A A V S O   A B S T R A C T S

Edited by R. Newton Mayall

PAPERS PRESENTED AT THE TORONTO MEETING, 21-23 MAY 1965

The 54th Spring Meeting of the AAVSO was held in Toronto, Canada, at the kind invitation of the Royal Astronomical Society of Canada, on 21-23 May 1965. Our accommodations were in the dormitories of the University of Toronto, and eating facilities were made available in the University cafeteria.

On Friday 21 May our Council was invited to attend the RASC Council meeting. In the afternoon, after the AAVSO Council meeting, Margaret Mayall, Clinton Ford, and Dr. K.O. Wright were interviewed by the local FM Station. Friday evening, we gathered in the Educational Centre Building for a lecture by Dr. C.S. Beals, who spoke on the meteor craters on earth as compared with craters on the moon. Excellent slides showing earthly and lunar craters illustrated his talk.

Saturday was given over to papers by both the RASC and AAVSO. Members of the various centres in Canada attended this, the 75th General Assembly of the RASC. This is the first time the RASC has invited any other organization to meet with them at a General Assembly.

Saturday evening about 200 of us sat down to dinner in Hart Hall at the University. Those seated at the head table were escorted down the corridor and to their seats by a bagpiper, blowing for all he was worth. It was a gala occasion. After dinner, Kenneth Wright gave a brief description of the new Dominion 150" telescope. He was followed by Margaret Mayall who gave some interesting and humorous bits about observing and observers. She was followed by Helen Hogg who read a poem she had written, much in the manner of the early days of AAVSO when Pickering, Olcott and Elmer seemed to have a monopoly on poetry. (See abstracts)

After dinner the out-of-towners boarded buses to visit the David Dunlap Observatory. The 72" telescope was open and everyone had a chance to look at M13, the globular Cluster in Hercules. This was a rare treat for many. After the observing session Dr. and Mrs. Heard were hosts for coffee and cakes in the Observatory.

Needless to say we returned to our lodgings in the early hours of the morning after.

Toronto is booming with new buildings, a subway, and many fine stores which the wives took advantage of, by the looks of the shopping bags as they returned after the meeting.

We are very proud to be asked to take part in the 75th General Assembly of the RASC. As always, the Canadians were generous and gracious hosts. Many changes have taken place in the past few years -- the entrance to Canada is now almost as easy as going from state to state, except that an immigration official asks your name, how long you are going to stay and wishes you a pleasant journey. Returning is just almost as simple -- our own immigration merely asks how long you have been in Canada and if you bought anything. This is further evidence of cementing the long friendship between the two countries.

We all had a pleasant and good meeting for which we express our thanks to RASC.

TO THE A.A.V.S.O. AND THE R.A.S.C., by Helen Sawyer Hogg (AAVSO & RASC)

In Upper Canada, long ago
Beside the lake Ontario,
The Astronom - and Phys -ical
Society, its principle
That truths of other worlds be sought -
Formed in eighteen ninety-naught,
The members came to talk on stars,
To bring their 'scopes and study Mars.
And year by year the group waxed strong-
Centre by Centre came along,
And now we have from coast to coast
Sixteen Centres of our host
The R.A.S.C. of Canada,
Headquarters Toronto, where we are.

In nineteen hundred ten plus one
A little group was then begun
To watch the stars that fade and flick-
To schedules they just don't stick.
The A.A.V.S.O. has thriven,
Its millionth observation given,
Its fame gone round the world all way
From its original U.S.A.

For many years these star-eyed groups
Have shared their interests and pursuits.
Together now we meet tonight
To reminisce with great delight;
To talk about our interests chief,
Such things as Algol, Delta Ceph,
Mira of course, and R Cor Bor
SS Cygni and a score
Of other variables as you please-
Thank goodness our sun's not like these!

To chat on trials of observation,
The good and bad at each one's station,
To note the depths the mercury hits
Before we are willing to call it quits,
(For most effect of course you will
Use the temperature called "wind chill"!)

To bring to mind those guiding sprites
Forever taken from our sights,
Chant, Campbell, Elmer, Miss Young,
We cannot let them go unsung,
Olcott, Miss Cannon, Pickering too
Hossack and Helm, to name a few,
Elkins and Reinhardt, Hogg, F.S.,
To these we give our thankfulness.
Now in nineteen sixty-five
Their vision must be kept alive.

Grand was the moment when we saw
There on TV, without a flaw
"LIVE FROM THE MOON", when Ranger nine
Sped to its destiny as a sign
Of man's conquest of time and space.
A Superb triumph of the human race.
The space age beckons - it must not smother
Or prompt us to say "Too much bother
To study these stars. One rocket can find
A lot more knowledge than my little mind!"

The challenge here we must avow:
Continue to use our own know-how,
Record the mags of various stars,
Report the changes seen on Mars;
Construct some 'scopes and with them show
The heavenly wonders brought below;
Inspire our youths to seek to learn
The myst'ries of the universe in their turn.

Ground-based astronomy marches on.
Its work is very far from done.
The lesson's clear for us to see,
To be carried out by you and me.
This poem ends now (and none too soon!).
That caption we saw "LIVE FROM THE MOON" -
We must not let it cause a dearth
Of observations LIVE FROM THE EARTH!

THE EARLY HISTORY OF AMATEUR ASTRONOMY IN CANADA AND OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA, by Jim Low(Montreal Centre & AAVSO)

This year is the seventy-fifth anniversary of the incorporation of the "Astronomical and Physical Society of Toronto," which became the "Royal Astronomical Society of Canada" in 1903.

The first meeting of the incorporated society was held in Toronto in 1890, but amateur astronomical activity existed well before that date, and the beginnings appeared before Confederation. The first record of amateur interest in Canada is a paper on "Meteors and Falling Stars," by Mr. T. Hemming read before the Canadian Institute in Toronto on February 4, 1854. In 1860, Mr. Andrew Elvins, a tailor in England, arrived in Toronto, and during the next few years he arranged informal meetings to discuss astronomical subjects and to observe the heavens. On December 1, 1868, largely through the efforts of Mr. Elvins, the first astronomical society in Canada was formed. It was originally called the "Toronto Astronomical Club," but was changed to the "Toronto Astronomical Society" five months later. In the minutes of the first meeting it was moved by Mr. Elvins "...that a society be formed under the name of the Toronto Astronomical Club, having for its object the aiding of each other in the pursuit of astronomical knowledge: in order to which it is proposed:-

1. To meet monthly at such time and place as may be agreed upon.
2. To spend the evening somewhat as follows:
    a. Reading extracts, from papers or publications, of anything new or otherwise interesting, bearing on the subject of Astronomy.
    b. Reading original papers connected with any department of Astronomy.

c. Examining anything new in astronomical science.
d. Observing celestial objects if circumstances should favour our doing so.
e. Conversation, etc. ..."

This astronomy club, which had eight members, was active for about a year, the last recorded meeting being held on December 7, 1869. The death of one active member,and the departure from Toronto of another resulted in suspension of formal activities.

Few records were kept of amateur astronomical activity between 1870 and 1890, but through the notes of Andrew Elvins and others, we know that informal activities continued, and that new amateurs joined the group. In the summer of 1872, 18 amateur astronomers held meetings as a group called the "Recreative and Science Association."

The first record of Canadian amateurs making serious observations is for the partial eclipse of the sun at Toronto on August 7, 1869. Members of the "Toronto Astronomical Society" recorded their observations of contact times, and temperature readings. About 1878, Andrew Elvins made a number of observations of the planet Jupiter when he was attracted by a large spot of reddish colour on the disc. Andrew Elvins, A. F. Miller, and probably others made plans to observe the transit of Venus December 6, 1882, but I was unable to find any reports of observations. Perhaps it was cloudy that day.

In 1890, the informal astronomical society became incorporated under Ontario provincial law, and on February 25 that year, the first meeting of the "Astronomical and Physical Society of Toronto" was held. Mr. Elvins read the first paper before the Society, entitled, "The Probability of Great Discoveries in Astronomy during the Next Decade." There were about 20 members.

Between 1893 and 1903, a number of astronomical clubs formed outside Toronto. Groups formed in Meaford, Tavistock, Orillia, Simcoe, Hamilton, and Owen Sound, Ontario, which became affiliated with Toronto. Other societies were formed in Leeds, Woodstock, and Galt, Ontario, and possibly Winnipeg, Manitoba.

In 1900, the name of the "Astronomical and Physical Society of Toronto" was changed to the "Toronto Astronomical Society," by majority vote. There is an interesting story behind this change in name. In the July-August 1931 issue of the Journal, Mr. David J. Howell explained why he voted against the change. He held that it was because Mrs. Lumsden, the wife of an outstanding member who was president of the society at the time, did not like the word "Physical." She had the idea that the word was too closely associated with the functions of the body or with physics in medicine and was not a nice word. And, thus, we come to the end of the Victorian era!

In 1902 the membership of the society had grown to 120, of whom 37 lived outside Toronto. At the end of that year, it was decided that the name of the society was too local, and should be changed to the "Astronomical Society of Canada." Before adopting that name, the society decided to petition the government for permission to prefix that new name with the word "Royal." A petition to this effect, dated January 7, 1903, was sent to the Governor General. In it, the work and purpose of the Society was outlined, and in conclusion it stated:

"...That your Petitioner having decided to change its name to that of The Astronomical Society of Canada has instructed its Council to solicit from His Majesty the King the privilege of prefixing to that new name the word "Royal;" for your Petitioner believes that such gracious permission would strongly stimulate its efforts in the promotion and diffusion of Astronomical Science and that its influence in this direction would be greatly extended thereby throughout His Majesty's Dominions,

Your Petitioner Therefore Prays, that Your Excellency may be pleased to lay at the foot of the Throne this its humble prayer for the privilege of prefixing the word "Royal" to its name, and your Petitioner as in duty bound will ever pray.

R. F. Stupart, President

J. R. Collins, Secretary January 7th, 1903."

King Edward VII was pleased to grant our request, and on March 3, 1903, our Royal Charter was granted.

Between 1890 and 1906, the society published annual "Transactions" in which some papers were published, and which reported on meetings of the previous year. In February 1907, largely through the efforts of Dr. C.A. Chant, the bi-monthly Journal was founded. In the first issue, Dr. Chant stated: "There are few technical articles on astronomy, which, if clearly written, have not a real value to the amateur, while the work of the latter is always of interest to his professional brother. There will be room for both in the pages of the Journal." This continues to be the Editorial policy of the Journal.

The Canadian Astronomical Handbook for 1907 was the Society's first Handbook, and was, in many ways, similar to the present day Observer's Handbook. Because of the difficulty and cost of producing this Handbook, it ceased being published after three years, and astronomical events were then included in the "Journal" until 1912. In that year, the first Observer's Handbook was published. For further information on the Handbook, see "The Inside Story of the Observer's Handbook", by Miss Ruth J. Northcott, in the June 1964 issue of the Journal.

Since 1905, the Royal Astronomical Society of Canada has grown rapidly across Canada. The first Centre of the Society was formed in Ottawa in 1905, and since then many new Centres have been formed from Halifax to Victoria until the present number of sixteen was reached when the Kingston Centre was formed in 1961.

Membership in the Society has shown some large fluctuations in the past. Growth was slow between 1892 and 1904 when membership varied between 100 and 125. Growth was then rapid for a few years, membership reaching nearly 450 by 1908. World War I resulted in difficult times for the Society, and membership fell to about 350, and several Centres became inactive. Membership increased at a moderate rate during the 1920's, but was nearly constant at 950 during the depression. At the outbreak of the Second World War, membership began to decrease again, but by 1942, interest in astronomy, along with other sciences began to increase, and membership increased to 1600 by the end of the war. During the past 20 years, membership has increased at a moderate rate, and there are about 2200 members today.

Before concluding, I should make brief statements on two outstanding members responsible for the founding and growth of our Society.

Andrew Elvins must be considered the "Father" of our Society. Through his efforts, he organized the first astronomical society in Canada, and he guided the work and growth of Canadian amateur astronomy until his death in 1918 at the age of 95. Mr. Elvins was a man of little formal education. He left school at the age of ten to work in the mines in England; but he soon educated himself, and eventually became a tailor. A detailed biography may be found in the March 1919 issue of the Journal.

Some of you will remember the second outstanding member of the Society -- Dr. C.A. Chant. He joined the society in 1892 as an amateur, but he soon became a professional. He was president from 1904 until 1907, and was founder of the Journal. He edited the Journal for exactly 50 years -- until his death in 1956 at the age of 91.

The Royal Astronomical Society of Canada is one of the few Societies of the world whose membership is composed of both amateurs and professionals, and the close co-operation between these two groups has earned the respect of astronomers around the world. The status of our Society was well put by H. Boyd Brydon in his paper "Popularizing Astronomy" in the 1935 Journal:

"The Royal Astronomical Society of Canada was originated by amateurs and is fundamentally a society of and for amateurs. It is honoured by having in its ranks many eminent professional astronomers. Indeed it owes an inestimable debt to them. Without their help and guidance it is doubtful whether the Society could have reached even its present status. But it remains for the amateurs, those members 'interested in astronomy', to make it the cultural force in Canadian life that it should be."

This present close cooperation between professional and amateur astronomers was aided and forseen by Dr. C.A. Chant at the beginning of the century. On the first page of the first issue of the Journal, in 1907, Dr. Chant stated:

"If all unite, the result will be highly creditable to Canadian science."

ANNUAL PROGRAMMING FOR OBSERVATIONS OF FAINT VARIABLE STARS

by Clinton B. Ford (AAVSO & RASC)

For many years the headquarters of the AAVSO issued to all active observers Bi-Monthly Bulletins which predicted long period variable star magnitudes in six different ranges, thus enabling observers with small telescopes to avoid wasting time looking for currently faint stars, and observers with large instruments to concentrate to maximum advantage on the faint stars and not waste time on the brighter ones. In recent years, the greatly increased work load at headquarters has forced the Director to abandon publication of these Bulletins. However, to replace them, Mrs. Mayall in July 1964 issued AAVSO Bulletin 27, a permanent publication which serves the same purpose in another way.

As indicated in the heading, the time intervals near maximum and minimum in the last four columns, determined from the mean light curves of each star given in the Campbell volume Studies of Long-Period Variables (AAVSO, 1955), can be combined with the Annual Predictions of Max. and Min. issued each year by the AAVSO, to determine the beginning and end dates of the desired interval in any given year.

Combined data of this type in tabular form have been compiled monthly by Thomas A. Cragg of Mount Wilson Observatory, and distributed for the past year to a group of AAVSO members who are equipped to observe faint variables and who are actively using telescopes for such work.

For the convenience of these observers -- and others -- it is also possible to present the combined data in graphical form, using five-day intervals for abscissae and star designations and names for ordinates. This graphical form has been found to be the most convenient tabulation for use at the telescope, saving much time by showing at a glance what are the most valuable observations to be made with a 12-inch or larger instrument.

The entire star list from Bulletin 27 for all stars which get as faint as mag. 13.5

can be plotted in this form for one full year on eight sheets of standard 8 1/2 x 11" paper. The same amount of information in tabular form, as compiled by Cragg, requires twelve sheets issued monthly, and involves much more work to assemble and distribute.

To set up his observing program using the graphical plots, for a given night, an observer with a large telescope needs only to select the current date at the top of the page, and read down the page to select the stars most desirable for his program.

L.P.V. PREDICTIONS -- ($13^{m}.5$ For 1965
(Extracted Sample)

```
                                                                    X = Min. date
Design.  Star         April                        May                      June
               5  10  15  20  25  30    5  10  15  20  25  30    5  10  15  20
154715  R Lib-----------X-----------------------------------------------------1
155018 RR Lib                      1----------------------------------------------X
155229  Z CrB------------------------------X-------------------------1
   '  '  '
   '  '  '
165631 RV Her---------------------------------------------X-----------------------------
170627 RT Her
172809 RU Oph                                                        1---------X---------
```

A MOUNTING FOR A LARGE AERIAL CAMERA, by D. Crampton (Toronto Centre)

A simple fork mounting and drive mechanism was constructed for a 72" focal length f/5.6 aerial camera purchased by the David Dunlap Observatory. The simplicity of the design makes feasible the construction of such a mounting by most amateurs.

A Basic outline of a fork is constructed with angle-iron. This angle-iron frame may be bolted together or welded into shape. A thin steel plate is then bolted onto the frame. This steel plate held together in a structure of rectangular cross-section provides the rigidity and strength required to support the telescope at the fork ends.

In most cases, the telescope is a reflecting type and the centre of gravity is quite close to the rear of the telescope. The arms of a fork mounting for such a telescope need not be very long. For the aerial lens mentioned above, however, the centre of gravity is closer to the front of the telescope than to the rear. This is due to a very heavy lens system consisting of six elements. The fork mounting constructed for the DDO, then, had to support a weight of nearly 1000 pounds at a point just over six feet from the pier. Surprisingly, the steel plate required to provide this support did not have to be more than 1/16th inch thick. A section of heavy pipe bolted to the base of the fork and a simple pier completed the mounting.

The drive mechanism is also quite simple and quite unusual in Canada. The clock mechanism essentially consists of a synchronous motor and several gear reductions with provision for a slow motion right ascension control. The unusual feature is the replacement of the common worm and worm wheel by a cast iron roller and steel drive wheel. The friction introduced by forcing the roller against the drive wheel turns the telescope. This type of drive is referred to as a "friction drive".

Friction drives have been used quite successfully in Europe for some years. Dr. Heard reported seeing one of these drives in Munich, Germany and one at Haute Provence Observatory in France when he visited there in 1963.

Dr. P. Wellmann described in detail the drive of the 28.5 cm. telescope at Munich. The drive wheel is a 43-inch diameter steel wheel with a flat rim. A small conical steel roller of mean diameter of approximately three inches drives the large wheel. Because of its conical shape, moving the roller along its own axis varies the rate at which the telescope turns. This is a very convenient feature. The driving roller is spring-loaded with adjustable pressure against the large wheel and easily provides the 65 ft-lb. of torque required to turn the telescope.

Munich Observatory is in the process of modifying the drive just described. Apparently experience has shown that the drive would be better if the large drive wheel had a convex edge. Flat-edged wheels put rim to rim make contact in a line. A conical roller, on the other hand, has only a point contact if the wheel has a convex or a flat edge.

The drive wheel of the DDO telescope is 23".941 in diameter with a flat edge. It was doubtful that a point contact would provide sufficient friction to turn the telescope. The roller, then, is a three-inch diameter cylinder instead of a cone. Simple calculation shows that if the clock drive turns a 24-inch wheel once in a solar day, then it would turn a 23.941-inch wheel once in a sidereal day. Hence, this friction drive presents a convenient method of obtaining the sidereal rate.

A further advantage of this system is that the drive wheel acts as an upper bearing for the polar axis. Two small rollers other than the driving roller support the drive wheel and, therefore, the telescope.

Perhaps the most important feature to amateurs is that the cost of such a drive is much less than that of an equivalent worm wheel drive.

OBSERVATIONS OF U GEMINORUM-TYPE VARIABLES, by Margaret W. Mayall (AAVSO & RASC)

U Geminorum-type variables have always been great favorites with observers. They are the stars which have been considered to be fairly constant at minimum light, but which increase rapidly (within a few days) by 3 to 6 magnitudes. These explosions occur at irregular intervals, although for any given star, the average interval remains fairly constant over the years.

Unfortunately, most of the stars of this class are faint and require the use of large instruments. The Table lists the ones on the AAVSO observing program, in order of increasing length of cycle. About half a dozen others are being watched by a few observers, but no regular AAVSO charts are available. As you can imagine, when a star is visible for such short intervals, it is difficult to get satisfactory identification charts.

	d	Range		d	Range
080362 SU UMa	16	11.1-14.5	060547 SS Aur	54	10.5-15.0
184826 CY Lyr	17	13.3-16.8	195109 UU Aql	56	11.0-16.8
094512 X Leo	22	12.0-15.1	220912 RU Peg	70	10.0-13.1
184137 AY Lyr	24	12.6-16.0	074922 U Gem	103	8.8-13.8
114003 TW Vir	25	11.8-16	020356 UV Per	300	12.0-17.5
061115 CZ Ori	30	11.8-16.2	082953 SW UMa	459	10.8-16
213843 SS Cyg	51	8.2-12.1			

The brightest of the group, and consequently the best observed, is SS Cygni. It has been thoroughly observed since its discovery in 1896, until March 1965. For the first time, there is a large gap in AAVSO observations, because we received nothing on

SS Cygni for about 25 days! The maximum observed around April 25 may be either No. 493 or 494. We hope the Scandinavians with their longer hours of darkness had good weather in March and made many observations. Each year in the June issue of the Journal of the RASC, I publish the light curve and give the statistics of the maxima of the previous year.

The next in order of brightness, and therefore the next best observed is the first star of the class to be discovered, U Geminorum. It was discovered in 1855 by the English astronomer, J.R. Hind. The rapidity of its rise and fall caused a great deal of interest among the observers of the mid 19th Century.

The curves are more or less repeated by all members of the group. The irregularities in the shapes of the individual maxima are even more pronounced in the stars with shorter cycles. For example, AY Lyrae, with a mean cycle of 24 days, had a maximum in July 1963 when it was brighter than 13 for 10 days, and the width at median magnitude, 14.0, was 18 days. The preceding maximum was 17 days earlier, when it was brighter than 14 for 4 days. The following maximum was 29 days later, and it was brighter than 14 for less than 2 days.

In April last year, SU Ursae Majoris, which has a mean cycle of 16 days, was brighter than 13 for about 15 days. The preceding maximum was 29 days earlier and it was brighter than 13 for less than 2 days.

One of the most difficult of the group to observe is SW Ursae Majoris, with a cycle length of 459 days and a range of brightness of 10.8 to 16. One of its rare maxima was caught in February of this year by Fernald, Baldwin and Peltier. It was brighter than 13 for less than 20 days. Needless to say, many observers who check it once or twice a month, missed the maximum completely. Ironically, during the 20 days before the sudden rise, we received 28 observations, and during the maximum, only 7.

It is now generally accepted that all U Geminorum stars are binaries, and those in which the system is oriented properly in relation to the earth, can be observed as eclipsing binaries.

A great deal of work is being done with photoelectric photometers on the large instruments at the California and Arizona observatories. George Mumford reported on his work and that of Kraft and Krzeminski in a very interesting series of articles in Sky and Telescope Magazine in 1962 and 1963.

The eclipses observed in U Geminorum were most spectacular, with a period of 4 hours 14 minutes. Totality lasted about 10 to 20 minutes and was followed by a rise about half way to maximum, where it stayed for about 2 hours. This was followed by a further rise to maximum and then the sharp drop to the next minimum.

Thomas Cragg and Larry Bornhurst are always on the look-out for curious and interesting objects to observe, and they decided to see what they could do with the U Geminorum eclipses. The normal minimum magnitude of U Geminorum is about 14 and the eclipse was supposed to be about 6 to 8 tenths of a magnitude deep. To make the situation look really good, the nearest companions to U were a 13.8 comparison star about 1 1/2 minutes of arc north and a 14.5 comparison about 1 minute south.

A paper by Bornhurst later in the program gives details of their work. Several other observers joined in the experiment and found many curious irregularities in the eclipses.

U Geminorum is getting too near the sun to be observed much more this season, but it is easy to guess that it will be a major AAVSO project as soon as it can be observed again in the summer. These observations have all been trial ones to see how much can be done visually with a faint star such as this, but with the concentrated efforts of our Inner Sanctum observers we hope we can solve some of the unanswered questions. This is another case where the amateur should be able to make a real contribution to our knowledge. Not many observatories can afford to tie up their photometers and large telescopes for coverage of a single star over a long period of time. From the minima so far observed, it is very evident that we cannot consider any minimum a typical one. The AAVSO Inner Sanctum members are only too delighted to have such an active and fascinating variable to work with.

The observation of U Geminorum eclipses will undoubtedly be one of the major projects for the new Ford Observatory on Mt. Peltier in California, after the Carpenter 18-inch reflector is installed there this summer.

Thus the U Geminorum stars continue to intrigue the observer just as much today as they did when U Geminorum itself was discovered more than 100 years ago.

REPORT ON THE NASA NETWORK COLLECTION CENTER AND OPERATION MOON-BLINK FOR LUNAR TRANSIENT PHENOMENA, by Winifred Sawtell Cameron(NASA;AAVSO)

In the past few years, a number of lunar transient phenomena have been reported with few, if any, independent confirmatory observations. The importance of these phenomena on the present state and past evolution of the moon hardly needs to be emphasized. It is, of course, of primary interest to the Apollo program to determine the nature of these changes, most of which have been observed as reddish glows or blue hazes. Therefore, the National Aeronautics and Space Administration has deemed it advisable to set up a network of observers willing to turn their telescopes to the moon to confirm a sighting, if alerted while the event is in progress. The network was initiated at NASA Headquarters by Mr. Donald Beattie, through the Office of Advanced Research and Technology (OART), who arranged the telephone link service whereby sixteen individuals can be simultaneously connected. Inquiries were made to most of the professional observatories along the eastern seaboard, and solicitations were made to amateurs, recommended by Mrs. Mayall, who fulfilled the requirements of possessing a telescope 15 inches or larger in aperture and living in the eastern time zone. The aperture requirement is based upon the experience of James Greenacre, who observed color events with the Lowell 24-inch refractor but failed to see it in the 6-inch finder. The eastern time zone restriction was made for two reasons: 1) one event was seen shortly after moonrise and was not visible anywhere else in the United States except in the east (this kind of situation may be frequent); 2) at present, the maximum number of participants is 16 and we considered that there would be greater chance of confirmation if all were in the same zone.

The network observatories are mostly professional, but four are amateur. Two of the latter have moon-blink devices and we are relying heavily upon them for detection of red or blue color events.

The procedure of an alert is as follows: if a member observes, or is informed by outside sources, that a transient phenomenon is taking place, he calls the network operator who immediately calls all the other members. Each reports in with his assigned number and observatory name. The information of α (or hour angle) and δ of moon, selenographic lambda and β, name of object, and location in or with respect to nearest named feature are then given to those answering, by means of a conference call. It is then hoped that those who conveniently can, will turn their telescopes immediately to that area. Confirmation can be reported while the line is still open (it is to be held open for one hour) or on a standard form, sent to me by mail. Some of the members may be able to take photographs, spectrograms or recordings if time permits.

The only two members that are likely to detect an event are those with the moon-blink, since the others do not normally observe the moon. Therefore, we would like to appeal to amateurs to observe the moon, especially Alphonsus, Aristarchus,Kunowsky, Piton and other previously reported changeable sites, and if an anomalous feature is noted, particularly a red color event, to please alert the nearest network member to him.

I have mentioned the moon-blink device several times without clarification. This is an instrument designed by Dr. James Edson of NASA Headquarters. It utilizes a color-blink technique in which incoming light passes alternately through the blue and red filters of a rapidly spinning filter wheel. The image then falls on the surface of an image converter tube. The observer watches the face of the image tube. It is possible to conduct normal observations with very little degradation of the image with the moon-blink equipment on the telescope. The resolution of the tube is better than 50 line pairs/mm and the newer ones give 80 line pairs/mm. The second-generation moon-blinks will make use of an image orthicon system which will allow variation of contrast and shorter exposure times for photography. At present, six instruments are installed at various locations forming a network across the country. Those at Port Tobacco, Maryland and Huntsville, Alabama are also on the confirmation network. Five more are being built. Under contract to NASA, the Trident Engineering Associates of Annapolis, Maryland, under project manager John Gilheany, are building these devices. They have done research on the development and improvements of the original design.

The moon-blink instrument has already proved itself by detecting two events, one in Alphonsus on October 27, 1964, and another in Kunowsky on September 21. In view of the report of about a dozen or so occurrences of temporary phenomena in the past 1 1/2 years, we are very hopeful of detecting and observing more and of determining the nature of these phenomena.

To that end, my office is to be a collection center for reports on lunar transient phenomena. We have sent out appeals to amateurs through the amateur journals to observe the moon as often as possible. It would be greatly appreciated if those amateurs in the east would contact the nearest network member in case of an event. May I make an appeal to any of you who have not seen or heard of this request, to observe the moon frequently? I have made a partial list of some of the lunar features frequently reported in the literature as having exhibited temporary anomalous appearances. Anyone desiring this list may obtain it by writing to me at Goddard Space Flight Center, Greenbelt, Maryland 20771, Code 641. We thank you for your cooperation both past and future.

IMPROVING METHODS IN ASTROPHOTOGRAPHY, by Paul Riherd(Lubbock, Texas,RASC)

As the amateur astronomer begins to delve into astrophotography, he begins to recognize a few of the problems confronting him in his endeavours, and usually attempts to seek solutions to them. Three areas of prime concern soon become apparent. The usual amateur equipment consisting of a 35mm camera body and a simple telescope can be immensely improved upon. A camera body with a 4 x 5 inch format will improve the final working quality tremendously. High quality lenses of various focal lengths will also aid performance of the system.

Because of several emulsion properties, slow films with fine grain will in some cases outperform in speed the fast, grainy films usually used by amateurs. Chemical and physical hypersensitization offer new fields to explore and experiment in. Chemical composition of developers can affect results drastically. Photocopying can be used to build contrast and reduce grain, and various colors and stains.

In the field of color the use of color negative materials and color printing techniques can be used to obtain true and balanced tones despite reciprocity failure.

In all phases of astrophotography, experimentation along with accurate records is important if reliable and worthwhile photos and data are to be obtained.

PHOTOS FROM THE SMALL DOME OF THE DOMINION OBSERVATORY

by Dan Brunton and Rick Salmon (Ottawa Centre)

Part I. Rick Salmon

About a year and a half ago the Observers Group of the R.A.S.C. Ottawa Centre was given permission to use the small Dome of the Dominion Observatory. The Observatory is built on two levels, the telescopes being upstairs in the dome. They range from an 8" and 6" refractor to a 4" guide scope, 3" wide-angle comet camera and a 2.5" finder. The darkroom of the Observatory is situated downstairs and is the only heated portion. For this reason it is a Godsend in the winter. It is here where the final plans for the night's observing are made. When the Observatory was built, at the beginning of the Century, the objectives were corrected for the blue and because of this our use of the Observatory is restricted to photography. The 6" and 8" telescopes take 4 x 5-inch plates and cover an area of 6 x 8 degrees, the 3-inch comet camera takes 6 1/2 x 8 1/2-inch plates and covers an area of about 30 x 40 degrees. The drive of the telescopes is weight driven and is equipped with a small electric correcting motor. Before we show the photos taken through the scopes Dan has a few to show of the Instruments themselves.

Part II. Slides - Dan Brunton

1) This is a view of the small Dome itself with the slit open facing North. The diameter of the Dome itself is 12 feet. The tree to the right of the Observatory has proven a nuisance in the past by growing higher than the Dome and has had to be clipped; it is about due for another clipping now.

2) This is the objective end views of the telescopes, this being the 8" refractor, the 6", and the 4" guide scope, the 3" comet camera and the 2.5" finder. As you can see here the 4" guide scope is offset because the telescopes were formerly used for spectroscopy and the 4" offset to stay in line with the prisms. To the left of the telescopes themselves you can see part of the setting circle mechanism and to the extreme left you can see a section of the counter-weights. Here are the lens covers for the 6 and 8" refractors which are controlled by sliding rods. The lens covers for the additional telescopes are all placed on by hand and are just leather caps. In the background can be seen the pulley which when rotated in turn revolves the Dome so that the slit is in the proper position for the exposure. Also you can see here extending right around the Dome the track on which the pulley itself revolves.

3) This is the plate end view or bottom end view of the telescopes as they are seen when facing directly out the slit. Now as you can see the 4 x 5" plateholder on the 6" scope and the eyepiece holder on the 8' scope can be easily interchanged; also you can see the 4' guide scope, the 2.5" finder and on top of everything the 3" comet camera. Down below are the controls for these scopes and on the other side of the telescopes are the focus adjusting knobs. A red wire which extends over the top of the 'scope is connected to a small light which illuminates the reticle of the 4' guide scope so that it can be seen at all times during the exposure. A small correcting motor can be inserted in either of the 4 x 5-inch plate holder positions to run the RA slow motion. 8 x 10-inch plate holders can be inserted in the back of both the 8' and 6" scopes.

Part III - Rick Salmon

Before we show the photos, we should mention something of the film used. A total of 8 different films was used; Royal Pan, Plus X and Ilford FP3 were the most common. The average exposure was about 20-30 minutes. All were developed the equivalent of 5-6 minutes at 68 degrees F. in D-11 and D-19.

Part IV. Dan Brunton and Rick Salmon

4) h/χ Persei. Here you can see the very well-known double cluster h/χ Persei.They are situated between η Persei and δ Cassiopeia. It is quite odd that Messier missed this outstanding object when compiling his famous Messier catalogue. This photo shows the excellent field in which the double cluster is situated and has a limiting magnitude of about 13.

5) M-45. You hardly need to be told what this is: M-45 or the Pleiades. Of note in the photograph is the double star Alcyone which is easily split.

6) Comet Everhart. In August of last year Dr. Everhart of the U.S.A. discovered a Comet in Ophiuchus and about two weeks later we were able to photograph it when it was about 10th magnitude in the constellation Serpens Caput. We were quite lucky to get the photograph at all since at the time we knew very little about the operations of the telescope -- the focus was bad, the exposure was too short, we used the wrong film, and the developing was too short.

7) M-13. Here we have a photograph of the well-known object M-13. This favourite amateur object is easily resolved. The limiting mag. of this photograph is the same as in most, 13.

8) Moon shots. These two photographs of full and last quarter moon were taken on high contrast, blue sensitive film. Of interest on this photograph are the craters Tycho and Clavius, Copernicus and Kepler as well as Plato. In the centre of the full moon you can see the crater Alphonsus which was the landing place of Ranger 9.

9) M-81/82. Here are visible M-81/82 as well as two other galaxies and a globular. M82 has been discovered to be an exploding galaxy. Also in M-81 the spiral arms can be seen and in M-82 two dark lanes are also visible. The limiting mag. of the photograph is 14.

10) M-31. Here we have the very famous galaxy, the great Andromeda Nebula or M-31 and the galaxies M-32 and NGC 205. You can see the broad spiral extent of the arms of M-31 and the spiral shape of NGC 205. Visible are 4 dark nebulous bands and a bright condensation in one of the arms. This photograph shows the excellent field around M-31 which goes down to 15th or 16th mag. To get this photograph we had to take two photographs of M-31, put them on top of each other to get a positive, from

this make a negative, and from this negative we got the positive you see.

11) M-3. M-3 is the bright globular cluster located in Canes Venatici, located half-way between Arcturus in Bootes and Cor Caroli in Canes Venatici. You may have realized that this is the object that Comet Alcock passed in 1963.

12) M-42. This is the very famous object M-42/43 of the Great Orion Nebula. Above and below M-42 a dark nebulous bar can be seen extending into the bottom part,and to the sides and top parts are quite easily seen the arms, extending outwards.

13) M-42/43, colour. The red colour of the Orion Nebula shows quite well, and also the extent to which the nebulosity has spread. You can see red bars and a blue one. This photo shows well how the 'scopes are corrected for the blue. The blue stars are in focus, whereas the red ones are badly out. Because of this the nebula also is out. The streak of light down the left side is the satellite Echo II.

14) M-44. This is the Beehive or M-44 open cluster in Cancer, located between γ and δ. It is quite large and bright and makes a good binocular object. You can see the small, triangular shape of stars which gives this object the name "Beehive". The limiting mag. of this photo is about 13th.

15) M-103. This is the open cluster M-103 in Cassiopeia. Prominent is the open cluster NGC 457. The trail of a plane is visible at the bottom of the photo. This photo is our best for limiting mag., going down to about 17th.

16) 3C-273. This photo shows 3C-273 one of the recently discovered quasi stellar objects. This object was found in Virgo. These objects are causing much controversy as to their age, distance and origin. 3C-273 is about mag. 13 and the limiting mag. of this photograph is about 14th of 15th.

Part V. Conclusion. Dan Brunton.

In conclusion I would like to mention a few additional facts about observing at the small Dome. In the 76 times the Observatory was used, about 200 pictures have been taken, most of these were long-exposure shots. Deep sky objects attracted the most number of photos although some planetary, and as you saw satellite pictures were taken. The observing and photography was done almost exclusively by Student Members. Since we have now overcome most of our major problems in using the Observatory, we hope to improve the quantity and quality of our photographs. (All photos were of good quality. ED)

THE MAYAN CALENDAR AND ASTRONOMY, by John J. Ruiz(AAVSO & Montreal Centre)

Let us take a trip in time and space and visit the Ancient Mayas in their habitat in Guatemala and Yucatan. At the time when Charlemagne reigned in Europe; that is, around the year 800 of our Era, the Mayas had already evolved during the previous centuries a calendar accurate to one day in 374,440 years.

In order to understand their calendar and astronomy let us keep in mind two facts deeply involved in their civilization and culture. The Mayas were obsessed with the notion of Time and Timekeeping and were forever looking for cycles that would repeat themselves and enable them, from a study of the past, to predict the future. The other fact is that their economic life was ruled by the cultivation of corn, more properly called maize. The priests were able to predict the time for each phase of the cultivation of Maize and this gave them great power over the common people.

The Mayas had two calendar years. One had 365 days and coincided approximately with the Tropical Year. This year was divided into 18 months of 20 days each and a short month with only 5 days. This year was known as the "Haab". The other year which ran concurrently had only 13 months of 20 days each, and is known as the "Tzoikin".

The priests knew very well that a year of 365 days would fall short of the Tropical Year by a fraction of a day and that the dates of their calendar would creep ahead of the true Tropical Year by about 15 days in the life time of a man of 60. Instead of making the correction as we do by inserting a leap year every 4th year or so,they applied a correction to each of their recorded dates on the stelae. This is known to modern investigators as the "Secondary Series". The priests in the course of centuries had determined the length of the Tropical Year with a greater accuracy than that of our own Gregorian Calendar:

Length of the Tropical Year

According to modern astronomy	365.2422	days
According to the Gregorian Calendar	365.2425	"
According to the Mayan Calendar	365.2420	"

The Mayan is thus more accurate than the Gregorian by 1/10,000 of a day.

We may well wonder how a people who lived in the Stone Age without the use of metal tools and telescopes could accomplish such a feat. They did it in the same way that Tycho Brahe would have done it. They erected observatories with long sights from which they could locate the Sun, Moon and the Planet Venus specially.

The other year of the Mayas, the "Tzolkin" was the only one of their complicated system known to the common people. It regulated their everyday activities and ceremonies. Each day was represented or ruled by a god with a number running from 1 to 13 and each day or god "carried" on his back the month of the year. Each day,therefore, was known by a number and name thus: 1 Ik, 2 Akbal, 13 Ahau. I shall not burden you with the names of the 20 months, which to tell the truth I cannot pronounce myself. The two calendars were run concurrently and to each day of the "Tzolkin" there was a corresponding day in the longer year of the "Haab". Thus each day was designated with four symbols such as: 1 Mix 4 Uayeb, 2 Ik 0 Pop, and all the rest of the tongue twisters. The Mayan priests kept good record of these days, for us we resort to some mechanical means and use the "Calendar Wheel" which I believe is due to the Mayan scholar, Eric Thompson. One fact of tremendous importance to the Mayas (and to the Aztecs as well) is that after 52 years of the large wheel (365 days) the names of the days in the two calendars coincide. We do not know what the Mayas called this period, but the Aztecs had a name for it and as they believed the world would come to an end at one of these periods or "centuries", they took to the hills and waited for the Sun Rise. If the Sun came out in the East (as it still does), then they knew the gods had granted to humanity another century of grace. It is believed that at the end of each one of these periods a correction amounting to 13 days was applied to the calendar. We know that in the year 700 of our Era, a convention was held at Copan, (the Mayan equivalent of Greenwich) to adjust this correction among the many City-States of the Mayan Empire.

Let me say something about the Mayan Arithmetic which, of course, is intimately connected with their chronology. They invented "zero", at least 1000 years before the Hindus and 2000 years before the Arabs introduced it into Europe. Mathematicians consider the invention of "zero" as one of the major breakthroughs. If you allow me to appear ungrammatical, I'll say that the Greeks and the Romans did not know nothing. Anybody who has tried to multiply using Roman numbers, would immediately recognize the importance of Zero and positional numeration. Our system of numeration is based on the ten fingers of our hands, but the Mayas used their toes as well (perhaps because they went barefooted or wore open sandals) so their numeration is a vigesimal progression. Each order is 20 times the preceding order instead of ten as with us. So that their numeration proceeds from Units to 20's, to 400's, 8,000's and so forth. (An exception in the value of third order was made when reckoning time, it being 360 instead of 400).

Regarding their astronomy, I have already mentioned their determination of the Tropical Year. They also determined the synodic period of Venus with extreme accuracy:

Synodic Period of Venus by modern astronomy	583.92 days
Mayan Astronomy	583.935 "

The priests even knew that this determination was a little too long.

The Dresden Codex is really a table of Lunations or eclipses.

They had a name for the Pleiades: "The Rattles of the Snake", Gemini was a "Turtle" and the Three Stars in the Belt of Orion were well known. And strange as it may seem Scorpio was a Scorpion. The Codex Peresian mentions only the three given above: The Scorpion, the Turtle and the Rattle, in the Mayan Zodiac.

As the Sun sets behind the Peak of Popocatepetl, we bid adieu to the Ancient Mayas, but unlike our Sun which will reappear in all its splendor on the morrow, the Mayan Civilization has set for ever!

MEASUREMENTS OF LINE-RATIOS USED FOR LUMINOSITY CLASSIFICATION IN STELLAR SPECTRA OF TYPES F TO K

by K.O. Wright and T.V. Jacobson
Dominion Astrophysics Observatory (Victoria Centre)

ABSTRACT. -- Spectroscopic absolute magnitudes have been derived from line-intensity ratios, using eye estimates, by Adams et al (1935), by Harper and Young (1924) and others, and, from measurements of central depths, by Oke (1957, 1959) and by Buscombe and Dickens (1964). In order further to compare the relative accuracy of visual and quantitative methods, intensity tracings have been made of Victoria spectrograms. Twenty-five stars of types F_0 to K_5 have been studied using high dispersion (2 to 5 A/mm.) spectrograms and seventeen using moderate dispersion (30 A/mm. at Hγ). Since the results are compared with those obtained by Harper and Young, the same lines have been studied. The same wave-length regions were studied for all stars but on the high dispersion tracings only lines sensitive to luminosity effects were measured, whereas on the tracings of moderate dispersion the blends that could be measured usually contained also lines that were not luminosity-sensitive. The classification on the Johnson-Morgan (1953) system has been adapted and the absolute magnitudes given by Blaauw (1953) have been accepted with a few modifications. It was found that spectral types F_0 to F_6, F_8 to G_5 and up to K_5 could usually be grouped together in drawing curves relating absolute magnitude and line intensity ratio. Table I lists the mean probable errors found for the two dispersions studied and from Harper and Young's published data. It is seen that the high-dispersion measures give definitely lower probable errors than those using spectra of moderate dispersion, but that the eye estimates of Harper and Young are almost comparable with the intensity measures of moderate dispersion, which is the same as they employed. The measures suggest that epsilon Leonis may be somewhat fainter and lambda Serpentis somewhat brighter than the Johnson-Morgan classification.

TABLE I
AVERAGE PROBABLE ERROR IN ABSOLUTE MAGNITUDES DERIVED FROM LINE-INTENSITY RATIOS

Spectral types	Harper and Young		Moderate Dispersion		High Dispersion	
	P.E.	No.	P.E.	No.	P.E.	No.
F_2 - F_6	0.24	4	0.32	5	0.17	4
F_8 - G_5	0.29	5	0.23	8	0.17	6
G_8 - K_5	0.21	11	0.31	11	0.22	6
Average	0.24	20	0.28	24	0.19	16

THE OBSERVATION OF EXTREME GRAZING OCCULTATIONS, by Thomas C. Van Flandern (U.S. Naval Observatory, AAVSO)

Extreme grazing occultations are a new and fascinating branch of observational astronomy. By an "extreme" graze is meant the passing of a star so close to the limb of the Moon that each individual mountain peak on the lunar limb is capable of causing its own occultation.

The width of the path over the Earth's surface within which an extreme grazing occultation is said to be visible is the width of the band within which multiple occultations of a star will occur for a single observer; it is generally less than one mile wide! Within this "graze" band, the observable events associated with the grazing occultation are varied, and in some respects analogous to those during solar eclipses. For example, the rough equivalent of total vs. annular eclipses may be thought of as dark limb vs. bright limb extreme grazing occultations. It is ordinary for all events in the extreme graze to occur entirely on the Moon's dark limb, or entirely on the bright limb (though always near the terminator). Bright limb grazes are less desirable, since most stars can only be seen to merge with the Moon's bright limb, instead of an instantaneous disappearance or reappearance, as on the dark limb; and many of the very short duration events go unnoticed altogether.

In addition to disappearances and reappearances of the star (there are four of each in the average case), observers will occasionally see "blinks" and "flashes"; where the star will be occulted or appear momentarily due to features on the Moon's limb too small to be resolved in the largest telescopes. There may be events which occur in stages, as each member of an unresolved multiple star system is occulted in turn. And an occasional very fortunate observer may actually see the star dim several magnitudes without disappearing due to a prolonged approach to a lunar feature so close that the effect of diffraction may be observed!

How often do extreme grazing occultations occur? It is safe to say that one would almost never be observed by chance. Consider the odds against the path of totality of an eclipse crossing your own back yard. However, there are a great many stars within the Moon's monthly path, so that if one were willing to travel about 100 miles in any direction, he could expect to observe about four extreme grazing occultations of stars brighter than magnitude 7.5 each year.

Quite a variety of information is obtainable in the reduction of observations of these occultations. Even the most "ordinary" of extreme grazes will provide information on the center and radius of the spherical datum to which charts of the contour of the Moon's limb are referred, and on the accuracy of such "limb corrections." Fluctuations in the latitude of the Moon can be studied in this way with an order of magnitude more accurate than any other type of observation in use today can provide. Precise corrections may be obtained to the positions of stars within the Moon's path;

or conversely, the precise location of the observer on Earth may be improved, if the Moon's and star's positions are known. It is especially interesting to note that, even though the time of events is the only measured quantity, it need not be measured very accurately to obtain the maximum information derivable from the graze. By comparing duration of and interval between events with charts of the lunar limb, a "fit" may be obtained which will yield an accuracy of perhaps a few hundredths of a second of arc on the celestial sphere, even when timings are made only to the nearest second.

Because of the moderate timing requirements, use of stop watches or voice signals is entirely adequate, if they are ultimately compared with short wave time signals. However, the large number of events which may occur within a five minute interval, which is the average duration of a graze, make a tape or chart recorder of some sort a virtual necessity. A telescope of any size adequate to see the star is sufficient. Portability of all equipment is an obvious asset. Perhaps the most important aspect of setting up to observe an extreme graze is location of the observers, which should be accomplished with the aid of a detailed topographic map. Since nothing but the long duration events can be predicted in advance, the greatest amount of information will be derived from observers who are spaced at the shortest possible intervals across the entire width of the grazing path (several thousand feet).

Since the southern regions of the Moon are far more mountainous than the northern regions, most successful observations to date are of southern limit grazes. One particular portion of the moon is so located that it can never be sunlit when it is on the limb, and hence has never been seen, but from the observation of a graze the contour of the limb can be inferred.

In summary, the observing of extreme grazing occultations may be thus seen as a challenging, and extremely valuable, new branch of astronomy. While this is definitely not a back yard project, the field belongs nonetheless to the amateur astronomers. And those willing to make the effort will have the additional satisfaction of knowing that each observation is of value in itself, and not just in a statistical summary.

WAS GALILEO AN ASTRONOMER OR PHYSICIST?, by Karel Hujer (University of Chattanooga, RASC)

The quartercentenary of Galileo's birth observed last year throughout the scientific world, culminating in an international symposium in his native Pisa and Florence, Italy, offered a rich opportunity to reconsider and reexamine immense sources of Galileo's creative heritage. A popular conception associates Galileo with the telescope. This is embellished with the legend of a dramatic stamping of the ground just outside the inquisitorial hall after the historical trial and the exclamation of his dogged "Oppure si muove," i.e. "nevertheless it does move." The reality actually was very different however, and it is always revealing, in the present state of physics, to retrace the picture of the struggling beginnings of this leading science of our age.

There is no question that the passion of Galileo's scientific life was to prove the Copernican heliocentric theory. The question of the truth of the Copernican theory was probably the fundamental problem of the latter part of the sixteenth and early seventeenth centuries. Galileo prepared himself for this herculean task, for it is significant that his first work "De Motu", written when he was only 25 years old, concerns the problem of motion. The arguments that Copernicus himself brings forth in his famous "De Revolutionibus Orbium Coelestium" are entirely of a geometrical and kinematic nature and involve neither dynamical nor gravitational aspects of matter. It is therefore difficult for us today to imagine how inacceptable was the motion of the earth when the concept of inertia was unknown. Thus, to introduce this new concept in physics into the petrified Aristotelian world view required the highest degree of resourcefulness.

In his work "Augustine to Galileo," A.C. Crombie states significantly:

> "It was, in fact, Galileo who was chiefly responsible for carrying the experimental and mathematical methods into the whole field of physics and for bringing about the intellectual revolution by which first dynamics and then all science were established in the direction from which there was no return."

This statement very aptly illustrates the evolution of Galileo's role in physics. Originally Galileo was inevitably influenced by the peripatetic school of thought, but already at his first post in Pisa he wrote his treatise on motion and began to challenge the mainstay of Aristotelian physics. He was first to become dissatisfied with the unsupported reference to the philosophysical authorities of his time and introduced careful and systematic observation and experimentation. Today this is an entirely obvious scientific method but then it was a radical novelty against the conceptual analysis of natural phenomena, a procedure generally practiced by the Aristotelians.

One of the fundamental dogmas of physics was that the time consumed by freely falling bodies is proportional to their weight. While still in Pisa, Galileo has reasonably well shown with weights of ratio as great as 1/200 that this peripatetic view has no experimental verification. However convincing and evidential were Galileo's experiments on this point, they could not shatter the authority of the Aristotelians. Despite the popularity of his lectures at the University of Pisa, Galileo aroused the enmity of the governing authorities and thus found conditions unfavorable in his native town for the continuation of his cherished studies.

While investigating freely falling bodies, Galileo could not fail to note that they are uniformly accelerated. This was, after all, admitted by the peripateticians themselves. Their naive explanation, however, was that all bodies have a tendency to occupy their natural position in the fastest way and therefore they accelerate. This, of course, could not satisfy Galileo's penetrating mind. Consequently he confronted the difficult problem of delicate measurement, and we must be aware that he did not possess a clock or any accurate time keeper as such instruments were still non-existent. First, Galileo had to define uniformly accelerated motion. He had two choices: either he could define motion in such a way that the velocity is proportional to the distance accomplished by the body, or define the uniformly accelerated motion as a movement whose velocity is proportional to time. After some deliberation Galileo chose the second definition. If the definition is properly formulated we can deduce therefrom such consequences that can be well verified by the results of measurement. This procedure presents Galileo as an entirely modern experimental scientist. He was the first to conduct systematic experiments. On the basis of preliminary observations he creates a working hypothesis. From a working hypothesis he traces such consequences as could be verified by measurement. In his measurements he selects such conditions that are accessible to his instrumental equipment and its constructibility. The results of his measurements he then checked with the consequences of his working hypothesis. Unlike Descartes and others, he followed the course of the physical events rather than their cause. Even this indicated his distinction because the search for causes can only follow the accurate quantitative description of natural phenomena. No one before Galileo followed this procedure. It is his uniqueness in the history of physics.

His working hypothesis was the admission that the free fall is uniformly accelerated. From his definition of uniformly accelerated motion he derived the relation between time and distance. It is impossible to observe a freely falling body directly, its course is too swift for measurement. Therefore, he slowed it down. Instead of dropping balls, he let them roll down the inclined plane. In this he was guided by the supposition that movement along the inclined plane can differ from the free fall only by the rate of its speed, not by the relation between velocity and time. Of course, for these experiments Galileo was in dire need of an accurate measurement of time. Therefore he had to find his own ingenious method of the needed time measurement.

From observation and reasoning he reached the conclusion that a ball will rise to the same elevation from which it started to roll down. Furthermore, he concluded that a body will reach the same final velocity at its lowest point as if it were freely falling, without regard to the angle of inclination of the plane, provided it started from the same elevation above the lowest point. This conclusion Galileo verified by observation of the oscillating pendulum. He represented the swing pendulum as a succession of motions of a body along a series of short planes of varying angles of inclination. This recalls the method of indivisibles practiced by Archimedes, whom Galileo liked to call his beloved teacher. The results of these observations not only confirm Galileo's original assumption but provided further important discoveries. In order to practice such preliminary assumptions and to process appropriately his observations, Galileo had to resort to idealized and schematized conditions. He was indeed the pioneering master in such mental processes. They enabled him to arrive at a number of other important discoveries such as the trajectory of a projectile as a result of the composition of two vectors. Consequently this discovery facilitated the study of complex movements and substantially influenced the further growth of physical science.

It is at this point that we may realize the crux of Galileo's geniality as a physicist and modern experimentalist -- by his discovery of the principle of inertia -- accomplished by his keen, penetrating observation of moving balls along an inclined plane. Now he posed a question for himself: What would happen if he were to continue to lower the opposite inclined plane along which the ball was impelled to move upward after it reached the lowest position? If the angle decreased, the ball would have to move farther in order to attain the same elevation. And what would happen if the opposite inclined plane along which the ball moved upward were lowered to a horizontal position? The ball evidently would roll along this horizontal plane indefinitely with the same velocity with which it reached the base of the downward inclined plane. It was in this way that Galileo arrived at the discovery of inertia.

While slowly changing the conditions that influence the phenomenon without affecting the very foundation of the process itself, Galileo was in position to reach a conclusion valid for circumstances that were different from those at the beginning of the experiment and thus to arrive at a generalization of the observed phenomena. This, undoubtedly, is the most genial aspect of Galileo as an explorer of physical laws accessible on this earth. Later, in his principal work "Dialogue on Two Chief World Systems," published in 1632, Galileo as an eloquent physicist becomes the defender of the Copernican system. His magnificent description of physical scenes and phenomena inside a quietly moving ship, representing earth moving through cosmic space, may be described as a superb exposition of the principle of inertia, or an accomplished, masterful and first introduction to the principle of relativity.

ECLIPSING VARIABLE V342 AQUILAE, by Marvin E. Baldwin(AAVSO)

As an amateur astronomer I have, during recent years, concentrated on the observation of eclipsing variables. Last year I was fortunate in selecting the little observed variable V342 Aquilae as one of my subjects. My observations revealed that V342 was running about 2.5 hours behind the schedule indicated by the most recent elements I had available.

L.J. Robinson has recently researched the subject of V342 and has found seven previous minima of this variable. Six minima from 1935 to June 1956 agree closely with the established elements. A minimum observed in August 1957 was about 25 minutes late. Apparently no other observations were made until last year when I found the minimum 2.5 hours late. Confirmation of this large deviation and continued monitoring of V342's behavior is highly desirable.

V342 Aquilae has a period of about 3.4 days and a visual range from 9.0 to 12.5 magnitude. Due to this large range in brightness its light curve has a fairly rapid and easily observable descent and ascent. The eclipse has a duration of 13 hours with a flat minimum of 3.3 hours.

The observer wishing to time a minimum should plan to observe at about ten minute intervals for a period of two hours immediately prior to the flat minimum and again for two hours following the flat minimum. This adds up to an observing session of no less than about 7 1/2 hours. An alternate observing plan may be used where the observer obtains data on the rising portion of the light curve during one eclipse and the declining leg during another eclipse. Data obtained by this method may be useful for reduction to an intervening time of minimum. However, this observing method is not without pitfalls and should be used with care and caution.

I will make a chart and eclipse predictions available to anyone contacting me who is interested in observing this variable.(Address: 2349 Travis Loop, Holloman AFB, New Mexico)

VISUAL PHOTOMETRY OF TWO LUNAR ECLIPSES, by Kenneth Chalk(Montreal Centre)

During the winter of 1963-64 I constructed a visual photometer to be used on a telescope for studying relative intensities of individual features on the moon and planets. It consists essentially of an assembly of rhomboidal prisms to obtain a divided field at the eyepiece of the telescope. One side of the field gives the image of a uniformly illuminated diffusing screen which is lit by an electric lamp. The intensity can be varied by means of an adjustable diaphragm. Readings are made by putting the feature to be observed at the centre of the field, and setting the comparison field to equal intensity. The aperture of the diaphragm is then read and squared, as the relative intensity is proportional to the area of the aperture. The diaphragm itself is of the cat-eye type, having two V-shaped vanes which run together on a screw which is half left-handed and half right-handed.

The instrument was first used at the Lunar eclipse of 24 June 1964, when the moon rose totally eclipsed, and it was intended that intensity readings be made as frequently as possible, successively in red, green, and blue light, of the emerging limb. This would have yielded three light curves of the edge of the umbra and the whole of the penumbra.

Because of passing clouds, it was possible only to obtain occasional readings, and these were confined to green light in order that a reasonably complete curve might be obtained. During the hour of observations, all after third contact, the light intensity was found to rise by a factor of 24, and apparently was beginning to level off when observations were discontinued on account of clouds. It was hoped that observations of the 18 December eclipse would yield more detailed information about this part of the light curve, and some success was obtained.

Observation of the December eclipse was not hampered by clouds. However, the cold weather resulted in a drop in voltage to the comparison lamp, with the result that only the first 40 minutes of egress could be measured before the moon became too bright. To increase accuracy at low light levels, a stepped neutral filter was used in front of the diaphragm so that it could be used at larger aperture. The filter had four segments which were used individually to give transmissions from 4.4% to 100% -- giving the instrument five working ranges.

Readings were made on the crater Copernicus, beginning while the latter was still in the umbra, and in red light. During the 40 minutes of observation the light intensity increased by a factor of nearly 700. Although the illumination was still increasing when observations were discontinued, the rate was diminishing.

The accuracy of the photometer is limited by the ability of the eye to distinguish small differences in intensity. I feel that this could be improved by modifying the apparatus used to obtain a divided field, as the prisms now in use leave a perceptible dark line between the two halves at all times. The division would be accomplished by using a diagonal mirror half of which is silvered. The edge of the silver layer would lie in the focal plane and constitute a well-defined, but invisible, boundary.

It is hoped that in the future the instrument will be useful in studying intensities and colours of the features visible on Jupiter and Venus. Finally, it might be used to investigate the lunar colour phenomena which have attracted recent attention, by replacing the eyepiece with a simple spectroscope to permit intensity measurements at specific wavelengths.

DWARF NOVAE AS BINARY SYSTEMS, by Larry C. Bornhurst(AAVSO)
Presented by C.B. Ford

The theory of the dwarf novae being associated with binary stellar systems is of a very recent origin. The first evidence of duplicity involving a dwarf nova type star was the discovery by Joy in 1956, which showed SS Cygni to be a spectroscopic binary of very short period. Since that time, a program of observations has been carried out by Kraft on many of the dwarf novae, which shows rather substantial evidence that all dwarf novae are themselves, members of binary systems. Observations by Kraft have covered most of the sub-classifications of the cataclysmic variables including U Gem, Z Cam and the novae proper. In all cases there is a strong argument in favor of duplicity which sheds a great deal of light on a problem that has long seemed to defy explanation. All of the work done so far along these lines has been of the photo-electric or spectroscopic nature, employing the large professional instruments. Having become aware of this study, I started a program of visual observations of U Gem early in 1964, to see if anything could be added by using much smaller instruments and visual methods such as have been used by the AAVSO for so many years.

The first order of business was to see if any of the published periods of the star were accurate. The first period[1] that was attempted of the star was in error as there was no evidence of an eclipse after several evenings of observing. Another period was found in Sky and Telescope[2] by Mumford which proved to be quite accurate. The elements given by Mumford are as follows: Min. = JD 2437639.00044 + $0^{d}.17690611$ E. Using these elements and making the proper heliocentric corrections, the star was observed to eclipse quite close to the computed time.

It should be mentioned at this time that the star U Geminorum is "normally" at a magnitude of something of the order of $14^{m}.0$ or $14^{m}.1$ visually and at mid-eclipse is somewhere around $14^{m}.7$. This will limit its study to the larger amateur instruments along with most of the other stars that fall into this classification. The absolute magnitude of the U Gem stars is thought to be somewhere around $9^{m}.0$. The data used in this report include 767 observations of 29 individual eclipses made by Thomas Cragg, Clinton Ford, Carolyn Hurless, Leslie Peltier, and myself. The very nature of the U Gem binary system, which I won't go into here, precludes any possibility of a symmetrical light curve. This was very evident in the results of my first observations and became more so as time went by. It seems quite difficult to establish the time of mid-eclipse, as such a short time has elapsed since the original epoch was determined, and the light curve is so asymmetric. However, it must be assumed to be very close to the proper period as the star showed no appreciable residual over a 14-month period.

The period[1] works out to just a little over four hours and fourteen minutes. Obviously, when the star is situated high in the winter and spring sky, it can be conveniently observed at least once a night in eclipse. Using a 10-inch telescope on several occasions, I was able to observe the extinction effect as the star dimmed below the threshold limit of the telescope and then reappeared. This, above all else, is certainly visual proof of the primary eclipse.

The resultant composite light curve[3] obtained from observations made by AAVSO observers certainly warrants further study. I was told to look for a brightening immediately before primary eclipse to about $13^{m}.8$ (visual). However, this brightening was only evident, if at all, on two or three occasions. The rest of the time the star dimmed as a regular binary. Recovery from primary eclipse is quite another story, however. At times the star appeared to recover to its original brightness in about twelve minutes after the calculated time of mid-eclipse. On one occasion, however, the star remained faint for over an hour. A further study may reveal a periodic change in the eclipse from the short to the long eclipse with the pre-brightening thrown in along the way. I would suggest that those with larger instruments make as many observations as possible of U Geminorum during the times of calculated eclipse and forward them to headquarters along with the usual observations. If there is any periodic change in the eclipse it should become evident with a mass of observations. If not, it will add to one's total of "sanctum" reports.

Editorial Notes, added by C.B. Ford June 4, 1965:

1. Bornhurst refers here to the period of the eclipses of U Gem observed during normal minimum phase of the well-established cataclysmic variations.
2. The period $0^{d}.17690611$ as given here does not appear in any of Mumford's Sky and Telescope articles I, II, or III (Feb. 1962, March 1962, Oct. 1963). The complete ephemeris Min = JD 2438799.6826 + $0^{d}.1769011$ E used currently by Cragg, Bornhurst, and Ford is from an unpublished determination by Krzeminski, using the epoch of an eclipse observed by Cragg (Feb. 7, 1965).
3. Bornhurst's "composite" light-curve, in which all 767 estimates on 29 different

eclipses made by four independent observers have been combined and each observer's curves adjusted in time to an estimated zero phase at mid-eclipse, presents a very large scattering which must be due primarily to real differences in the shape of individual eclipse cycles, and not to errors of visual observation. This viewpoint is justified by considering the unusually favorable positions of the $13^m_.8$ and $14^m_.5$ comparison stars, roughly equidistant from U Geminorum, which have been used consistently by all four observers in making visual estimates.

As more observations become available from the observers mentioned in Bornhurst's paper, and others, it is hoped that simultaneous observations of individual eclipses by more than one observer will be made, thus establishing that the eclipse cycles are not uniform in visual light. Such non-uniformity has already been observed photo-electrically in the U, B, V observations of U Gem by Mumford reported in Sky and Telescope (Oct. 1963).

* * * * * * * * * *

CONTENTS