THE MARIA MITCHELL OBSERVATORY—FOR ASTRONOMICAL RESEARCH AND PUBLIC ENLIGHTENMENT

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Received 1999; revised 2001

Abstract

When the Maria Mitchell Observatory was erected in 1908 to house the 5-inch telescope that had been given Maria Mitchell in 1859, Mrs. Lydia Hinchman, niece of Maria and the principal co-founder of the Maria Mitchell Association, wanted the Observatory to specialize in research while not neglecting public relations entirely. She contacted Professor E. C. Pickering, Director of Harvard College Observatory, for advice. He recommended installing a photographic telescope and having the astronomer specialize in observations of variable asteroids, Eros in particular. Margaret Harwood, one of his assistants at Harvard, was chosen to head the Maria Mitchell Observatory, a post she held for 45 years. Besides lesser contributions, she published a catalogue of 74 asteroids known to have variable brightness. She discovered DF Cygni, an unusual type of variable star with multiple periods, and analyzed its variation on Harvard and Nantucket plates spanning over 50 years. Her final masterpiece was an analysis of 419 variable stars in the Scutum region of the Milky Way, the majority of the variables having been discovered by her High School assistant John Heath. The second Director, Dorrit Hoffleit, instituted a new project, Summer Research Participation on Variable Stars by College Undergraduates, especially women. This project was continued by her successor, Emilia Belserene. Nearly 200 college undergraduates participated in these programs. The fourth Director, Eileen Friel concentrated on both observational and theoretical researches on star clusters, her students contributing few papers on variable stars. The current Director, Vladimir Strelnitski, again enthusiastically specializes on modern problems of variable stars.

1. Introduction

Maria Mitchell (1818–1889) America's first woman astronomer, was born on the island of Nantucket where she was educated mainly by her father, William Mitchell, a gentleman of many talents, a teacher, banker, and trustee of Harvard College

Observatory (Figure 1). Maria became famous when she discovered a telescopic comet in 1847, for which she was awarded a gold medal established by the King of Denmark. When Matthew Vassar in 1865 opened the first liberal arts college for women, Maria was invited to become the first woman Professor of Astronomy in America and Director of the Vassar College Observatory. She became an inspiring teacher (Hoffleit 1983). After her death her students and associates visited Nantucket to see where she had been born and lived before going to Vassar.

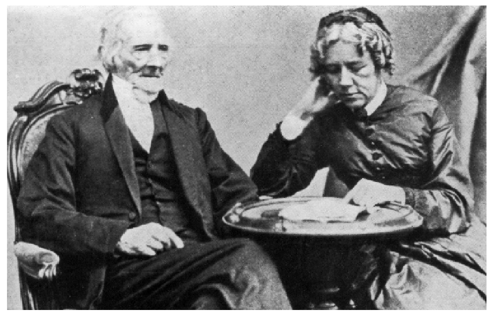

Figure 1. William Mitchell and daughter Maria.

When, in 1837, William Mitchell had become cashier for the Pacific Bank, where he was given living quarters on the second floor of the bank, William sold the 1790 house where Maria was born to his brother Peleg. In 1902 Mrs. Peleg Mitchell, widow of Maria's uncle, died. Some years previously Charles Hinchman, husband of Lydia, Peleg Mitchell's youngest of three daughters, had suggested that the birthplace be made into a memorial for Maria Mitchell (Drake 1968). The three sisters enthusiastically agreed, and Lydia Hinchman (Figure 2) contacted Vassar alumnae and others associated with Vassar, and members and friends of the Mitchell family. A committee of twelve was assembled to look into forming a Maria Mitchell Association with headquarters in the birthplace. Mary Whitney, Maria's first student and her successor as Professor and Director of the Vassar Observatory, was made the Chairperson of the committee. Their objective was "to purchase and preserve the birthplace of Maria Mitchell as

Figure 2. Oil portrait of Lydia S. (Mitchell) Hinchman at the age of eighty-eight. Painted by her daughter Margaretta S. Hinchman. *Courtesy of the Nantucket Maria Mitchell Association.*

a memorial museum for scientific purposes" (Anon. 1903). They circulated the plans mainly to Vassar alumnae and others associated with Vassar and to friends and members of the Mitchell family. By the end of 1902 their goal was accomplished, with a membership of 191 women and 28 men. The original By-Laws defined the composition of the Board of Managers as follows:

> The Association shall be managed by a Board of not fewer than five persons, who shall have been at some time students at Vassar College, or affiliated with it, except in the case of Nantucket resident members, concerning whom it is necessary to make an exception.... From this Board shall be elected the officers of the Association. (Anon. 1903)

The first President was Professor Whitney, and the first Board was all women. The Association was incorporated in the state of Massachusetts in July 1903.

The first curator of the Birthplace was Mrs. Mary Albertson, Lydia Hinchman's oldest sister. Under her leadership the activities of the Association ultimately fell into four categories, The Memorial House specializing on mementos of Maria Mitchell herself, natural science of Nantucket Island, astronomy, and finally a library. Mrs. Albertson and her daughter Alice (later Mrs. Alfred Shurrocks) were biologists so it was not surprising that natural science classes would get a head start on astronomy. Mrs. Albertson in 1906 started a program of talks on birds, butterflies, and solar eclipses, and arranged for "Moon Evenings" at which visitors could observe with Maria's own telescopes. However, through Mrs. Hinchman's contacts with Professor E. C. Pickering, Director of the Harvard College Observatory, Annie Jump Cannon, Wellesley Class of 1884, was asked to chair an Astronomy Committee. She started coming to the island in 1906 to spend two weeks a year on the island giving classes in astronomy, and carrying out suggestions by correspondence for further work.

Members and friends donated or loaned memorabilia, portraits, and books, including Maria's personal library donated by her brother Professor Henry Mitchell (1830–1902), and furniture either formerly belonging to Maria or typical of her time on Nantucket. Most important was the loan by Mrs. John F. Havemeyer, Henry's daughter, of a small spy glass formerly belonging to Maria; and the loan, by Dr. Clifford Mitchell, a nephew of Maria, of the 3-inch "Little Dollond" with which Maria had discovered her comet (later he donated it outright). The 5-inch Alvan Clark telescope that had been given Maria in 1859 by "the Women of America" was donated in 1906 by Dr. and Mrs. William Rollins of Boston who had purchased it at the sale of Maria Mitchell's estate. The 5th Annual Report for 1907 commented, "The Association could scarcely receive a more valuable gift, unless it were a fireproof building in which to place it; and now that the telescope is ours, we should work earnestly for its proper protection and preservation." That goal was promptly achieved by the erection of the Observatory on land next door to the West of the Birthplace on Vestal Street (land where formerly Maria's grandparents' house had stood). With foresight, in 1906, Mrs. Hinchman had bought the land, had the old house demolished, and donated the land to the Association for the purpose of erecting an observatory (Drake 1968, p. 8). The dedication exercises for the "Fire-Proof Observatory" were held on July 15, 1908.

In her first Report of the Observatory Committee, Miss Cannon (1908) stated that one of Maria Mitchell's students, Ida Whiteside, Assistant at the Wellesley Observatory, was appointed the first observer at the new observatory. She came to the island on July 15, and conducted observations and classes for three weeks, giving numerous public lectures. The astronomy class had a regular attendance of about 25. Among the subjects taken up were variable stars. In her initial Report Miss Cannon stated:

> Special Instruction on variable stars was also given to three residents of the Island, who, it is hoped, may continue observations, and thus render the telescope useful during other seasons of the year. There are now over 3,000 known variable stars, many of which may be followed through all their changes with a five-inch telescope. The observations are simple, and especially suited for isolated observers, who may in this way do really valuable work, worthy to be printed in the astronomical journals. Thus might the Maria Mitchell Observatory be the means, not only of bringing pleasure to the observers themselves, but of adding a little mite to the sum of human knowledge, and of helping to unravel some of the mysteries of the universe. (Cannon 1908)

Table 1. Membership of the Maria Mitchell Association.

Year	*Men*	*Women*	*Total N*	*Life*	*Annual*	*Honorary*	*D N/yr*
1902	28	191	**219**				
1903	27	207	**234**	179	54	1	15
1906	37	230	**267**	205	55	7	11
1908	58	292	**350**	261	72	17	42
1909	59	310	**369**	282	71	16	19
1912	91	448	**539**	375	137	27	57
1922	129	531	**660**	458	162	40	12
1932	113	502	**615**	402	193	20	-4
1942	131	402	**533**	361	159	13	-8
1952	158	380	**538**	373	153	12	1
1958	182	367	**549**	313	225	11	2
1968	232	429	**661**	338	308	15	11
1978	233	406	**639**	310	315	14	-2
1982	230	373	**603**	292	297	14	-9
1985	413	564	**977**	279	681	17	125
1988	481	615	**1096**	245	830	21	40
1992	550	659	**1209**	220	971	18	28
1999	515	640	**1155**	175	971	9	-8

Table 1 shows the growth of adult membership in the Nantucket Maria Mitchell Association from its founding through its 90th anniversary in 1992 and the most recent report for 1999. Only selected years are shown, mainly anniversary years. The Table obviously stresses the involvement of women, who have always outnumbered the men in the membership. The ratio of numbers of men to women has increased from 15% in 1902 to 83% in 1992 but dropped slightly to 80% in1999. The Great Depression of 1929 and World War II may have played a role in the decline of numbers between 1922 and 1952. At first the number of Life members significantly exceeded the number of Annual. But by about 1970 the numbers were about equal and in the mid-1980s the Annual had increased spectacularly while the Life declined somewhat. Finally by 1992 the Annual were nearly five times as numerous as the Life. This trend may have been stimulated by the establishment of "Family" membership with increased activities involving children. The first listing of Families in 1982 indicated 73; a high of 270 was recorded in 1986; followed by a low around 220 between 1990 and 1993, and another high, 282 families in 1994.

2. The first four years at MMO

Mrs. Albertson and her daughter, Alice, had worked voluntarily for the Association, looking after exhibits, collecting natural history specimen, giving lectures for the public, and classes especially for children. But by 1906 the Board of Managers was concerned that without an endowment for salaries the Association might not survive. By January 1907, their fund drive yielded over $2200, and by January 31, 1911, it reached $10,765, sufficient for the purpose of employing an astronomer to conduct the proper activities of the observatory. Meanwhile, for three weeks in the summer of 1908 Ida Whiteside had been appointed an observer. She held three public evenings, giving lectures on the constellations, the planets, and on the Moon. The day of the second lecture was cloudy, so instead of observing she lectured on the possibility of life on Mars. After the third lecture the 150–200 visitors were able to observe the Moon through the 5-inch telescope.

Miss Florence E. Harpham, Ph.D. from Carleton College, and Professor of Mathematics and Astronomy at the College for Women at Columbia, South Carolina, was appointed for six weeks in 1908 as observer and instructor, an appointment that was renewed for July 5 to September 1909, and again for the summers of 1910 and 1911. Dr. Harpham began a series of variable star observations, but was hampered by greater demands on her for lectures and classes. In general, the Observatory was open to the public one evening a week throughout the summer. In 1911 the 5-inch telescope had been sent back to the Alvan Clark company to have the old mahogany tube replaced by a brass tube. The original is now on exhibit in the Memorial House. Through Mrs. Hinchman's efforts fund raising continued. In 1911 Andrew Carnegie, stimulated by an appeal from Caroline Furness at Vassar, gave $10,000, bringing the total contributions to over $25,000. The time was now ripe for selecting an astronomer, to be called a Fellow of the Association. Circulars describing the position and necessary qualifications were widely distributed and eight women applied. Margaret Harwood (1886–1979), Radcliffe class of 1907, and one of Pickering's employees at Harvard Observatory, was finally selected over several other candidates. According to Miss Harwood (in a private conversation with me) the preferred candidate was Mary Proctor, born in Dublin, Ireland in 1862, the daughter of Richard A. Proctor (1837–1888), eminent author of books on astronomy for laymen. They emigrated to the United States in 1882. Mary followed closely in her father's footsteps, also writing popular books and articles on astronomy. She frequently consulted Pickering, asking for data or photographs, to which he graciously responded (Jones and Boyd 1971). Evidently Pickering, himself, was the one to propose her for the Maria Mitchell Fellowship. But when Miss Proctor realized that the term "Fellowship" was somewhat of a misnomer, in that she would find herself the lone astronomer on an isolated island some 30 miles offshore, she declined the honor. Miss Harwood was anxious to get the appointment, but at first Pickering told her she was not sufficiently qualified. But better qualified persons were evidently not available and the choice was reduced to two equally qualified candidates, Harwood and a graduate of Mount Holyoke College in South Hadley, Massachusetts. Harwood was a native New Englander; the other candidate, a native of California. The Committee decided that Harwood would be better able to tolerate the harsh winters on Nantucket than would a Californian.

As quoted by Drake (1968) the Maria Mitchell Fellow was to spend from mid-June to mid-December in Nantucket making observations, doing research or study, and giving lectures or instruction to classes or individuals. Following a six weeks' vacation she was to go to some other observatory for four and a half months for research or study. Finally, every fourth year she was to go to some other observatory—either American or European. Where else could one find such opportunities—either then or now!

When Harwood visited the Mount Wilson Observatory in 1924, as Director of a small observatory she was the first woman to be accorded the privilege of using not only a 10-inch Cook triplet for her work on Eros, but even the great 60-inch reflector.

Mrs. Hinchman wrote Miss Harwood (Drake, p. 11), stressing that now scientific work should take precedence over more popular activities. Mrs. Hinchman apologized for the amount of time the previous astronomers had spent on popular lectures, elementary classes, and star-gazing, efforts that were necessary for fund raising purposes, adding "Now, not dropping the popular program altogether, we wish to leave our fellow free for her real work as far as possible."

In Miss Cannon's Annual report of the Astronomical Fellowship Committee, she reported most favorably on Miss Harwood's activities during her first term as Fellow on the Island, particularly her success in public relations and instruction of Island and summer visitor children. For her research, Harwood made visual observations of variable stars and borrowed plates from Harvard for photographic observations. That first summer, Professor Pickering visited the Observatory. As a pioneer in photographic astronomy, he proposed that with the addition of a photographic refractor, the Observatory could carry out important work on the variability of asteroids as well as variable stars. The possibility was presented to Mrs. Hinchman and Mrs. Albertson, and funds for the purchase of a 7.5-inch telescope were quickly acquired. The lens was ordered from Thomas Cooke & Son in England and the mounting provided by Alvan Clark Co. in Cambridge, Massachusetts. The telescope was delivered on November 15, 1913, and a few plates were taken before Miss Harwood returned to Harvard in December.

During the 1914 season, after considerable effort was spent readjusting the focus of the new telescope, 84 photographs of excellent quality were obtained, 22 of them on the asteroid Eros. Meanwhile, funds were raised for appointing a second Fellow during the quadrennial years when Harwood would be at another observatory for study or research. This was called the $500 Fellow; the first appointee, for the summer of 1915, was Susan Raymond, a 1913 graduate of Smith College. Before starting her work at the Maria Mitchell Observatory, Miss Raymond spent several weeks at Harvard learning the procedures for photographing star fields and determining magnitudes of variable stars.

Miss Harwood spent her first Quadrennial year as a graduate student at the University of California at Berkeley and the Lick Observatory. Her chief mentor was Professor A. O. Leuschner, who taught her orbit computing. The University of California required a thesis before awarding the degree. A paper on the variables Y Cam and TT Lyr which she had examined at Harvard was accepted as her M.A. thesis (Harwood 1916). Upon completion of this term, Miss Harwood's title was changed from Fellow to Director of the Maria Mitchell Observatory, with tenure.

The Hinchmans and the Board were well pleased, not only with Miss Harwood's success as Director of the Observatory, but they were particularly grateful to Professor Pickering for all his efforts in establishing and equiping the Observatory and guiding its initial projects. Hence, Mr. and Mrs. Hinchman were influential in starting a fund drive for the establishment at Harvard of an Edward C. Pickering Astronomical Fellowship for Women. This was completed in 1916 and was presented to Pickering on the 40th anniversary of his becoming the Director of the Harvard College Observatory, where his assistance to the Nantucket Observatory as well as his "early appreciation of woman's ability in scientific research" were stressed (Cannon 1917).

3. Variable asteroids

The first asteroid discovered was Ceres, by Giuseppi Piazzi in 1801. By about 1900 some 800 were known and new ones frequently discovered thereafter. Eros, the 433rd, was discovered by G. Witt in Germany in 1898. Pickering (1898) declared it "one of the most important discoveries of recent years." It orbits the sun in a period of 1.76 years. It was found to come within 15 million miles of the Earth, closer than any other then known satellite except the Moon (Clerke 1902). Ever since 1866 Harvard astronomers had made observations of asteroids but only for position, not magnitude (Winlock and Pickering 1882). E. von Oppolzer (1901) was surprised to find that Eros was variable in brightness, and requested confirmation. It was found temporarily to go through a double cycle in a period of 5^h 16^m, but it soon stopped varying (Clerke 1902). After that, astronomers closely watched the asteroid whenever it came within viewing range. Pickering in 1901 pointed out a number of corrections that should be applied to determinations of the apparent magnitudes of the asteroid in order to ascertain whether the variations could be attributed to the rotation of the asteroid or whether it were actually a pair of objects periodically eclipsing one-another. The corrections he indicated are for the velocity of light, the distances to the Earth and the Sun, the phase angle, and the direction of the pole of rotation. When he suggested that variable asteroids be a major research project for the Maria Mitchell Observatory, Miss Harwood's work (in addition to variable stars) was clearly defined.

Pickering (1901) indicated that photographs taken in 1893 and 1894 showed images of Eros, but failed to show any variation. Plates taken in 1896 gave more conclusive evidence of changes. In 1904 he gave magnitudes for the four brightest asteroids measured in 1895–1898, but commented that Eros in 1900–1901 was too faint for reliable visual estimates with the meridian photometer (Pickering 1901). He concluded (p. 202), "The rapid variations in light of Eros (433) and Iris (7) suggest that much remains to be done in studying the photometry of these bodies." Miss Harwood (1918) examined the 750 photographic images of Eros that had been acquired at Harvard in 1900 and 1901. She found that Eros was varying between 0.4 and 1.1 magnitudes between November 1, 1900, and June 21, 1901, maximum light being nearly constant while the minimum varied. The period also appeared to be varying but needed further confirmation.

O. C. Wendell (1913) made some 835 photometric measurements of 13 asteroids at the Harvard 15-inch refractor, including 295 of Eros between 1898 and 1908. In 1913 Bailey at Harvard's station in Arequipa, Peru, obtained both photometric and photographic measurements from December 6, 1902, through August 19, 1903, and derived a period of 0.2196 day, showing both a primary and secondary minimum (Bailey 1913). He also found indications of variability in five other asteroids. More work was clearly wanted, and results from the new Maria Mitchell Observatory telescope were eagerly awaited.

In all, between 1915 and 1930 Harwood published 14 notes or longer articles dealing with the magnitudes of asteroids. Her first (1915) reported that the period of Eros obtained by Bailey in 1903 would not represent her observations from 121 images obtained at Harvard and at the Maria Mitchell Observatories between August 28 and December 17, 1914. For the 1914 opposition of Eros, she reported a period of 0.3064 day at the American Astronomical Society meeting in Berkeley, August, 1915. Miss Cannon (1916), Chairman of the Astronomical Fellowship Committee, was favorably impressed, reporting: "Miss Harwood's work on Eros and discovery of a change in the period of the variability of this asteroid was a subject of such an unusual interest at the California meeting of the American Astronomical

Figure 3. Margaret Harwood, Margaret Walton (Mayall), and Harlow Shapley, advertising an MMO "Open Night" to hear a talk by Shapley in 1925.

Society that it was fully discussed by the astronomers present, while owing to lack of time, titles only of several other papers were read." Alas, subsequent re-examination of the plates revealed that the supposed variation of the asteroid instead came about from the variability of one of the comparison stars (Harwood 1920). In 1926 she reported that plates she obtained at Mount Wilson and Harvard plates taken at Arequipa indicated that during the 1924 opposition of Eros, its period was approximately 0.1988 day, or $4^h 46^m$ (Harwood 1926).

Harwood's most important paper on asteroids was a summary of all asteroids known to have shown variability up to 1922 (Harwood 1924). Here she tabulated from the literature the numbers of all available observations, as well as noting unpublished data from Harvard and Nantucket for 74 asteroids, 36 of which had been photographed at the Maria Mitchell Observatory. The numbers of observations for each of the 74 ranged from only 3 for Melusina in 1903, to over 1900 for Eros. Unpublished Harvard observations of various asteroids totaled over 3200. A history of the discoveries and subsequent investigations is given as well as a discussion of then prevalent theories to account for the variability, usually assumed to be due to rotation.

In a review paper on Eros, Harwood (1930b) discussed the achievements and short-comings of previous determinations of its period and amplitude variations. The asteroid would be in favorable opposition from late 1930 until June 1931 and she hoped adequate closely-spaced observations would become available to resolve some of the problems. However, in the

Figure 4. Maria Mitchell Observatory Director Margaret Harwood (second from left) flanked by David Pickering (AAVSO President), Leah B. Allen (AAVSO Charter Member), and Leon Campbell (AAVSO Recorder), at the AAVSO's Spring Meeting held at MMO, June 1930.

field of Eros adequate comparison stars were not yet available. By mid-October, she had already obtained plates on 13 nights, but the asteroid was too faint and moving too swiftly for useful magnitude determinations. Then on October 26 and 27 she obtained 24 exposures within an interval of $6^h 31^m$, stating that they showed a well defined double light curve confirming the 5^h16^m period (Harwood 1930c). In her Report for 1931, Harwood stated that between July 28, 1930, and May 18, 1931, 826 images had been taken on 55 nights, and the plates were still in the process of measurement (Harwood 1932).

The Annual Reports of the Director of the Maria Mitchell Observatory indicate that she must have acquired over 2000 images on multiple exposure plates on Eros from 1930 through 1939, but she published no further results from these years (Harwood 1956). The next opposition of Eros was scheduled for 1945 when Harwood was busy with war work, not able to devote time to astronomical observations. Could the fact that Harwood did not complete her analysis of her observations of 1931–1939 have been the consequence of the decease of her three most important mentors at Harvard: Pickering in 1919, Bailey and King both in 1931? The new Director, Harlow Shapley, warmly supported her making use of all the Harvard Observatory facilities for her work and published all of her papers that she submitted to him. But he in no way specifically directed her work as they had done.

From a quick inspection of Harwood's record books at the Maria Mitchell Observatory, it is apparent that she had made considerable progress in examining

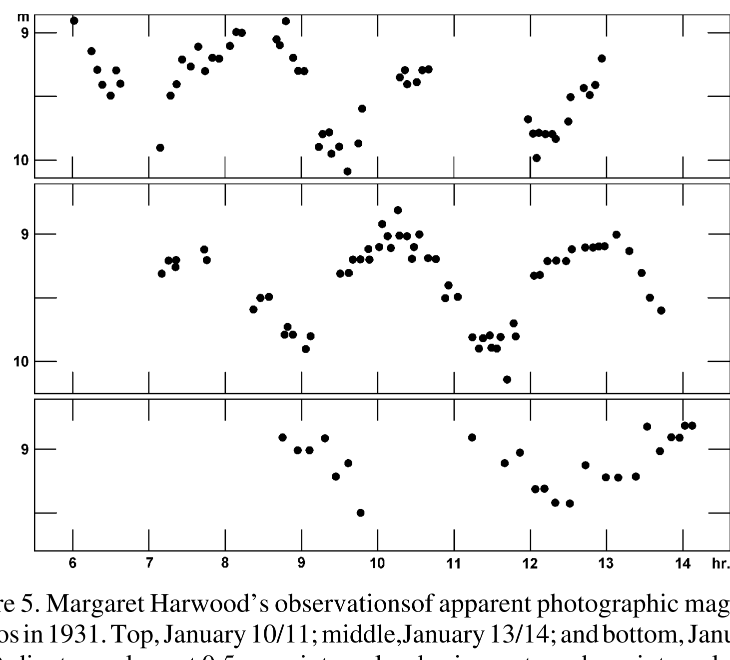

Figure 5. Margaret Harwood's observationsof apparent photographic magnitudes of Eros in 1931. Top, January 10/11; middle,January 13/14; and bottom, January 21/22. Ordinate markers at 0.5 mag. intervals; abscissae at one hour intervals.

her plates of Eros taken in 1931. She must have spent a great deal of time ascertaining magnitudes for comparison stars, making as certain as possible that all lying along Eros' path were consistent. The magnitudes she recorded for Eros are probably apparent, not absolute. The amplitudes and true periods of rotation will differ from the apparent. So-called absolute are apparent magnitudes corrected for phase (the angle between the sun and the asteroid) and changing distance. Presumably, she had not gone beyond the apparent estimates. However, on a day-to-day basis, they reveal the approximate period and amplitude, giving a reliable impression of the quality of the observations. She obtained about 275 images on eight nights between January 10 and January 22, 1931. Figure 5 shows the three longest night-runs. These observations are fitted to a half-period of 0.1102 day, or total period of 0.2204 day. Previous determinations of the rotational period had ranged from 0.1988 to 0.2196 day. Leon Campbell (1931), from visual estimates with the Harvard 15-inch and 12-inch refractors, determined a mean half-period of 0.1097971 day or a total period of $5^h16^m13^s$ for the time-span 1898 to 1931. The mean rotational period from 543 minima from 1900 through 1938 (including 385 observed 1930–1931 and 124, 1937–1938) compiled by Huruhata (1940) is 0.21949088 day or $5^h16^m04.012^s \pm 0.005^s$, somewhat shorter than the other values in Table 2.

Table 2. Published rotational periods and dimensions of Eros.

Name	*Year*	*Period*			*Dimensions (km)*
E. von Oppolzer	1901	5^h	16^m	^{s}	
S. Bailey*	1903	5	16	13	
M. Harwood	1930	5	16		
L. Campbell*	1931	5	16	12.94	
F. Watson*	1937	5	16	13	35 × 11 × 11
M. Huruhata*	1940	5	16	4.012	
B. Zellner	1976	5	16	13.4	36 × 15 × 13
NEAR	1999				33 × 13 × 13
NEAR	2000	5	16	12.89	

**At Harvard*

Paraskevopoulos and Steyn (1931) in Bloemfontein, South Africa, obtained observations on January 21–22 and February 16–17, 1931; and on January 18 Leon Campbell at Harvard obtained observations consistent with those from Bloemfontein. Paraskevopoulos and Steyn derived a period of 2^h45^m followed by one of 2^h30^m, but not showing the characteristic light curve similar to β Lyrae's found earlier by Bailey. Meanwhile others carried on similar investigations, confirming the period of rotation as close to 5^h16^m but at other times failing to show any significant variation.

Fletcher Watson (1937) at Harvard made an extensive analysis of the physical nature of Eros based on available observations from 1893 through 1935 (summarized by Rice 1937). He concluded that the asteroid is not a binary as some others had surmised (*e.g.*, W. H. Pickering 1932), but has an irregular shape about 35 km long with diameter 11 km. (Roach and Stoddard, 1938, gave the dimensions as 35.0 x 15.6 x 7.2 km.) Watson was able to account for the changes in amplitude and period of rotation depending upon the position of the asteroid relative to the Earth and Sun. He predicted that the maximum amplitude, 1.5 magnitude, should occur on February 5, 1938. Japanese visiting astronomer at Harvard M. Huruhata (1940) analysed the rotation period of Eros and pointed out that the shape of the asteroid cannot be assumed to be a regular ellipsoid, but must be an irregular-shaped body. Disappointingly, he did not include in his article a discussion of the light curves, so confirmation of Watson's prediction of maximum amplitude in February 1938 is not available there. However, Gadomski (1938) published his observations and light curves of Eros on January 31, February 16 and 27, 1938, indicating a half period of 0.109796 day and that the maximum amplitude of 1.5 magnitudes occurred on the first of these three dates, January 31, 1938. Roach and Stoddard (1938) made a series of photoelectric observations on February 5 and found the variation to be 1.34. Perhaps the most extensive observations of Eros, between September 27, 1937, and April 4, 1938, were made by Beyer (1938), comprising 1730 observations on 69 nights. These show that the amplitude exceeded 1.5 mag between February 11 and February 25.

In her report for 1937 Miss Harwood (1938) stated, "Eros is now near the Earth and in a favorable position for observation. In order to assist in the study of the physical nature of the little planet, we are again working on the variations of its light.... This work will continue through February and March." The following year she reported that she had followed Eros until April 6, 1938, obtaining 112 plates showing 656 separate images obtained between October 1937 and April 1938, adding "From these, light curves have been derived which show ranges in magnitude quite different from any of the predictions. This season, plates have been made for the purpose of checking the scale and zero point of the magnitudes of the many different fields of comparison stars. The work will soon be ready for publication." The next year she reported that 12 plates had been exposed on the comparison stars for Eros. This appears to be her last mention of Eros, except for her final report calling attention to her long series of unpublished observations for the years 1931–1939 (Harwood 1956). At this late date (2001) there may be little incentive for anyone to make reductions of these data. Results from NASA's January 1998–February 2000 Near

Table 3. Asteroids coming closer to the Earth than Eros.

Name	*Discoverer*	*Year*	*Discovery mag*	*Closest Approach (miles)*	*Ref.**
Amor	Delporte	1932	9	<10,000,000	HAC 191; 1
Apollo	Reinmuth	1932	12	1,800,000	HAC 210; 1
Adonis	Delporte	1936	13	1,209,000	HAC 361; 2
Hermes	Reinmuth	1937	10	362,300:	HAC 435; 3

*HAC = *Harvard Announcement Card.*

1. Van Biesbroeck 1932. 2. Rice 1936. 3. Rice 1938.

Earth Asteroid Rendezvous (NEAR) has already produced definitive results (Veverka *et al.* 1999; Clark *et al.* 2000; Thomas *et al.* 2000) that confirm and improve upon earlier results.

Until 1932, Eros was assumed to be the asteroid that came closer to the Earth than any other (14 million miles). Then four others (Table 3) were discovered between 1932 and 1937 (Van Biesbroeck 1932; Rice 1936, 1938). These were faint objects generally moving fast across the sky, making it difficult to get round images comparable with stellar images. Nevertheless, it seems strange that Harwood, who had devoted considerable time to the study of the variability of asteroids, did not make a single mention in her Annual reports of these remarkable new discoveries.

4. Solar eclipses

A total eclipse of the sun was observed at Nantucket on January 24, 1925. In 1831 Maria Mitchell and her father witnessed the Annlar eclipse, but this did not reveal the magnificence of the corona. Professor E. S. King and Margaret Harwood planned for detailed observations at the Maria Mitchell Observatory, where Cecilia Payne (Harvard/Radcliffe's first Ph.D. in astronomy, in June of 1925) played an important role. King and Harwood (1927) wrote up their results on the distribution of light in 437 small areas of the corona and in 15 small areas of the Moon as illuminated by Earth light. She also wrote an extensive description of how Nantucket people were encouraged to participate in observations, especially of shadow bands both before and after totality (Harwood 1925). She was very successful in stimulating public interest not only in the eclipse but also in astronomy in general.

At another eclipse on August 31, 1932, the Moon covered only 99% of the sun as seen from Nantucket, leaving too much light for the solar corona to be seen. Harwood (1933a) therefore organized a team to go elsewhere to observe totality. As most other astronomers picked sites farther north where prospects appeared most favorable, Harwood selected Cape Cod, the farthest southern land site where the sun would be totally eclipsed. Mr. H. M. Aldrich of Boston heard of her plans and offered the use of a tower he owned in Truro, on a hill with magnificent view of the horizon and adequate facilities for work shop and makeshift dark room for loading photographic plates. Moreover, he gave her and her crew the use of a furnished cottage. Her crew of seven included Marjorie Williams, a Smith College instructor who spent several summers at the Maria Mitchell Observatory assisting Miss Harwood, several prominent Nantucket residents and members of the Maria Mitchell Association, and several Nantucket High School students. They had extensive plans for timing the eclipse contacts, photographing the event, watching shadow bands, and making important photometric observations of brightness and color. While the sky was not completely clear during the eclipse, useful results were obtained. In addition to Miss Harwood's assistants for her professional work, other prominent friends or associates of the Maria Mitchell Asssociation came on the day of the eclipse to view the spectacle, including Mrs. Francis Davis, President of the

Association, Mrs. Russell Hinchman from Philadelphia, and Harry B. Turner, Editor and owner of Nantucket's newspaper, *The Inquirer and Mirror*. Another group from Nantucket observed the eclipse from a boat at sea, and seemed to have been able to observe coronal streamers to a greater distance from the sun's photosphere than the observers at Truro, and see more stars during totality. Interested people remaining on Nantucket were instructed to watch for shadow bands, seen successfully from an eastern portion of the Island, but not from sites farther to the west of the actual path of totality. Certainly Miss Harwood had a real gift for inspiring the public to observe celestial phenomena.

The next total eclipse visible from Nantucket occurred on March 7, 1970 (Hoffleit 1971), during Hoffleit's Directorship of the Observatory. The Eastman Kodak Company graciously supplied a large roll of film which was blackened and cut into 200 strips for the Scouts and public to view the partial phases of the eclipse safely. Hoffleit, who at the time was spending half of each year at Yale, the other half at the Maria Mitchell Observatory, arranged for the Yale astronomy faculty and friends, astronomy graduate students and undergraduates taking the elementary astronomy courses, to observe the eclipse from Nantucket. All told, some 40 visitors from Yale and five former Maria Mitchell summer students came. They were distributed mainly at three sites: the Maria Mitchell Observatory, the Loines Observatory half a mile away (established in 1966), and Eileen McGrath's meadow. (McGrath, the Director of the Natural Science Department, had been a frequent volunteer at public open nights under both Harwood and Hoffleit.) Mr. Kimball of Yale took moving pictures of the eclipse at the Loines Observatory. Hoffleit was assisted by Dr. Lawrence Auer and two graduate students at the Maria Mitchell Observatory taking photographs of the eclipse with the 7.5-inch photographic refractor. Another graduate student assisted his father, Professor Byron Janes of Connecticut College, measuring changes in temperature and radiation during the eclipse, observations duplicated at Coventry, Connecticut. They determined that minimum temperature occurred five minutes after the end of totality. For the undergraduates Professor Richard Larson and Dr. Auer had designed projects to be carried out at the Loines and the meadow, making accurate timings of the contacts of the eclipse. Dr. Shirley Patterson Jones of Trinity College, Hartford, was invited by Edith and Clinton Andrews to observe at the Massachusetts Field Station in Quaise, Nantucket. After the eclipse was over coffee and doughnuts were served at Observatory Cottage, where some 200 people trickled in and out to tell their experiences and compare notes with one another.

Three Yale graduate students, Wayne Osborn, Kenneth Janes, and David DeVorkin, all now professional astronomers, wrote an account for the Maria Mitchell Annual Report (1971) describing the various projects. The eclipse was partially interrupted by passing clouds, but on the whole was considered successful. Some other New Englanders who had considered Florida more propitious than Nantucket were not so successful.

5. DF Cygni

A rewarding discovery by Miss Harwood on Nantucket plates in 1926 was the RV Tauri type star DF Cygni, a semiregular star with generally alternating deep and shallow minima. From an examination of 29 Nantucket and 758 Harvard plates, she determined a provisional period of 49.4 days between primary minima (Harwood 1927). Shortly later, collaborating with Russian visiting Professor Boris Gerasimovic at Harvard, they derived more erudite results compensating for a changing period (Harwood and Gerasimovic 1927), representing the primary minima by the formula:

$$\text{J.D.}\,2423321.9 + 49.856E \pm 8.5 \sin(2.17E),$$

where E represents the number of epochs from the initial J.D. At a meeting of the American Astronomical Society in Cambridge in December 1933, Harwood (1936) summarized updated results from 1400 Harvard and Nantucket plates spanning the years 1899 through 1933. The "remarkably regular period" was revised to 49.808 days and she cited A. Brun (1932) as having ascertained that the star also had a secondary period of 790 days. For the Harvard Tercentenary in 1936, Harwood presented a beautifully complete account of the variability of this star on 1757 Harvard and Nantucket plates dating from 1889 through 1936. Now she found that the primary period of 49.808 days is superposed on a long period of 782 days, and found evidence for a third period of about thirty years. Complete diagrams and a catalogue of the observations were included.

In RV Tauri type stars, primary and secondary minima are sometimes interchanged. By 1940 Harwood had obtained 208 additional Harvard and 170 Nantucket plates on DF Cygni, revealing that such an interchange had occurred during a maximum phase of the 782-day period (Harwood 1940, 1950a).

Margaret Vogt comments, "If there is any one star that can really be said to belong to the Maria Mitchell Observatory, that star would be DF Cygni" (Vogt 1970). In 1970 Swarthmore student Vogt was spending the summer at the Maria Mitchell Observatory, bringing the Nantucket observations of DF Cygni up to date using 730 plates taken between 1937 and 1970. She found that the primary period shows a slow secular variation of about 0.00065 day per epoch.

6. The Scutum Cloud

Although Miss Harwood published five papers on variable stars between 1912 and 1925, it was in 1925 that she selected the Scutum Cloud, centered on the open cluster M11, as her primary field for variable star research. At Harvard in 1923 Harlow Shapley had divided the sky into numbered variable star fields for the discovery and analysis of variable stars, a project expected to take from 10 to 15 years (Miller 1946). The field Harwood picked, 210 square degrees in Scutum and Aquila, overlapped nine of the approximately 8×10 degree Harvard variable stars fields (Harwood 1930a, d).

Harvard refrained from examining these fields for variables in deference to the Maria Mitchell Observatory, but continued systematic photography for the benefit of Harwood's project. In particular, the Harvard Bruce plates, 24-inch photographic refractor, plate scale 60 arcseconds/mm (in contrast to 248 arcseconds/mm for the Nantucket plates), provided the bulk of the variable star discoveries in this area. Harwood shared this work with a few gifted Nantucket High School students, other adult assistants who were residents of Nantucket, and during summers with young professional women astronomers: at different times, Margaret Walton, a Swarthmore graduate working at Harvard; Martha Stahr and Helen Dodson from Wellesley; Marjorie Williams from Smith; Jocelyn Gill from Mount Holyoke; and astronomy historian Helen Wright, a Vassar graduate working on a biography of Maria Mitchell (Wright 1950).

In 1934 Harlow Shapley cancelled further work on the discovery of faint variables in low galactic latitudes (*i.e.*, along the Milky Way) in favor of fields at high galactic latitudes. His major goal had been the discovery of the kinds of periodic variables whose absolute or intrinsic magnitude could be assumed from period-luminosity relations. In 1912 Henrietta Leavitt had found from her discovery of variable stars in the Magellanic Clouds that the Cepheid variables with longest periods were apparently the brightest. This meant that once the distances of some similar variables could be determined, the period-luminosity relation could be expressed in terms of absolute magnitude. Hence, from the period, the absolute magnitude could be assumed, and from the difference between the apparent and absolute magnitudes, the distances could be determined. One of Shapley's major interests was the determination of the spatial distribution of stars in our galaxy, and variable stars were presumably easy targets. But he assumed that interstellar absorption (making the stars appear significantly fainter than they would if there were no interstellar dust), about which little was known in the early 1920s, would not be a serious handicap. When he realized the seriousness of the problem, he switched the emphasis of discovery to the high galactic fields where the assumption of negligible absorption was more reasonable. Hence, I stopped working on a rich field in Sagittarius where I had discovered or re-discovered about 500 variables (Hoffleit 1972) but had determined periods for only 18, noting that one with a period of 66 days would be at an incredible distance if its brightness had not been affected by unknown interstellar absorption (Shapley and Swope 1934).

When Miss Harwood learned that the Harvard work on low galactic regions was being cancelled she came to me, deeply concerned, asking if she, too, should cancel her work on the Scutum cloud. I assured her, there were other reasons for working on new variables than Shapley's major reason for his researches. For example, the apparent relative distributions of different types of variables within the galactic system seemed to me of considerable interest. This was before the differences between Population I and Population II stars was pointed out by Baade (1944), and in the case of Cepheid variables, was meticulously demonstrated by Baade and Swope (1963) in the Andromeda galaxy, showing that Population II Cepheids

(W Virginis Stars) are period-for-period two magnitudes fainter than the classical Population I Cepheids.

Although Harwood continued working on the variable stars in Scutum, her pace and enthusiasm seemed to decline. In 1930 she had published a survey of what had already been accomplished (Harwood 1930a, d): 218 Nantucket and 266 Harvard plates available, the total spanning 1901 to 1930; 39 new variables discovered with periods or provisional periods for 23 of these; and new or revised periods for 36 previously known variables. This was followed (1933b) by a report giving corrected or confirmed periods for 10 short and 14 long period variables and announcement of five new discoveries with periods for three. The Annual Reports for the next four years reported only on the accumulation of plates for this project.

Dr. Gustav A. Bakos, a refugee from Czechoslovakia at the Leiden Observatory, had also been working on variable stars in Scutum (Bakos 1950). He had discovered or rediscovered 31 variables, of which a few had already been discovered by Harwood's assistants. She had visited Leiden the previous year, and planned an arrangement with the Leiden Observatory, whereby Bakos would spend half time working on the Scutum variables discovered at the Maria Mitchell Observatory (Harwood 1949, 1950b). She commented that the Leiden materials were best suited for the determination of elements of short period variables, whereas the Nantucket plates were more suitable for investigations of long period stars. The frequently exposed Leiden plates barely exceeded an interval of two months whereas the 1095 available Nantucket plates, more sparsely spaced, went back to 1918 and Harvard plates to about 1900. In 1950 Harwood reported that Bakos had already obtained preliminary results for 94, and was working on an additional 121 of the 500 variables that had been discovered and verified by John Heath.

In her last Annual report before her retirement in 1957, Harwood reported that Bakos, now an instructor at the University of Ottawa, Canada, came to Nantucket for ten days in September 1956 to round off the work he had done on the Scutum variables: elements and light curves for 28 short period variables, measurements of 46 long perod variables, and preliminary estimates for 100 additional stars to aid in the determination of their types. It would be another five years before Harwood's results on the variables in the Scutum cloud would be published.

From 1912, when she started working at the Maria Mitchell Observatory, through 1935, she had published 25 astronomical articles. Between 1935 and her retirement in 1957 the number dropped to only five more. In 1959, she reported at an American Astronomical Society meeting on the distribution of different types of variables in the Scutum cloud (Harwood 1959). During the Pickering and Shapley Directorships, Harwood's scientific papers, usually based largely on Harvard materials and guidance, were accepted for publication in the Harvard Observatory *Bulletins*, *Circulars*, or *Annals*. But before she finished her work on the Scutum variables, Harvard had discontinued its own publications. In view of her final close collaboration with Leiden, her ultimate masterpiece was therefore published in the Leiden *Annals* in 1962. Later, in 1970–1972, she was co-author with Harvard astronomers (mainly L. J. Robinson) on six brief notes of observations on Harvard photographs, of objects of then current interest at Harvard.

The final paper on the Scutum Cloud (Harwood 1962), to apply a cliché, "was well worth waiting for." Its 60 pages cover almost anything one might want for the 65 named and 354 new variables it decribed: observations and dates of maxima and minima, types and periods of variables, the distributions of the various types, 133 magnitude sequences, light curves for 33 short period variables, 164 finder charts for all the variables and sequences of comparison stars, and profuse additional remarks on about a fourth of the variables. Yet she pointed out there were still 194 new red variables (spectral class M5 or later) and 88 apparently blue variables that had not yet been investigated.

Of the 31 variables that Bakos had published in 1950, six are included in Harwood's final paper. One of the six she did not identify with the one in Bakos' list, perhaps because their positions differed slightly, although she gave the Cepheid period as 14: days, whereas he gave 14.167days. *The General Catalogue of Variable Stars* (GCVS) (Kukarkin et al. 1969) named the star V801 Aql and gives the position from Harwood, the magnitudes and period from Bakos. In the five cases where she did indicate that both had measured the same star, she gave the same period that he had originally published.

Miss Harwood's personal involvement in the compilation of all the data in her masterpiece was mainly in the planning, supervising, a considerable part of the work on magnitude sequences, checking period computations and remeasuring questioned data, and writing the final report. At least 16 assistants helped in various phases of the work, among whom special credits go to Bakos, to John Heath who discovered the vast majority of the 500 new variables, to Mrs. Ida Lowell and Mrs. Virginia Swain who did a tremendous proportion of the estimates of magnitude and period computations, and to Dr. Marjorie Williams who not only contributed significantly to the determinations of magnitude sequences, but was Acting Director during several of Miss Harwood's extended absences surrounding I.A.U. and other meetings. Astronomers not specifically working at the Maria Mitchell Observatory donated auxiliary data, especially spectral classes or infrared data, namely Drs. Victor Blanco and Jason Nassau of Case-Western Reserve, Gerald Kron at Lick, and Henry Smith at Harvard. Harwood also expresses gratitude for encouragement from Walter Baade of Mount Wilson, and Jan Oort and P. T. Osterhoff of Leiden.

Miss Harwood was an expert photographer. Of the 3652 plates taken during her regime, 2120 were exposed by herself. This was not only an asset to her own investigations but is a lasting contribution to those of her successors who are interested in pursuing variable star researches.

In reading Miss Harwood's Annual Reports one may have the impression (somewhat contrary to Mrs. Hinchmann's desire that the main function of the Maria Mitchell Observatory should be research) that her strongest interests were in public relations: teaching largely school age children and interested public, and conducting public open nights at the Observatory.

On a far away island, a knowledge of navigation is important. Harwood did her share in teaching celestial navigation, in the late pre-WWII years assisted by John Heath. In her legacy she left the Association modest funds for teaching classes in astronomy.

7. Henrietta Hill Swope (1902–1980)

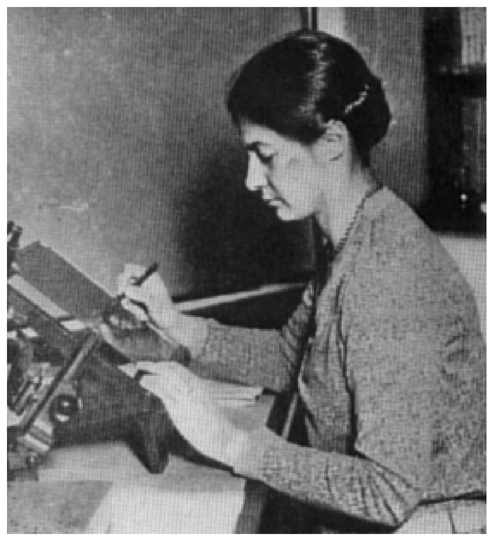

Figure 6. Henrietta Hill Swope. From *The Monthly Evening Sky Map*, Vol. 25, May, 1931.

Gerard Swope, President of the General Electric Company, had a cottage on Nantucket where his family spent summer vacations. His daughter, Henrietta, had graduated from Barnard College in 1925 where she majored in mathematics (Figure 6). The following year she spent as a graduate student in the department of Commerce and Administration at the University of Chicago but found the courses not to her liking. Miss Harwood then suggested that she apply for a job at the Harvard College Observatory. She was accepted as a research assistant to scan plates for variable stars and determine the types of variation and periods of the variables. In this, she was supremely successful. During her first two years she published two papers revealing the discovery of 380 new variables, with approxmate periods for 25 of these (Swope 1928a, b). At the same time she earned an M.A. degree from Radcliffe in astronomy. Eventually, she was put in charge of supervising other workers, examining photographs of different fields of the sky. Gerard Swope was so impressed that he gave Harvard Observatory funds to hire an assistant for her. That is how I happened to get a job at Harvard in 1929, and ultimately to become Miss Harwood's successor several decades later.

Compared with her own mentor, Miss Harwood, Henrietta Swope's successes in variable star astronomy were fantastic. She worked at Harvard from 1926 until the outbreak of the United States involvement in World War II in 1942, when she became part of the MIT Radiation Laboratory staff. In that interval she published 27 papers on variable stars, including the discovery of over 1600 new variables. She supervised some three or four assistants a year, and was secretary to the arm-chair amateurs, the Bond Astronomical Club. She did not attach her name to the publications of the fields investigated by those she supervised, except in the rare instances when those assistants left the observatory before completing their investigations. In the fields she published, all of the work had been her own except for the acknowledgement of the help of one assistant (Constance Boyd) in determining the positions of 121 of her new variables.

8. The Hoffleit Regime

To paraphrase President John F. Kennedy:
Ask not what your students can do for you,
Ask what you can do for your students.

The job I was offered at the Maria Mitchell Observatory was quite different from what Harwood had been offered in 1912. Now the finances of the Observatory were insufficient for both a full-time Director and a pension for the outgoing Director. Hence I was offered the position for six months bracketing the summer months. Dr. Dirk Brouwer, Director of the Yale University Observatory, was chairman of the Maria Mitchell search committee. He offered me a position at Yale for the winter half of the year, working on Zone Catalogues (the determination of proper motions, mainly for southern stars). Instead of the six-weeks vacation given Harwood, I would get four, two from each institution, with, of course, no provision for travelling to other institutions to collect relevant additional data for my researches.

The year before starting my work at the Maria Mitchell Observatory, I accepted a part-time temporary appointment teaching at Wellesley College. When the Board of Managers in Nantucket asked for a plan of what I proposed to do at the Maria Mitchell Observatory, I consulted both the Director of the Wellesley Observatory, Sarah J. Hill, and the President of Wellesley, Margaret Clapp. Their reactions to my proposals were favorable.

I wished to continue investigations of variable stars, at first in Sagittarius to resume work that had been discontinued at Harvard in 1934. I would not deal with stars in Scutum, at least not until Harwood would have completed her investigations. As the Maria Mitchell Observatory is a memorial to America's first woman astronomer and first woman professor, and as women students always had more difficulty than men in getting summer jobs, I planned to engage only women students during the summer.

Already in the 1950s (Figure 7) the equipment at the Observatory was old fashioned, requiring longer photographic exposures on our variables than with most modern and larger instruments. However, somewhat slower instruments have an advantage for beginners, enabling them more easily to discover operational problems and what to do about them. My plan was to establish a research training program for women undergraduates, assigning each student a few stars about which nothing was yet known other than that their light does vary—but how? The students were to take part in taking photographs with the 7.5-inch refractor, examine all available plates to estimate magnitudes, determine therefrom the type of each variable, and if relevant, the period. One afternoon every week we were to conduct a seminar at which the Director, a student, or occasionally a visiting astronomer would discuss a variety of problems about variable stars, including, for example, the hazards of spurious periods, discovery probabilities (*e.g.*, from the number of discoveries and independent re-discoveries in a given field, how many variables all told might be expected), and suggested theories for why the stars vary, with possible bearing on stellar evolution. President Clapp said for what I was planning I should charge tuition instead of paying the students! This I considered strong endorsement for my program. Of course, the assistants needed paying jobs for the summer, so their pay was considered the equivalent of a scholarship.

In addition to research, public open nights were an important part of the summer program and the students took part in showing visitors objects in the Maria Mitchell 5-inch telescope as well as with several portable telescopes. Eventually we started regular open nights for school-age children. Each of the students was then required to give one open night lecture for children. Skills in teaching and public speaking are assets when the students are applying for jobs after graduation. This was an opportunity to try out such skills and aid the students in decisions as to whether to seek teaching or research jobs after graduation.

At the end of the summer season the students were requested to write up their results. I asked the Director of the American Association of Variable Star Observers, if the students might present their papers at the Annual Meetings of the AAVSO. She, Mrs. Margaret Walton Mayall, heartily welcomed them. The AAVSO had been founded in 1911 so that amateur astronomers could enjoy themselves doing work useful to the over-burdened professional. At their meetings it was obvious that if things did not go too well, the response was sympathetic, whereas good reports were warmly applauded. It was an excellent environment for as yet inexperienced students. After one meeting, *Sky & Telescope* (Anon. 1968)

Figure 7. The Maria Mitchell Observatory in June, 1958, on the occasion of the AAVSO Spring Meeting *(photo by AAVSO member Jeremy Knowles).*

commented, "Each summer at Maria Mitchell Observatory on the island of Nantucket, Massachusetts, several college girls make photographic studies of variable stars under the direction of Dr. Dorrit Hoffleit. Their reports are regular highlights of AAVSO meetings." Over the course of my 22 years as Director 166 papers on variables were published by the AAVSO or elsewhere, 96 of them by the students. In all, they represented about 600 stars, the majority in Sagittarius, 41 in Cygnus, 6 each in Scutum and Coma Berenices, and 11 in miscellaneous constellations.

Figure 8. "Dorrit's Girls" at MMO in 1975: (from left) Pattie Guida, Debby Carmichael, Valerie Mehlig (library assistant), Dorrit, Mary Jane Taylor (who now enjoys a career as a professional astronomer), Joan Lucas (a direct descendant of William Mitchell), and Melissa McGrath.

During my Directorship (1957 through 1978, Figures 8–10) approximately 100 women and men participated in the project. Throughout, we depended heavily on outside support, mainly NSF grants. During my last few years there were stringent rules against discrimination. Having lived through many instances of discrimination against women, I was now being criticized as discriminating against men. I had limited housing facilities, mainly having been assigned one 4-cot bedroom for the students, and I was too old fashioned to make that co-educational. One well-to-do young man pleaded to become a part of my program. I told him that I could not provide him with a room and neither could I pay him more than I did the women. If he could afford to find a room on his own, and accept the same monetary remuneration as the female students, he could join the group. This he accepted, evidently with pleasure. But that embarrassed the President of the Association, who found him a room in the attic of the Hinchman House (where the first students had stayed before we acquired Terrace Cottage). John Briggs not only worked on variables but proved himself an asset in solving instrumentation problems.

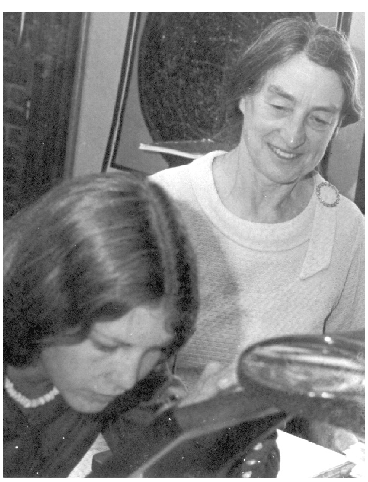

Figure 9. Dorrit Hoffleit at Maria Mitchell Observatory with Joan Lukas, a great-great-grand-daughter of William Mitchell. Summer 1975. *Figures 8 and 9 courtesy of Dorrit Hoffleit.*

He is now Observatory Engineer at Yerkes Observatory.

Figure 10. Dorrit Hoffleit (at left) is presented a painting of Loines Observatory on the occasion of her retirement as Director of MMO in 1978.

Of the students who participated in my variable star project at the Maria Mitchell Observatory, I have not been able to keep in touch with all. To my knowledge at least 25 have earned Doctorate degrees in astronomy or physics and continued professional work. Several others have jobs at astronomical institutions, and several have gone into computer sciences. Many have expressed appreciation that the program clinched their desire to continue in astronomy. One of the most rewarding tributes I received was from Margo Friedel Aller who was at the Maria Mitchell Observatory the summer of 1958, now a radio astronomer at the University of Michigan. In an article circulated to high school science students by the Department of Astronomy at the University of Michigan (Aller 1996), she wrote that when she entered Vassar college she started majoring in French because her father believed strongly that women should follow traditional liberal arts studies. But she had been interested in astronomy ever since, as a child, she attended presentations at the Hayden Planetarium in New York. When I had been invited to give a lecture at Vassar, I described the newly created program at the Maria Mitchell Observatory. Margo was fascinated and successfully applied. Her mother encouraged her to accept. She said she loved the work, "my first experience dealing with scientific problems on my own." When she returned to Vassar she switched her major to astronomy, "with no regrets about the change in career." She, like numerous others, fullfilled my fondest hopes for the project.

Upon my retirement at the close of the 1978 season (Figure 10), the Maria Mitchell Association established a Hoffleit Assistantship to aid in the continuation of the program I had initiated. One student each year from 1979 through 1989 was awarded this title. Three are now active astronomers: Karen Gloria (1983), at the Apache Point Observatory, Sunspot, New Mexico: Amy Lovell (1988) in radio astronomy at the University of Massachusetts at Amherst; and Nancy Chanover (1989) at the Department of Astronomy, New Mexico State University.

9. The third directorship (1979–1991)

Upon my retirement, the Association felt it could afford to appoint the new Director for a period of nine, instead of only six, months a year. Dr. Emilia Pisani Belserene, A. B. Smith College 1943, Ph. D. Columbia 1947, Professor at Lehman College, N.Y., was appointed (Figure 11). She was a recognized expert on changing periods, especially of RR Lyrae type variables. At the Maria Mitchell Observatory she concentrated in this field, assigning the student assistants stars with already known provisional periods to check if and how the periods were changing. This is actually an easier task than starting from scratch to find a first period. However, the students gained a greater appreciation of the value of their tasks by relevant discussions on possible stellar evolutionary implications of the changes, a complex problem in the sense that all the changes are not similar: in some cases the periods progressively increase, in others, decrease; some appear to change abruptly. In my era, the students or I had found changing periods for ten stars of previously unknown types. In Belserene's twelve years as Director she was able to employ 87 students who investigated about 100 periodic variables, of which 66 appeared to show variable periods. Belserene and her students published over 100 articles.

Figure 11. Dorrit Hoffleit, Director Emeritus of MMO (at left), Jane Merrill, President of the Maria Mitchell Association, and Lee Belserene, Director of MMO, at a celebration in honor of Maira Mitchell at Vassar College Observatory, 1987. *Courtesy of the Nantucket Maria Mitchell Association.*

Changes in period were found among just about all types of periodic variables, Mira, δ Cephei, W Virginis, and eclipsing, but the vast majority occurred among the RR Lyrae type stars. 37 RR Lyrae stars were measured on all available Nantucket plates to test for changing periods. Of these, 15 appeared to have constant periods. The (O-C) curves showed that parabolas indicated either steadily increasing or decreasing periods; others showed sudden changes, some quite erratic, and two suggested sine curves which would indicate periodically changing periods. Table 4 summarizes the results for the RR Lyrae stars. There appears to be no consistent pattern between the ranges of periods and the character of their changes. Table 5 similarly shows no significant differences dependent on the part of the sky represented. Coma Berenices is at the galactic north pole, Sagittarius near the galactic center, all the others are in spiral arms. As yet there is no concise theory for the different changes in periods for stars within the same ranges of periods and

Table 4. A search for changing periods among RR Lyrae stars on MMO plates.

Type of Change	*Number*	*Approximate periods*
Constant	15	0.35–0.63 day
Parabolic (O-C)		
Increasing	9	0.35–0.61
Decreasing	6	0.45–0.59
Abrupt	5	0.33–0.69
(O-C) sine curve?	2	0.47–0.58

Table 5. Distributions by constellation.

Constellation	*Aql*	*CVn*	*Cas*	*Com*	*Cyg*	*Sgr*	*Sct*	*Total*
Total No.	4	4	1	16	8	2	2	37
Constant Period	2	3	0	9	0	1	0	15
Secular.Increasing	1	0	1	2	3	1	1	9
Decreasing	1	1	0	3	0	0	1	6
Other	0	0	0	2	5	0	0	7

whose spectral classes (available for only a few of the stars represented here) are all nearly alike. Strangely, in Cygnus all of the stars examined showed changes in period.

The diversity of results obtained by the students under Dr. Belserene's guidance provides much material for the theoretician to ponder and explain. And the collection of photographic plates, increased to 8435 by the end of Belserene's term, remains an asset for checking on the variability of interesting objects, new or needing up-dating (Friel 1992).

10. Changing times

From its inception the Maria Mitchell Observatory was a haven for observational research on variable stars and asteroids. But with changes of directorship and the ever-increasing numbers of new problems crying for attention, the character of work at most institutions has changed, sometimes abruptly and radically with change of directorship. The fourth Director of the Maria Mitchell Association, Eileen Friel, concentrated on star clusters and galaxies, and was a stimulating teacher stressing both the observational and theoretical astrophysical aspects of her fields. Also, the students of this period have had stronger basic training than those in my era. Then, few of the students had been able to take more than just one or two introductory courses in astronomy. The students of this period have had more advanced courses as undergraduates than students during my regime had available even in graduate school. Hence they are prepared for gaining research experience in more difficult advanced problems.

Friel's work with the students was stimulating and productive. Nearly all her students were co-authors with her or her professional assistant in the papers presented at the prestigious American Astronomical Society meetings. Co-authorship may have been necessary because of the possibly greater complexity of an assigned problem than the student could handle with only the supervision of the project director. But when students can present papers of which they are sole authors, their chances for jobs or graduate school are better than when their publications are only as co-authors of already distinguished astronomers. During Friel's regime only two papers of which I am aware were published under a student's name alone, both presented at the AAVSO, not at the American Astronomical Society. At the request of Professor Scott Kenyon at Harvard, Tania Ruiz (1992) brought up to date the light curve of the symbiotic variable, CI Cygni. Then in 1994 Valorie Burkholder (1995) tested a new CCD photometer on Nantucket plates of Supernova 1974G. In her Annual report for 1993 Friel indicated that one student was assigned a project on CCD photometry of the cluster NGC 2324 (M11, at the center of Harwood's Scutum region), identifying X-ray sources on MMO plates and testing for variability. However, the AAS Abstract of this project (White and Friel 1993) makes no mention of tests for variability.

There has been a curious trend in the lengths of the terms of the successive Maria Mitchell Observatory Directors: Harwood 45 years, Hoffleit 22, Belserene 12, and Friel 5. With the appointment of the first male Director, Dr. Vladimir Strelnitski, in 1997, this halving trend appears to have been reversed as he begins his sixth year. He has worked with obvious enthusiasm training undergraduates in modern research. His first year he took the entire group to Arizona to observe the peculiar variable MWC 349 at both the Kitt Peak and the Lowell Observatories. One of the students examined the orbit of Maria Mitchell's comet in order to locate its probable present position, concluding that the comet is receding from the solar system more slowly than the sensitivity of modern astronomical telescopes increases. Hence there is a possibility that the comet may again be observed within a few decades!

For part of all the following years Strelnitski has invited Dr. Nicolai Samus of Moscow to spend a few weeks in Nantucket in order to participate in the supervision of student research projects. Samus is the current editor for updating the *General Catalogue of Variable Stars* (GCVS) sponsored by the International Astronomical Union. Thus the summer students get first-class training. They present the results of their summer's work at professional meetings as well as—when appropriate—at the AAVSO. Many of them expand their summer projects into honor theses at their colleges. Thus the Nantucket Maria Mitchell Observatory has achieved its goal of giving early research training to potential next-generation professional astronomers.

The public has been far from neglected during all the professional training projects. Public open nights are held regularly throughout the year. In 1999 (the last year for which an Annual Report is available) 2083 visitors attended, up from an annual 1700 in 1997–1998 and only about 700 in each of the years 1990–1996.

11. Chronology

1902	Maria Mitchell Association founded: 191 Women, 28 Men.
1906	Maria Mitchell's 5-inch acquired.
	A. J. Cannon came to Island a few weeks a year to instruct Islanders and show sights through the telescopes.
1908	Observatory erected.
1911	Carnegie donated $10,000.
1912	Margaret Harwood elected Fellow.
1913	7.5-inch photographic telescope installed.
1914	Eros opposition. Asteroid research begun. (Eros about twice the area of Nantucket)
1916	Harwood earns M.A. degree at University of California. Her title changed to Director.
	Association established a Pickering Fellowship at Harvard.
1922	Observatory study erected.
1924	Harwood's most comprehensive publication on asteroids published in Harvard Observatory *Annals*.
1925	Work on Scutum Cloud initiated.
	Total solar eclipse at Nantucket.
1926	Harwood discovered the complex variable, DF Cygni.
	American Astronomical Society met on Nantucket. Largest AAS convention to that date, 122 members and guests.
1930	AAVSO Spring meeting on Nantucket.
1932	Nantucket group at Truro to observe total solar eclipse.
1944	Hinchman House bequeathed to Association by Russell Hinchman, and named Lydia Hinchman House in honor of his mother.
1949	Publication of Helen Wright's *Sweeper in the Sky*, a biography of Maria Mitchell (Macmillan).
1950	Collaboration established with Leiden Observatory for Gustav Bakos to work on 500 Scutum variables discovered by high school student John Heath at Nantucket.
1957	Margaret Harwood retired and Dorrit Hoffleit appointed her successor.
	Hoffleit, Director of Observatory, received first NSF Grant for Research Participation of Undergraduates in Astronomy.
1958	50th anniversary of Maria Mitchell Observatory.
	AAVSO Spring meeting attended by largest number since its foundation, over 100.
	American Academy of Arts and Sciences presented the Association a plaque honoring the memory of Maria Mitchell, its first woman member, elected in 1848.
1959	Elma Loines donated her 8-inch Alvan Clark refractor.

1961	The Meteoritical Society held a meeting on Nantucket, attended by 25 members.
	American Astronomical Society held its largest meeting to that date on Nantucket, 500 members, family, and guests.
	Terrace Cottage acquired for use as dormitory for summer assistants.
1962	Harwood's work on Scutum Cloud published in Leiden.
1966	AAVSO held its Annual Meeting on Nantucket.
1968	Loines Observatory dedicated on 150th anniversary of Maria Mitchell's birth.
1969	AAVSO held Annual Meeting on Nantucket.
1970	Total eclipse of sun observed by about 200 visitors to the Island.
1972	AAVSO held its Annual Meeting on Nantucket.
	Elma Loines donated her summer home on Nantucket to the Association and stipulated that the proceeds of its sale be devoted to the summer research participation program for college women undergraduates at the Observatory.
1978	Dorrit Hoffleit retired. The Association established a Hoffleit Summer Assistantship fund in her honor.
	Emilia Belserene elected third Director of the Observatory, an authority on changing periods of variables.
1979	Margaret Harwood died February 6, at age 93.
1983	AAVSO held meeting in Nantucket, celebrating the 75th anniversary of the Maria Mitchell Observatory.
1991	Belserene retired at end of summer season.
	Eileen Friel elected fourth Director.
1992–1996	Most of research is on clusters and galaxies.
1996	Friel resigned near end of season.
1997	Vladimir Strelnitski appointed fifth Director.
	Strelnitski escorted the summer students to Arizona to obtain observations with varied instruments of a peculiar star, MWC 349.
1998	Purchase of 8-inch CCD telescope.
1998–2001	Dr. Nicolai Samus of Moscow Observatory spent part of each summer on Nantucket supervising projects for the summer students.
1999	Acquisition of a new dome for the CCD telescope, next to the Loines Dome.
2000	Sunrise on January 1 occurred on Nantucket 3 minutes before anywhere else in the USA!

12. Acknowledgements

This article is an enlargement of an earlier oral presentation given at the Annual Meeting of the Maria Mitchell Association in July 1997.

I wish to thank Dr. Janet Mattei for accepting this article for publication. Dr. Michael Saladyga and Sara Beck have been very helpful in editing and preparing the manuscript for publication.

The original version of this paper was written some five years ago. In the meantime some sections have become outdated. Dr. Saladyga has been very helpful not only with considerable editing but also in pointing out where additions or changes might be in order.

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