury did not have \$1,200. The managers, therefore, disallowed the \$1,200 claim and offered Bradley only the \$150.

This settlement was quite unacceptable to Bradley and he refused to vacate the premises to the appointed director, Dean. A legend has persisted to the present day that, during the weeks that elapsed after this decision of the managers, an impasse resulted, as Bradley sat guarding the telescope with his *shotgun*.³⁹ Because Bradley still did have friends among the body of incorporators, some pressures were brought to bear, and the managers finally agreed to pay him the full amount, \$1,350, for which they had once again to encumber the association with a loan.⁴⁰ Thus, Lewis Bradley faded from the scene of the Allegheny Observatory, to reappear years later as a central figure in an even more bizarre circumstance — the theft of the lens from the great refractor. That, in itself, is another story.⁴¹

The choice of Professor Philotus Dean as director was not altogether surprising. Dean was a graduate of Yale College and he possessed an A.M. degree from Oberlin College. He was a learned man in his own right, and some years earlier had been principal of the Avery College, a school for blacks in Pittsburgh. Thomas Howe and Josiah King, managers, had also at that time been trustees of the Avery institution. Dean was now principal of Pittsburgh High School where he taught mathematics and astronomy, and he was obligated to continue in his principalship, which left very little time to devote to the affairs of the observatory.⁴² He did, however, live in the dwelling on the premises and acted in a custodial capacity.

George Woods, who had failed to place his man as director of the observatory, now came forward with an alternative plan. The past few years had been marked by expansion at the university. Enrollment was up, the Ross Street site had become cramped for space, and

39 Although the name Philotus Dean is generally associated with this legend, it is more reasonable in the light of the facts presented here that this was Bradley. As John Brashear, who was a confidant of William Thaw during the 1880s, recalled many years later, "Prof. Bradley . . . a teacher well known to many of the older citizens of Allegheny and Pittsburgh, a man with an eccentric character coupled with his wisdom. My friend William Thaw told me that at one time Prof. Bradley refused to allow even the trustees of the institution to look into the telescope — 'he made it a fetish.'" (Undated and unidentified newspaper clipping in Allegheny Observatory Documents, probably about March 1909.)

40 Minute Book, Jan. 5, 1864, 48; Feb. 1, 1864, 49.

41 See Wallace R. Beardsley, "Samuel Pierpont Langley — His Early Academic Years at the Western University of Pennsylvania" (Ph.D. diss., University of Pittsburgh, 1978), 94.

42 For a biography of Philotus Dean, see Fleming, *My High School Days*, 71. Dean is portrayed as a man beloved by all who knew him.

Woods envisioned a future institution in the truest university sense, large in size and in scope rivaling Harvard and Yale. He looked to that day, not far off, when a move to larger quarters would be necessitated and he began to eye covetously the large ten-acre site of the observatory.⁴³ He proposed the two institutions merge; the university would if necessary assume the debt and thus preserve the observatory, but more important, at least to Woods and his grandiose future plans, a large plot of land would be obtained on which could be built his university of the future. Small matter, at least to him, that the site surmounted a steep hill and was at that time virtually inaccessible. William Thaw concurred with Woods on this plan, and the managers began to lay the necessary groundwork for the proposed merger.

A significant feature of their plans was that every effort would be made to free the observatory of debt and to endow a professorship of astronomy by means of a subscription drive before the transfer. The board of managers, as trustees of the university also, certainly had no desire further to encumber the university if it were at all possible. The initial results of this subscription drive showed that \$15,000 was quickly pledged in addition to the \$15,650 previously raised (at least in theory) by means of the original stockholder pledges. The goal of \$30,000 was met which covered the \$12,000 indebtedness (paid off by the managers personally) and which enabled the remainder to serve as an endowment sufficient to pay the salary of a professor of astronomy.⁴⁴ The university was absolved from incurring any part of the indebtedness.

On March 23, 1865, the Pennsylvania state legislature passed an enabling act permitting the Allegheny Observatory and the Western University of Pennsylvania to merge, provided that "nothing shall relieve the Trustees of the University from carrying out the trust vested in the Managers of said Observatory."⁴⁵

43 "The Allegheny Observatory," *People's Monthly*, 57. The evidence that Woods considered expanding the university to the observatory site is indirect. Nevertheless, a clear-cut statement of this intent appears in the Agreement to Merger (Minute Book, May 10, 1867, 62). Also, the 1869 will of William Thaw (Thaw papers, Archives, Historical Society of Western Pennsylvania) makes this a necessary condition. (See Beardsley, "Samuel Pierpont Langley — His Early Academic Years," 21.) The university eventually did move to the observatory site twenty-two years later after the completion of an electric street-car line on Perrysville Avenue.

44 Large Minute Book, Nov. 3, 1864, 56.

45 See Holland, comp., *Acts of Assembly and Other Important Papers Relating to the Western University of Pennsylvania*, 14.

All that was needed now for the merger to occur was a meeting of the incorporators of the Allegheny Observatory at which they would ratify a "Consent to Transfer" document, and a meeting of the board of trustees of the university at which they would accept the transfer and acknowledge and agree to abide by its terms. For some unexplainable reason these meetings did not occur. In fact, it was not until February 8, 1867, that the Allegheny Observatory was at last accorded mention in the minutes of the board of trustees of the university.⁴⁶ The board had resolved that a committee of trustees be formed and do whatever necessary to secure the transfer of the property of the Allegheny Observatory to the university, under the provisions of the Act of Assembly of March 23, 1865, in a legal and proper manner.

Just what did transpire during the interval from November 1864 through February 1867? The records are completely mute. No meetings of the board of managers or of the incorporators occurred, nor is it entirely clear whether Philotus Dean remained on as director beyond the term of his one-year appointment. It does seem certain, however, that the observatory and the telescope sat through a period of disuse and neglect. Telescopes in unheated domes are quickly subject to the depredation of dampness and cold. The telescope and dome garnered corrosion and rust. The university may have finally realized that immediate action had become necessary lest they suffer irreparable loss to their potential investment. On May 10, 1867, the final meeting of the stockholders (incorporators) of the Allegheny Observatory was held at the offices of Thomas M. Howe. Out of an original sixty-six incorporators, only fourteen were present. The vote was nine to one in favor of merger (several of those present left early), and on June 24 the board of trustees of the university accepted the merger — the institution was now the Allegheny Observatory of the Western University of Pennsylvania.⁴⁷ In August the board of trustees elected Samuel Pierpont Langley to the chair of astronomy and physics. Professor Langley came at once and commenced teaching physics, astronomy, and engineering. With him, the Allegheny Observatory entered a new era, an era of professionalism. The coming years would be busy ones for Langley, but the story of these years, the story of scientific achievement, is far beyond the scope of this investigation.⁴⁸

46 Records of the Board of Trustees, Western University of Pennsylvania, Minute Book No. 1, Apr. 1, 22, 1867.

47 Minute Book, May 10, 1867, 62, and Records of the Board of Trustees, Western University of Pennsylvania, Minute Book No. 1, June 24, 1867.

48 See Donald L. Obendorf, "Samuel P. Langley: Solar Scientist, 1867-1891" (Ph.D. diss., University of California, 1969).

In retrospect, it might be well to ask if the foregoing events relate to an overall emerging consciousness about science in nineteenth-century America. Even though ensconced as it was within a strictly local framework, the arousal of scientific enthusiasm in Allegheny and Pittsburgh was not atypical of an upsurge of popular interest in science throughout the antebellum United States. William Goetzmann⁴⁹ refers to this era as belonging to the Second Age of Discovery. Many of his conclusions and also those of Deborah Jean Warner in an accompanying article were arrived at independently by this author while researching this article. A careful reading of the newspapers of the day (in this case the *Pittsburgh Dispatch*) should impress even the most avowed skeptic that the 1850s was an exciting decade indeed. One reads of the fervor of the California Gold Rush, the settlement of Kansas, and fascinating narratives of journeys to far-off places. Photography was coming to the fore, and the stereogram brought the distant world into one's livingroom. Public lectures zoomed in interest as they became vividly illustrated by use of lantern slides. Bookstores stocked a vast inventory of travel and adventure volumes including such scientific discourses as Herschel's *Outlines of Astronomy*, which placed emphasis upon the physical nature and wonders of *other* worlds. The populace eagerly devoured such journals as the *American Journal of Science and the Arts*, *Scientific American*, and *Harper's Weekly*. As a multitude of lecturers marched from city to city each fall and winter giving lectures on widely diverse topics including every phase of science, these lectures became the social outlet of the era. Everyone of affluence came to give them their rapt attention.

In all this regard the Pittsburgh area was no exception. But it did differ from most other areas of the country because of three local factors which ultimately spawned the Telescope Association. First, there was the presence of many captains of industry, men of affluence who were making Pittsburgh the forge of the nation. These men were technically oriented, many were well read in scientific subjects. They envisioned the wonders of technical achievement and reached out in their minds to grasp for other worlds; they were like Abraham Garrison who, as a young boy, stood with his father on the bank of the Hudson River gazing with awe as Robert Fulton's *North River Steamboat* churned by on its maiden voyage to Albany. This memory

49 William H. Goetzmann, "Paradigm Lost," in Nathan Reingold, ed., *The Sciences in the American Context: New Perspectives* (Washington, 1979), 21, and also Deborah Jean Warner, "Astronomy in Antebellum America," 55.

served as an inspiration to him for the rest of his life. The second factor might be interpreted as an essential ingredient at the local level, critical to the inauguration of strong action such as the Telescope Association. This was a scientifically sympathetic press. In Pittsburgh, the *Dispatch* served in this capacity, reporting astronomical events, discoveries, and theories in a sense of wonder and preciseness suggesting an editor with deep scientific acumen. The third factor, of course, was Lewis Bradley. It was he who spoke to all of the wonders of the heavens, introduced them with his small telescope, and it was he who convinced everyone that there was no limit to the wonders that a larger telescope would reveal.

Finally, there was a profound change in the nature of scientific investigation in the offing during the 1850s. The Second Age of Discovery may be regarded as an era involving "democratic science." It was an era of discovery of form, species, and domain, and the attempt to link these to temporal and evolutionary relationships. Much of this investigation was "democratic" in the sense that an amateur could easily play a significant role, particularly through discovery and classification. But in the latter part of the nineteenth century the Second Age began to draw to a close and with it went an era when the amateur (with a few exceptions today) could establish a notable reputation in science. The Telescope Association was a last gasp, so to speak, of "democratic science." After the Civil War a spirit of professionalism emerged: universities began providing full curricular training for scientists; observatories and laboratories were increasingly incorporated into the university framework; organizations of scientists were formed which advocated rigid accreditation. Support for complex research was to become dependent on financial resources far beyond the means of small amateur groups such as the Telescope Association.

It is of course true that amateur scientists continue to exist in the present day. But now the domain of discovery still open to the amateur has become greatly restricted. Amateur astronomers routinely chart the deviations of variable stars and search for comets. They still do band together into associations and construct observatories, and the wonder of other worlds is still there, as is the thrill of discovery. But the instruments they use remain small by present-day research standards. An ever-widening gulf separates them from the professional astronomers and the frontiers of space.