AAVSO ABSTRACTS

Edited by R. Newton Mayall

AAVSO ECLIPSED, WILTON, MAINE, 19-21 JULY 1963

During 1963 the AAVSO will have three meetings -- 2 official and 1 unofficial. The unofficial meeting was held in Wilton, Maine situated about 40 miles west of north of Augusta. Because of the proximity to the total solar eclipse path on 20 July 1963, Cy and Emily Fernald invited the AAVSO to spend that weekend in Wilton.

The Fernalds optioned all available good motel space in Wilton and Farmington up to 21 May 1963 so that AAVSO'ers would have a place to stay. This was necessary, because millions have found Maine a year-round vacationland, and with the added attraction of an eclipse, many additional hundreds of thousands would visit the area on that weekend.

On Friday evening 19 July, over one hundred met in Legion Hall, Wilton to hear Dr. Vainu Bappu, Director of Kodaikanal Observatory. Dr. Bappu is no stranger to AAVSO. He has been a member and observer since he was a boy, as was his father before him. We were pleased to have him with us and glad he brought his attractive wife with him. After Dr. Bappu's talk, Cy outlined the plans for the eclipse.

Cy had picked out a beautiful site on Lord's Hill in Athens, for our exclusive use. It was a particularly scenic site with a 360° horizon at the top. By noon on the 20th, the beautiful hay field changed to a parking lot for cars and the greatest array of equipment ever seen at an AAVSO meeting; or for that matter, any other amateur meeting. There was everything from cameras, shadow band accessories, to electronic equipment and coelostats.

We are particularly grateful to Mr. Clarence Gilman, the owner of the hill and surrounding farms, for permission to use his land. Also, all AAVSO'ers will be proud and glad to know that Mr. Gilman said that he liked us very much and that, when going over his land later, he did not find any bottles, broken glass, cans or rubbish thrown on the fields. This is the kind of behavior that makes our hosts happy to have us around. We can all feel proud that we left such a feeling with Mr. Gilman.

At 2 p.m. we had a good shower, but at 3 p.m. the clouds began to break; and from then on to 1st contact and through totality we had nothing to kick about. This is one eclipse and one meeting of AAVSO that will be remembered for a long time. As soon as the sun came out from hiding, equipment was dismantled and the trek back to Wilton began, to a fine lobster dinner at Legion Hall. One hundred and thirty-four happy and hungry AAVSO'ers sat down to a luscious lobster dinner. And there is nothing as good as a Maine lobster in Maine.

After dinner Cy once again gave out instructions how to get to the Earth Station of Telstar at Andover, Maine. It was only a year or two ago that Andover was just another typical country town in Maine. Today it is known throughout the world,for it was here that the first live television was broadcast to and received from Europe.

We are deeply indebted to Jack Pierce of Harvard, and Dr. James B. Fiske, President of the Bell Telephone Laboratories, for making it possible to visit this famous communications center -- to see and do things not available to the public. We arrived at 11 a.m. and were guided through air lock doors to the interior of the 200-foot synthetic rubber dome, where we were greeted by members of the staff of Bell

Laboratories. When everyone was seated Mr. Lewis Thomas mounted the platform on which the great "horn" antenna is rotated. He told about the work they had hoped to do at the eclipse, on temperature; and explained the technical details surrounding the installation. He announced that Telstar II had just gone out of commission, and the staff was trying to get it back in order again, while we were there. The horn was tracking the satellite, but its voice was gone.

At 12 noon we were served a delicious lunch of a variety of sandwiches (including lobster), coffee and strawberry shortcake. After lunch we broke up into small groups and walked to the control building, about a quarter of a mile from the big dome. Before entering the building the external structures, and antennas were explained.

Inside the building we had an opportunity to observe the intricate equipment and the computing machines, which working together make possible our transatlantic telephones and TV via satellite.

The staff was most kind and attentive. What a fitting end to a perfect weekend! And what a wonderful opportunity for AAVSO'ers to just get together and know each other better.

For those who were unable to attend the eclipse and Andover, a few statistics may be of interest:

Dome is made of fabric and synthetic rubber, inflated to 161 feet high and 210 feet across. It is held up by air pressure of less than 1/10 of a pound per square inch.
The great horn antenna is constructed of aluminum and steel. It measures about 180 feet long, 95 feet high, and weighs 380 tons. It is controlled by a precision tracking system.
Microwave signals are transmitted to Telstar satellites.
Tracking Telstar can be done with an accuracy of 1/100 degree.
The horn rotates on a wheel 70 feet in diameter, accurate to 1/32nd inch.
The mouth of the horn is 68 feet wide and funnels down to a waveguide of one-square-inch aperture, then to a pencil thin tube that leads to a ruby maser, which is the heart of the ultra-sensitive receiving equipment.
The signals sent back from Telstar are weak, only about a billionth of a watt.
Signals are received at 4,000 megacycles and sent on 6,000 megacycles.(R.N.M.)

NARROW BAND PHOTOMETRY, by Vainu Bappu

The AAVSO introduced me to astronomy, and the experience in observing has stood me in good stead. It has been so useful that every young graduate student (at Kodaikanal) who goes through for a doctor's degree must have a stint at variable star observing, regardless of the subject of his thesis.

Before going into the subject of my talk, I thought you might like to know something about my observatory. I have brought along a few slides to show the character of the country and the numerous instruments we have to work with -- the 20" reflector; solar telescope; 24-inch coelostat giving an image of the sun 30 inches in diameter; horizontal spectrograph of 60 feet focus; 8-inch refractor; and 8-inch coronagraph.

The observatory at Kodaikanal is about 65 years old, although it really has been in existence for more than a century, at Madras, where it was founded by the East India Company in 1791, as a means of providing time signals to the company ships, and for making some of the fundamental observations on stars in the Southern Hemisphere.

In 1898 interest was turned toward solar physics, and a solar observatory was established in the hills at an altitude of about 7700 feet. Many years of solar observations have justified the selection of this site. The observatory is in the town of Kodaikanal, which has a population of about 7,000, and is essentially a hill resort patronized by many well-to-do people.

At Kodaikanal, the fields of activity are mostly in solar physics, but there has been concentration in recent years in Solar terrestrial relationships and stellar physics.

The Herzsprung-Russell diagram constitutes the very foundation of astrophysics. It is the schematic distribution of stars plotted on a scale of intrinsic brightness (absolute magnitude) versus effective temperature. A lot of effort has gone into the construction of this diagram over the century and it has acquired an international character.

To obtain absolute magnitudes, one of the essential parameters is the distance of the stars. Distances of stars can be measured by several different means, the simplest being by trigonometric parallax.

In the early decades prior to 1920, the separation of stars into main sequence stars and giant stars was recognized. One of my very distinguished countrymen -- Saha -- was responsible for interpreting the real nature of the H-R diagram. He showed that classification of spectral types was a function not only of temperature but also of pressure. Hence the classification of stars into the main sequence, the giants, and the supergiants.

Early magnitudes were not as good as those of today, therefore most of the branches were separated into the three different branches and there was a large scatter about them. This scatter has been considerably reduced by modern investigations.

Narrow band photometry is a new statement, in words of recent technology, of something that has been well known for over a half century.

In the old days spectra were used to determine the surface temperature of the stars, the effective temperature, and the spectral type, and from a visual inspection it was possible to separate the stars into the giant-dwarf categories. In recent years with the development of photoelectric techniques, it has been possible to utilize the PE cell to do the job the eye did, but in a little more refined way. Precision has been increased by use of PEP as a result of which more effects creep up into the overall analysis.

Spectra are compared against standards much as you do in estimating variables, to obtain the class. This was done visually. The same principle was extended into narrow band photometry. If a very narrow region can be isolated, say around the $H\gamma$ line, then the brightness of the $H\gamma$ line can be compared with several others to obtain a measure of the brightness of the $H\gamma$ line. This brightness changes with spectral types, and with luminosity. The intensity changes from the supergiants down to the Main Sequence dwarfs -- $H\gamma$ is a very narrow line in the supergiants, a little wider in the giants, and considerably wider in the dwarfs.

This phenomenon of line widening for the same spectral type, but of different luminosity classes, comes about by a change in pressure in the atmosphere of the stars.

Supergiants are extremely massive stars with large gaseous envelopes. Pressures are different from what you would have in a typical compact main sequence dwarf star. This process of line widening is called the "Stark Effect".

The technique of narrow band photometry enables one to make a measurement, which will categorize the stars quite distinctly. A very narrow filter is used. The ratio of intensity transmitted through the filter is measured, and the ratio is quite large.

Measuring the intensities of the hydrogen lines, one can assign an age to the star, by using as reference a typical galactic cluster, such as the Pleiades, of age about 150 million years. Another kind is the double cluster in Perseus -- a very young cluster, barely a few million years old, -- which has one interesting feature. It has a large nest of supergiants and is the best place to study supergiants in the northern hemisphere. Since the stars of the cluster are of the same distance the brightness difference between the stars will be directly proportional to differences in intrinsic brightnesses. The stars are measured in different colors, and the color-magnitude array can define the age of the cluster.

A star, in very ancient days, is essentially a mass of gas, which coalesces around the stellar medium, it collapses, and in the very early days energy is obtained by virtue of the gravitational collapse. As the collapse increases the temperature at the center increases until it reaches a million or 2 million degrees, and at this instant the nuclear reaction settles. This is when nature plays its best role.When you have this onset of nuclear energy generation started you have a perfect case of equilibrium. The collapse is immediately stopped, nuclear reaction provides the energy, and the star adjusts itself in such a way that it can radiate in equilibrium all around.

The star then continues to burn up its hydrogen, and becomes brighter and brighter and the temperature in the center keeps increasing until about 15 or 20 million degrees when the hydrogen-hydrogen reaction, that is the proton-proton reaction,stops and the carbon cycle takes over. This process of temperature increase at the center continues until very high temperatures are reached, of about 100 million degrees.

This is the process of evolution a star experiences. When this happens, the star, to start with, is not on the main sequence. It is off to the right of the main sequence and as gravitational contraction continues it moves slowly to the left, and when it starts having the nuclear reaction, it finds a position on the H-R diagram, which is really the main sequence position we call age zero. This is the birth of the star and is the beginning of its active life.

There is a large range of brightness of stars along the main sequence. The only distinguishing feature seems to be the mass. The more massive, the more quickly it evolves. The result is that the brightest stars do not stay very long on the main sequence. The smaller stars are a little more thrifty in their energy consumption.

A color magnitude array that can be determined for any galactic cluster is essentially a picture of the state of evolution of the cluster at that specified instant.

The position on the color-magnitude array will tell us at a glance the state of evolution of the galactic cluster. By computation we can determine the ages by knowing the degree of turnoff from the age zero main sequence.

We can use this method only for stars that are members of the galactic cluster. This is where the principle of narrow band photometry has been a great help.

All we have to do to determine the age of any star irrespective of whether it is a member of a galactic cluster, is to measure accurately its brightness in the Hγ line and its effective temperature, and then plot it on a diagram which has clusters plotted so they can be used as a means of calibration. This means of determining age is one of the interesting results that can be obtained by the use of the technique of narrow band photometry.

One of the things you would like to know about other stars, is whether you have a cycle pattern of activity like the sun.

The sun varies in brightness from minimum to maximum sunspot activity, about 0.1 magnitude. The H and K lines of the sun are weak. If the K line can be isolated it may be possible to pick out similar activity in a star as that on the sun.

Narrow band photometry, by itself, will not displace spectral analysis or spectral classification by conventional methods. But used by itself, supplemented by spectrographic information, it provides one of the important tools the astronomer will use in the future. (From a tape recording by Richard Davis)

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