BUFFALO ASTRONOMICAL ASSOCIATION INC.
BUFFALO MUSEUM OF SCIENCE
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the Spectrum

Editor:
Lawrence L. Carlino

JANUARY - FEBRUARY 1979

SPECIAL EXPANDED ISSUE!!

This issue of the Spectrum is unique in its expansion from the more conventional eight or ten page format. A "technical supplement" consisting of two articles by BAA members adds to the newsletter's regular features. Although not all issues of the Spectrum will be able to offer such fascinating "extras", we do hope to provide this additional coverage on an occasional basis in the future. I hope you enjoy the expanded format.

- the Editor

JANUARY MEETING: Dr. Francis Lestingi of Buffalo State's Department of Geoscience, Physics and Interdisciplinary Sciences will speak on "Einstein" at 8:00 p.m., January 12, 1979, in the auditorium of the New Science Building at Buffalo State. Dr. Lestingi is an authority on the history of science and is noted for his work in making movies. He will show a movie he has produced relating to his topic.

FEBRUARY MEETING: Three club members will give brief talks at the February 9, 1979, meeting which commences at 8:00 p.m. at the Buffalo Museum of Science (Please note the location). Charlie Miess, who has had several of his astrophotos published in Sky and Telescope recently, will speak on "Astrophotography." Larry Hazel, a long-term member of the American Association of Variable Star Observers (AAVSO), will bring us up to date on his work on variable stars. Our final speaker will be Edith Geiger, who will speak on "Lunar Domes." Edith has observed and sketched lunar features for several years.

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ODDS AND ENDS: Have you forgotten to pay your dues?

Have you picked up your BAA Directory?

Note of pride: Fred Price's splendid new biology textbook is now rolling off the presses. More details in the next issue. Congratulations, Fred!

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SPY AND TELL: Our president has been spending the holidays at home in England. And speaking of England--the Rabes had a wonderful time in England, Wales, and Italy, and Orrin Christy, on his recent business trip to England, toured through the Mullard Radio Observatory outside of Cambridge.

MORE SPY AND TELL: Lillian Von Gerichten has moved across the street to 12 Lexington Ave. after many years on Delaware Ave. She continues to sing in the Westminster Church choir.

Ken Biggie spoke on community development at the new Senior Citizens Center in West Seneca. He will speak on the same subject at a January meeting of the West Seneca Chamber of Commerce.

Kenneth and Adrienne Kimble are busy parents with Kevin, 13 mos., and Karen, 3 mos. Ken works at Brighton Tool and Die and in his spare time, if any, is building a 6" telescope.

Tom Giasomo has joined the YMCA Indian Guides father and son activity program, with son Michael.

Bob Schneider keeps "a pickin'" in the Border City Blue Grass group.

- Edith L. Geiger

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A NEW METEOR SHOWER?

The American Meteor Society has been monitoring a suspected new meteor shower. The shower was suspected to have a radiant in or near the Great Square of Pegasus. This was first noted in 1975. No previous shower has been seen but during the last few years, the appearance of meteors from Pegasus has been observed while viewing the Perseids.

The shower is called the Upsilon Pegasids because the radiant is closest to the naked eye star Upsilon Pegasi. Its period has been determined to be about sixteen days (nights). The focal point of the shower has been determined to be that of the great Perseid shower. The average velocity is slower than the Perseids. Their color appears to be yellow-white with an average magnitude of 3.5. The general count has been put at about 12 hourly and, according to the 1975 through 1977 reports, the shower is getting stronger.

This would be an opportune time for those who use the Beaver Meadow site to observe these meteors while watching for the Perseids.

- Darwin Christy

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BAA ANNALS

25 YEARS AGO

There's no newsletter from 1954 but a program list written by Program Chairman Jack Ballantyne gives two topics for January: Gene Wallmeyer on "Celestial Photography" and Jack himself on "Solar Energy." In February, the BAA heard Dr. Davis of U.B. on "Astronomical Mechanics."

15 YEARS AGO

Ernst Both spoke at the February meeting on the December 30, 1963, lunar eclipse. Also on the program was a panel discussion on Catadioptic telescopes. Panel members were Ron Clippinger, Ed Lindberg and Paul Redding.

We had three special groups in 1964. They were the Elementary Study Group with Paul Redding as Chairman, the Advanced Study Group with Ron Clippinger as Chairman, and the Observing Section with Ernst Both as Chairman. In addition, a new drive to raise funds for an observatory was being started.

10 YEARS AGO

"Standard Telescopes" was the topic for the January 1969 meeting. Ron Clippinger, an authority on the history of telescopes and observatories, was the speaker. One of the many "Observations of Deep Sky Objects" written over the years by John Riggs appeared in this Spectrum.

5 YEARS AGO

Dale Hankin spoke on "Astrophotography" in January 1974. I have been told that Dale died early in 1978 after a long illness. His excellent talk five years ago encouraged me to try astrophotography myself. In February, Dr. Jack Mack shed light on "The Quest for the Black Hole." Jack's expertise in x-ray astronomy was particularly suited to this topic.

Major articles in the January-February Spectrum were on "The Transit of Mercury of November 10th, 1973" by Dr. Fred Price and "Spacecraft Launch Windows" by Dr. Fred West. Darwin Christy, then President of the BAA, included a short article on meteor showers. Darwin had been lucky; he had just been released from the hospital after recovering from multiple injuries suffered when he fell from a power lift bucket while on the job for NMP. According to Edith Geiger's "Spy and Tell," Darwin landed on his head--is that what saved his life?

- Rowland Rupp

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BAA PROFILE

ORRIN D. CHRISTY

Orrin, the son of Ruth and Darwin Christy, is a gifted young man with a bright future. He was born in Buffalo, has always lived in Tonawanda, and went to Fletcher Elementary, and Tonawanda Junior and Senior High Schools.

While in junior high, he won two prizes for physics projects, the prizes being two gift certificates from Science Kit. It was decided that the certificates would be redeemed for a 3" reflector. This telescope started Orrin and his father on an astronomical adventure. This 3" would later be used as a finder-scope for a larger telescope.

In 1963, when Orrin was a junior in high school, he won third place in the Western New York Science Congress. His lecture demonstration was on selenography. He had sketched a composite map of the moon based on 1000 lunar photos he had taken. This fine rendition represented 400 hours of work. As a result of placing among the winners, Orrin went on to the state competition at Corning where he received a bronze medal.

The following year, when Orrin was a senior, he won first place in the Western New York Science Congress. This time his project was on lunar rills. He went on to Corning to win seventh place and a gold medal in the state competition. He also won a scholarship to Canisius College where he had already been accepted. The top winners were invited to exhibit their projects at the New York State Fair in Syracuse. It was a very interesting week for Orrin with one of the highlights being a chance to meet Lieutenant-Governor Malcolm Wilson.

In 1969, Orrin received his B.S. degree in Physics from Canisius. Having been in the ROTC in college, he received his 2nd Lieutenant commission on graduation.

During Orrin's college years he spent his summers working at Niagara Mohawk. His first job after graduation was at Children's Hospital as a lab technician.

In 1970, wedding bells rang out for Orrin and Jane Sugden, the girl down the street, who had graduated from SUNY College at Brockport in 1969. On arriving home from their honeymoon, Orrin showed Jane his devotion to astronomy by getting up at 2:30 in the morning to photograph comet Bennett.

In the early summer of 1970, Orrin was sent to Fort Bliss in El Paso, Texas. In 1971, he was stationed in Vietnam where he became a 1st Lieutenant. After what, at the time, was thought to be a heart attack, he was sent back to the United States. His medical problem was finally diagnosed as pericarditis, and he was discharged from the army in 1972. He remained in the Reserves and taught computer classes for several years and also attended classes in El Paso for two weeks out of every year for as long as he was in the Reserves. On one occasion he was bitten twice by a rattlesnake. A trip to the hospital and an injection of anti-venom saved Orrin's life.

After leaving the army, Orrin went to work at Calspan where he was employed in the electronic research department. During the same period he also taught night classes in astronomy, photography, and basic electronics at Niagara College of Arts and Science at Welland, Ontario.

In 1974, Orrin went to American Optical where he worked in lens production for a few years, then back to Calspan where he remained until this year when he took a position as a research physicist with Moore Business Forms. His present employment has him working with ink jet printing systems which keeps him extensively on the road.

Astronomy has been and continues to be of great interest to Orrin. He and his father have worked together making several telescopes. They made two 6" telescopes, and Orrin built a 6" long focus reflector and displayed it on WBEN-TV with Fred Hall and Virgil Booth. The mirror from this telescope has since been redone. Orrin and Darwin obtained two 8" blanks and made two 8" telescopes, one of which was put in the Christy's Honeyhouse Observatory and the other being given to a man from Lockport in appreciation for his donation of a recording instrument for the Christy's radio telescope. A Christy-made 10" telescope was mounted in Honeyhouse with the 8", but Orrin has taken the 10" to use in the almost completed observatory at his home. Orrin helped with the figuring for a 12.5" telescope which Darwin has built. It will be aluminized soon and all will be finished by spring.

One of their unique astronomical projects over the years has been the radio telescope with which Orrin has been very successful. They started with a 5 x 5 foot corner reflector, then built a 16 x 20 foot parabolic cylindrical reflector at 27 MHz. Then it was on to the dish, a 16 foot radio telescope operating to 162 MHz. Snow crumpled this structure, so it was rebuilt to a 20 foot dish on a far superior altazimuth mounting.

The first recording instrument for the radio telescope was the one donated by the gentleman from Lockport. Next came the army radar set with main pickup, amplifier and receiver which was fed into a Micromax record chart. This has a retail value of from $4500 to $6000. Orrin has charted noises from the Milky Way, Cygnus A, Cassiopeia A and the sun. It is hoped that in the future a new unit will be constructed with more sophisticated electronics.

Orrin is on the speakers' list for the NFCAAA. He speaks on CETI (Communication with Extra-Terrestrial Intelligence), Honeyhouse Observatory, building one's own telescope, radio astronomy, and the teaching of astronomy. He also talks to young people on these subjects in language suitable to their understanding.

Orrin has been an instructor in astronomy for several years in the Adult Education Program in Tonawanda High School, and one night a week, during the course, he invites the students to his home for further investigation and observing.

He has a machine shop in which he has a lathe and drill press along with other equipment. He also has a drafting set-up for designing most anything. He has used this to design, among other things, a hydroplane, his own observatory and many other mechanical devices. The very near future should bring completion of the new observatory and the construction of a new hydroplane. During the construction of his observatory, he made and placed a time capsule five feet down in the concrete pier. It is a machined aluminum capsule encased in fiberglass. Over a period of three years, he took a correspondence course in electronics and, as a result, has made testing equipment, meters, and his own colored television set.

Orrin has been actively engaged in the Tonawanda schools' outdoor education program. Throughout the year he gives evening astronomy programs with a follow-up at his home observatory. In 1977, he was awarded the Fletcher PTA Life Membership.

Jane, who received her Masters degree from Buff State, taught first grade but is, at present, subbing in the Fletcher Elementary School when needed. On Fridays, if she isn't called to sub, she volunteers her time to work with children on various projects at school. Jane was awarded the Fletcher PTA Life Membership in 1978.

Orrin took a speed reading course and achieved the amazing official score of 39,400 words per minute, with a retention of 60% of the material read. He is also gifted with a remarkable photographic memory.

Power boat racing is a favorite sport with Orrin. He is a member of the B & T Power Boat Association. He has been general chairman for the association's Grand Island Marathon Race, and also chairman and announcer for the Ice Breaker Regatta in 1978. He received a trophy in '78 for his contributions to boat racing.

Orrin is a fine, brilliant and humble young man filled with human kindness. His many talents portend great success in the years ahead and we wish him the very best.

Edith L. Geiger

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On the Venus Probe

Now that the scientists have found her
they have laser-beamed her crown,
with busy metal fingers
they have torn her sapphire gown.
It seems like such a pity
for I always thought her worth
lay in the Star performance
she played for Planet Earth.

Esther L. Goetz '78

From her "SORRY ABOUT THAT" collection.

THE RELATIONSHIP BETWEEN THE SIDEREAL PERIODS
OF REVOLUTION OF TWO ORBITING BODIES AND
THEIR MUTUAL SYNODIC PERIOD

by
Thomas R. Giasomo

Most amateur astronomers know the difference between the definitions of sidereal period and synodic period. However, few understand the relationship which exists between these two parameters for a given set of bodies. Therefore, let us take a closer look at their definitions and determine, if we can, the relationship which links these two time elements.

A sidereal period refers to the time it takes a body to return to the same position in the sky with respect to the fixed stars. In the case of the earth's rotation, we are referring to two consecutive upper culminations of a star across our meridian. For all practical purposes it is equal to 360 degrees or 2π (pi) radians in angle. The earth, therefore, turns 360 degrees in one sidereal day, or about 23 hours and 56 minutes. (NOTE: I am ignoring the difference between a True Sidereal Day and an Equinoctial Sidereal Day as defined in Norton's Star Atlas.) A synodic period, on the other hand, is the period it takes for two bodies (or more bodies if desired) to return to the same relative phase with respect to a point of reference. In terms of the earth's rotation, the period from high noon to high noon (about 24 hours) represents a synodic period. In this case the earth actually rotates beyond 360 degrees (to 360.986 degrees, more or less) to return to high noon due to the simultaneous revolution of the earth around the sun (see Figure 1).

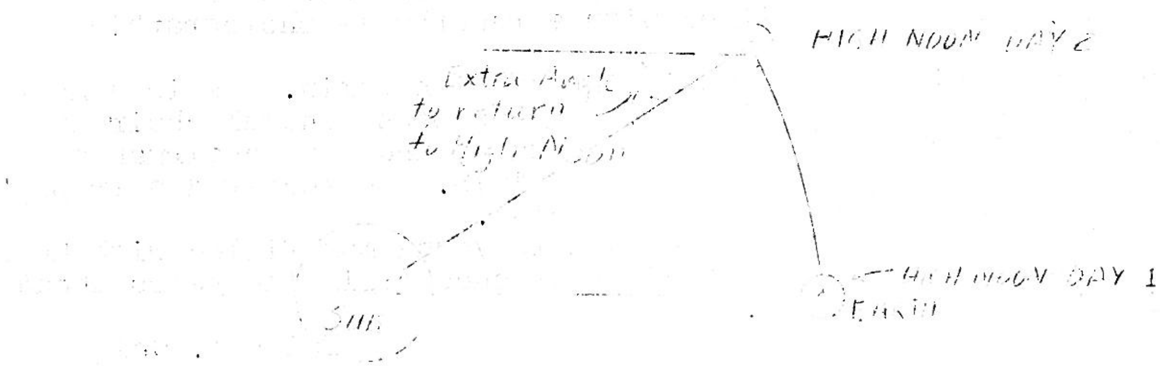

Figure 1

Now let us consider the revolutions of the planets. The sidereal period of revolution of a planet is the time it takes to sweep out an angle of 360 degrees or 2π radians. The mutual synodic period of two planets is the period of time between two consecutive identical phases. Let planet E be the earth and planet P be any superior planet, and let S be the sun. At some time, say at $t = 0$, let E and P be colinear, that is, be in line, with S, as in Figure 2. Also, let S, P and E be coplanar, that is, be in the same plane, and let P and E have concentric circular orbits. Now let us assume that E travels faster in its orbit than P does in its orbit, such that after one earth year E will return back to where it was at $t = 0$. P, however, will have only advanced to some point in its orbit, short of a full revolution. Hence, at t = 1 year E will be the same as for t = 0 (in position only) but P will be as indicated in Figure 2.

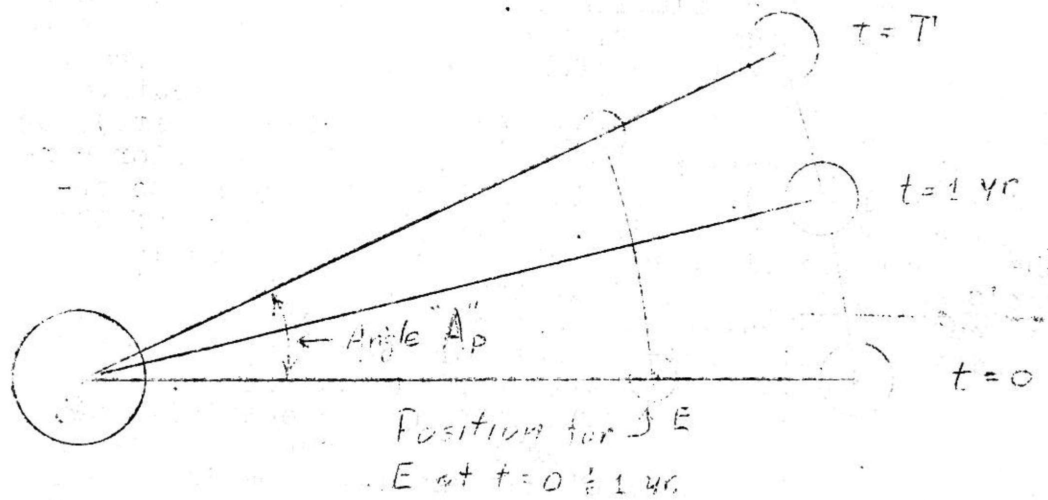

Figure 2

Now let E "catch up" with P to again create a syzygy (see Figure 2), and let us call the entire time elapsed since the beginning t = T, where T is the mutual synodic period for the two planets. Let the angle swept out by P during the period T be called Ap (see Figure 2). Therefore, E has gone through an angle Ae which is equal to Ap plus 360 degrees, or 2π radians. Mathematically,

(1) $$Ae = Ap + 360^\circ$$

or

(1a) $$Ae = Ap + 2\pi$$

Remembering back to the definition of sidereal period we know that during its sidereal period, tp, a planet sweeps out an angle of 360 degrees or 2π radians. Hence, the angle a planet sweeps out in a time period T is given by

(2) $$Ap = 2\pi(T/tp).$$

Substituting this into (1a) we get

(3) $$2\pi(T/te) = 2\pi(T/tp) + 2\pi$$

Dividing by 2π and regrouping to factor out T we get:

(4) $$T(1/te - 1/tp) = 1.$$

Upon solving for T we get

(5) $$T = (tetp)/(te + tp)$$

Or instead, solving for tp:

(6) $$tp = (teT)/(T - te)$$

Similar reasoning when considering an inferior planet leads to the similar relation:

(7) $$tp' = (teT)/(T + te)$$

where tp' is the sidereal period for the inferior planet.

Hence, we now have "first order approximation" relations between the sidereal rates of revolution of two planets and their mutual synodic periods. The ancients had measured each of these values in antiquity through generations of observation. Whether they realized the relationship or not, I do not know.

Let us see how accurate our relation is. One can easily measure the synodic periods of any of the superior planets in a little over two years (780 days). Hence, one could hopefully calculate the sidereal periods of revolution by measuring the time between two consecutive oppositions or two consecutive conjunctions (for superior planets), or two consecutive superior conjunctions or two consecutive inferior conjunctions (for inferior planets). This is easier than trying to observe the planets over a 248 year period. Table 1 lists each of the other planets, the mutual synodic period with earth (as given in the RASC 1978 Observer's Handbook), the calculated value of tp and the error between the true and calculated values of tp. The value of te is taken as 365.26 days. It is obvious that our model begins breaking down with Uranus and completely breaks with Neptune and Pluto. Some error would seemingly arise from the effects of the eccentricity and inclination of the orbits. However, the orbits of Uranus and Neptune have fairly small eccentricities and inclinations in comparison to some of the other planets, and Pluto, which has by far the largest of each, shows less error in the calculations than Neptune and not significantly more than Uranus. For similar reasons, the error is not strictly a function of solar radial distance. I am not quite sure of the reason for this discrepancy, however, long period perturbations may have an effect, that is, the effects of the other Jovian planets on outer planets. Certainly, some error enters from the inaccuracy entered through the inexactness of the values used, but I doubt to the degree witnessed here. I would be interested in any feedback members may wish to submit.

Table 1

Planet	T (da)	tp	Error (%)
Mercury	116	88.0 d	0.0
Venus	584	224.7 d	0.0
Mars	780	686.9 d	0.1
Jupiter	399	11.83 y	0.3
Saturn	378	29.67 y	0.7
Uranus	370	78.06 y	7.1
Neptune	367	210.9 y	28.0
Pluto	367	210.9 y	14.9

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YARDSTICKS OF THE UNIVERSE

The Cepheid variables are called the "Yardsticks of the Universe" because astronomers were first able to measure large distances in the universe by using the period-luminosity relationship of Cepheids recognized by H. Leavitt and developed by Dr. Harlow Shapley of the Harvard Observatory. In fact, this relationship at one time provided the scale of distances of almost every object outside the Milky Way.

The Cepheids are pulsating variable stars named for Delta Cephei, a naked-eye star whose fluctuating brightness was first noticed in 1784 by John Goodricke. Classical Cepheids are yellow supergiants belonging to the type I stellar population, thus lying mostly in the Milky Way where some 700 have been recognized and in other spiral galaxies. Their periods typically range from five to ten days with six days being the most common and they are the most regular of the variable stars. The visual range of the variation is usually about one magnitude. About a dozen classical Cepheids are visible to the naked eye--Polaris, Delta Cephei, Eta Aquilae, and Zeta Geminorum are the brightest. Polaris, however, has the smallest variation of all; its fluctuation cannot be detected by the eye.

Type II Cepheids are found more often in globular clusters and belong to the type II stellar population. Their periods are longer, twelve to twenty-five days, and they are fainter by about 1.4 magnitudes when compared to the classical Cepheids. Type II Cepheids are relatively rare, W Virginis being the prototype.

Since Cepheids are bright and have rather short periods, a great amount of data has been collected and studied. The light curves of Cepheids (and other pulsating stars) exhibit continual changes in brightness. Their spectra vary periodically (corresponding to a change in stellar surface temperature which may range over an entire spectral class), and the spectral lines show variable Doppler shifts due to radial velocities of the stellar atmosphere. These velocities can be determined from the amount of shift. Light and velocity curves of Delta Cephei are illustrated in Fig. 1.

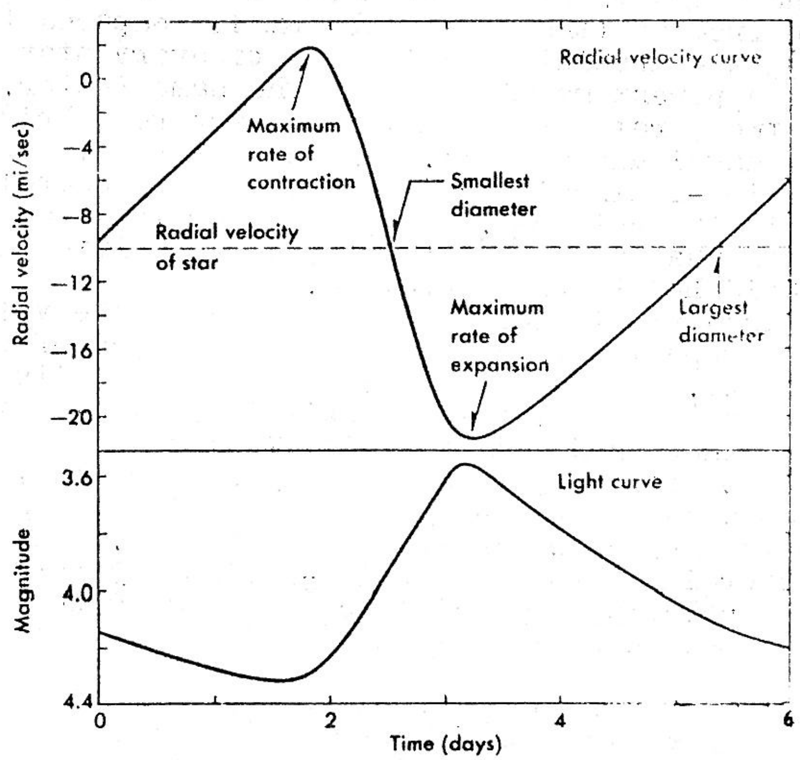


Fig. 1

The radial velocity curve (top) and the light curve (bottom) of the cepheid variable star Delta Cephei explained as the expansion and contraction of a star.

Initially, astronomers did not understand what caused the variations in brightness and spectra, some suggesting that the Cepheids might be binary stars while others maintained that the rhythmic contraction and expansion of stellar atmosphere could account for both light and velocity fluctuations. This latter idea was not generally accepted until 1914 when Dr. Shapley advocated the pulsation theory. It was just prior to this time that H. Leavitt, working with observations of Cepheids in the Magellanic Clouds, discovered that the period of fluctuation of a classical Cepheid is longer as the brightness of the star is greater.

The apparent brightness ℓ of a star at a distance r is related to its intrinsic brightness or luminosity L (at the distance R of 10 parsecs) as

$$L/\ell = r^2/R^2 = r^2/100 \text{ , r in parsecs} \tag{1}$$

since the brightness of a point source of light varies inversely as the square of its distance. By convention, a difference of one magnitude corresponds to a factor of approximately 2.5 in brightness and the difference in apparent magnitude $(m_2 - m_1)$ of two stars having apparent brightnesses ℓ_2 and ℓ_1 is given by

$$(m_2 - m_1) = 2.5 \log (\ell_1/\ell_2) \tag{2}$$

If the absolute magnitude M (the star's apparent magnitude were it at a distance of 10 parsecs) corresponds to L and the apparent magnitude m (the star's magnitude as observed visually) corresponds to ℓ, then Eq. (2) becomes, when (1) is substituted,

$$M = m + 5 - 5(\log r) \tag{3}$$

or

$$r = \text{antilog } \left[(m - M + 5)/5\right] \text{, r in parsecs} \tag{4}$$

Since all the stars in one Magellanic Cloud are at approximately the same distance from us (the clouds are small compared to their distance from Earth), the absolute magnitude M of every star in the cloud is related to its apparent magnitude m by the same factor. Thus, the correspondence between rate of pulsation and apparent brightness is true for absolute magnitude as well. In fact, for all Cepheids of the same type, the period-luminosity curve is the same regardless of where the Cepheid lies in the universe. But, in order to know what absolute magnitude went with what pulsation period, the absolute magnitude of at least one Cepheid had to be determined.

Dr. Shapley used statistical methods based on the velocities of some of the closer Cepheids to determine the distance of a nearby Cepheid in our galaxy. He was then able to calculate its absolute magnitude. Thus, Shapley calibrated Leavitt's period-luminosity relation and now astronomers had a method of determining the distances of objects which are too far away to measure by conventional methods.

The median apparent magnitude m and the period of oscillation of a Cepheid within the object of interest is measured. Its absolute magnitude M is determined from the period-luminosity curve (Fig. 2) and Eq. (4) is used to calculate the distance r of the Cepheid. This gives a very good approximation of the distance of the extragalactic object in question.

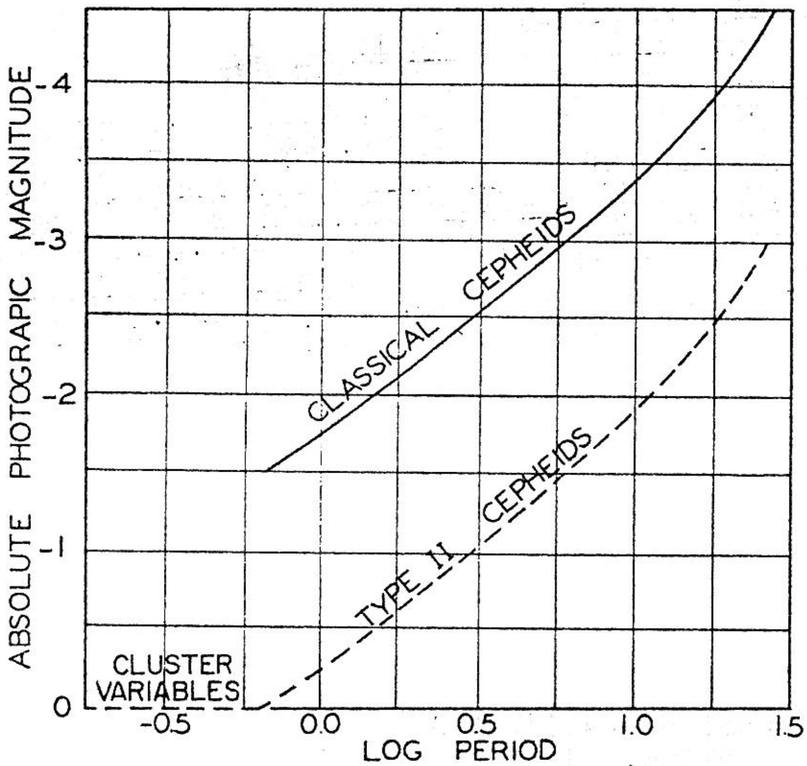
Shapley's method was revised in the 1950's when it was determined that the initial calibration was inaccurate (RR Lyrae stars, originally thought to be the same type as Cepheids, had been used) and the distance scale of the universe has now been increased by a factor of 2 and the corresponding absolute stellar magnitudes decreased by 1.5. This can be seen by substituting in Eq. (4) the revised distance 2r, where r is Shapley's original value, and recognizing that the apparent magnitude will remain the same. Thus,

$$M_{Rev} = m + 5 - 5 \log (2r)$$

or

$$M_{Rev} = M - 1.5$$

which, because more negative, represents an increase in brightness.



Period-Luminosity Curves for Cepheids. From these curves the absolute photographic magnitude of a cepheid can be read when the period of its light variation is known. The magnitudes of all cluster variables are not far from zero.

Who was H. Leavitt, the discoverer of the period-luminosity relation? She was Henrietta Swan Leavitt, born in 1868 in Lancaster, Massachusetts, the daughter of a minister. She graduated in 1892 from the Society for the Collegiate Instruction of Women (later Radcliff College) and spent several years traveling and teaching. She then joined the Harvard College Observatory as an advanced student and volunteer research assistant, becoming a permanent member of the staff in 1902. She was assigned to Harvard's observatory at Arequipa, Peru, to study the Magellanic Clouds and she became interested in the Cepheid variables therein. Her observations, because of their accuracy, are considered classic.

Miss Leavitt became head of the Department of Photographic Stellar Photometry at the Harvard Observatory and did much work in the determination of photographic magnitudes of stars and the development of standards of reference for different areas of the sky. These results were published in 1912, 1917, and 1919. She was still engaged in this work when she died in 1921. In the course of her work, she discovered four novae and 2400 variable stars or more than half those listed in the variable star catalogue for 1930. In 1913, Miss Leavitt's greatest contribution to astronomy was made when she discovered the period-luminosity relation--the key to determining distances outside the galactic system.

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FIRST CLASS