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NOTES ON THE HISTORY OF OBSERVATION OF DOUBLE STARS

by C. D. Reid, F.R.A.S.

Summary:—In this paper are discussed the different reasons which have led to observations of double stars, and also some of the important results which have emerged from Those observations.

The observation of double stars is now a well-established branch of practical astronomy. So well founded is it now that it is with some surprise that we remember that there was a time when double stars were unknown.

The distinction of being the first person to discover a telescopic double star belongs to Riccioli, who found zeta Ursae Majoris (Mizar) to be separated into two, in the year 1650. This star is, of course, the brighter component of the naked-eye pair formed with Alcor. No more than four more doubles were discovered during the rest of the seventeenth century, these being gamma Arietis, theta Orionis, alpha Crucis, and alpha Centauri. Discovery of others was slow, and up till 1776, when Christian Mayer started a deliberate search, only four more had been found. These were gamma Virginis, Castor, beta Cygni, and 61 Cygni. Practically all of these early doubles have attained distinction in one way or another, and we shall have occasion to refer to them from time to time.

Christian Mayer found thirty-three more in the course of two years, and his research was the first instance of doubles being observed for their own sake.

Initially, double stars were thought to be chance alignments of two stars in reality separated considerably in space, although in 1767 John Michell had pointed out that the odds against such an alignment were impossibly great, even for the small number of doubles then known. However, it was with the idea that double stars were merely optical that Sir William Herschel began his studies.

Herschel had the notion that if he made careful micrometric ob-
servation of double stars, then if they really were separated by great
ting distances they should appear to move relative to each
other as the earth swung round the sun during the course of the year.
Observations of their relative separations, he thought, ought to en-
able measurement to be made of the distance of the nearer star.

In 1803 and later in 1804, the first results of Herschel's re-
searches were published. He had found, not that a measurable parallax
could be obtained, but that some half dozen or so pairs were actually
linked gravitationally. That is, the pairs revolved about each other
in elliptical orbits. John Michell's theoretical prediction had been
found true. It is of interest to note that Castor was amongst these
first stars announced as binary.

The discovery of binary systems made possible "guesswork" calcula-
tions of the masses and distances of the stars. If it is assumed
that the stars comprising a binary are of the same order of mass as
the sun, then a simple calculation from the period and the orbital
constants enable a rough estimate of distance to be reached. An idea
of the relative masses of the stars can be obtained if measurements
are made of the positions of the components with respect to other
stars nearby.

The double 61 Cygni is distinguished as the first "star" to have
a reliable measurement made of its parallax. At the beginning of the
last century Bessel began some serious work in order to discover a
stellar parallax. Beforehand the brightest stars were thought to be
the nearest, but Bessel considered that possibly a more reliable indica-
tion of nearness might be greatness of proper motion. 61 Cygni was
known to possess a proper motion of about 5" annually, so Bessel con-
sidered it a fair object of attack. His first result, obtained in
1836, indicated a parallax of about 0.3". Two other parallaxes were
obtained in quick succession, that of alpha Centauri, by Henderson in
1839, and that of Vega, by Struve in 1840.

With the information available in 1840, therefore, one could work
out with some accuracy the masses, relative to the sun, distances, and
brightnesses of four stars. These results would show that there was
in fact considerable variation in these quantities from one star to
another. The apparent brightness was therefore no guide either to
distance or size of orbit.

Observations of double stars by many people, both in the last
century and this, have raised the number known up to more than 20,000.
Of this number it is not possible to say how many are binaries, but it
is highly probable that most pairs are in fact physically connected.

Bessel was responsible for another important discovery. Investi-
gation of the proper motion of Sirius convinced him that this star was
in fact one component of a binary system, with a period of about fifty
years. These conclusions were published in 1844. Orbits for the
satellite were worked out by Auwers and Peters, these orbits giving
the directions in which the unknown star would lie, it being impos-
sible to arrive at an estimate of its distance.
In 1862, Alvan Clark was testing the objective of an 18" telescope for the Chicago Observatory. On directing it to Sirius, the companion was picked up. At first, it was thought that the tiny point of light seen next to Sirius was due to some defect in the objective, but further observation rapidly dispelled that alarming notion. The companion to Sirius was found at just the right direction to the major star.

The discovery of the companion to Sirius was really more than the finding of a predicted satellite. It was the discovery of a previously unrecognised type of star. When the light from Sirius B was analysed by the spectroscope, it was found that the star must be intensely hot, in fact decidedly hotter than the sun. As it was so faint (about 1/10,000 the brightness of Sirius), the only explanation could be that the star was quite small. Sirius B, then, is hot, fairly heavy (nearly the mass of the sun), and much smaller than the sun. Its density must be much greater than any substance we know—averaging about one ten or so per cubic inch.

This conclusion was so startling that it was some time before it was generally accepted. However, the discovery of more stars of the same type made it certain that Alvan Clark had found a new type of star, as well as a predicted satellite.

It is apparent that unless the mass of such a white dwarf can be measured, it would be impossible to prove it to be of high density, even though its temperature and distance are known. So another discovery resulting from the study of double stars was that of the existence of white dwarfs.

Nor does the story of discoveries end here. The application of the spectroscope to stars had revealed the existence of a new class of binary stars—those which can be detected only by periodic shifting and doubling of the lines in the spectrum. This movement of the Fraunhofer lines, due to the Doppler effect, can only be noticed when the star is moving towards or away from us. Spectroscopic binaries have periods which vary from several years down to a few hours. At the long period end of the scale, the binaries merge into the closer visual. At the short period end, the components can be considered to be virtually in contact.

The first of these spectroscopic binaries to be discovered was Minor, zeta Ursae Majoris. A periodic doubling of the spectral lines was noticed by Professor Pickering in 1886. Not long after, Vogel discovered a periodic oscillation of the lines in the spectrum of Algol.

Analysis of the spectra of the closer binaries has revealed some information on the atmospheres of the component stars. Valuable evidence has been secured on the way in which the gases forming the atmospheres of stars behave when subjected to large rotational and perturbing forces.

We can see, therefore, that in the last three hundred years, double stars have been studied for many different reasons, and, often enough, with results completely unanticipated.
PRELUDE TO OBSERVING

by E. W. Turner, F.R.A.S.

The study of astronomy begins by making an acquaintance with the stars, and the long dark nights and brilliantly starry skies of winter provide the training ground for beginners.

The winter is now upon us, and some of our members are preparing to enter astronomy seriously for the first time. Those members who attend J.A.S. group meetings will be taught the constellations by their Group Directors and experienced members, whilst others may have to rely on text-books and their own initiative. I would like to say now that if any members are starting star-gazing for the first time this winter and would like help and guidance in finding the constellations, if they care to write to me I shall be happy to assist them.

When we first look up at the night sky and see what appears to be myriads of stars, some faint, some bright, some straggling thinly across the sky and others so tightly packed together that they look like hazy clouds, we think to ourselves "what a hopeless task it must be to sort them out and learn their names". But after studying them for a while, we notice that some seem to assume a little order or "shape". We can see five stars in one part of the sky which seem to trace a definite "W" pattern, whilst another group forms a little square, and yet another patch shines as a distinct cross of stars.

Although there seem to be millions of stars in the night sky, the average person can see only about 3,000 with the naked eye at any one time. The stars are split up into different lots or "groups" which are called "constellations". When learning the constellations their names may seem somewhat peculiar, for only in a very few cases does the arrangement of the stars in the groups resemble in any way the object they are supposed to represent; but we must remember that they were named by the Greeks and the Ancient World who thought they saw in the stars the figures and shapes of immortalized heroes and characters from their numerous legends.

Some say why should we keep these old names - why not alter the groups and call the stars by more modern objects. Fortunately we prefer to leave them as they are, for not only have the names been preserved and handed down for hundreds of years, but it is so much more interesting and "romantic" to call a group of stars by a mythological name such as, for instance, Cygnus (the swan), or Equuleus (the little horse), than by names such as Trolibus (the trolleybus) or Vitas-capsulium (the Vitamin Pill)! Of course, there are no names such as these last two, but some star groups in the southern skies have been named since European civilization spread to the southern hemisphere. There is one group called Telescopium (the telescope), and another is called Antlia (the air pump). How much nicer the old legendary names sound! Once we know our way about the night sky and come to treat the star groups as familiar friends, we find much beauty and feeling in the "ancient history" flavour of the old constellation names.

If we live in the towns we may be unfortunate in not being able
to see the wonderance of the starry sky as do our friends in the open
country, but if there is a walk which can be taken where the street
lamps are not quite so bright, and where a more unrestricted view of
the bright sky can be had, it will be a stroll well worth taking. In
any case, do not be dismayed, for we all manage to see some stars at
some time or another — and talking of "somes", I do not think that our
younger members will find astronomy as hard to learn as some of their
school "dums"

I would like to mention a few points of advice so that when we
commence star-gazing we will be thoroughly equipped.

The most important thing to remember is this — keep warm and well
wrapped up.

The worst enemy of an astronomer is the cold and damp of the night
air, especially in winter. To stand in the garden or in a field look-
ing at the stars on a chilly evening, perhaps after a day of rain, is
very risky indeed unless proper care is taken to safeguard oneself
against these conditions. I remember once during the war standing for
just a little while on the concrete top of a defence post trying to
catch a glimpse of Mercury one windy evening. I didn't bother to put
on a coat or thick footwear, with the result that for some weeks later
I had a very nasty chill. On another night I was using a small tele-
scope on a rather short stand to observe some stars near the zenith
(the point directly overhead). Being a warm summer night I lay on the
grass in the garden to be able to see through the eyepiece properly,
for I had no star-diagonal. Just a few minutes on a warm night, but
again I caught a cold through the dampening, dewy ground. One just
cannot be too careful when observing. Always remember that a few
quick minutes star-gazing whilst unsuitably clothed can lead to a few
months' ills and chills, or, worse still rheumatic pains in later
years if you do it too often. Young members' bones are young now, and
they may feel no effects through standing in, say, light slippers on
the garden path one night now and then for a few moments, but the germ
may then be born which will give much discomfort in later years. Do
not say, "I just want to nip outside quickly to see the position of
Orion tonight, shan't need a coat", or "It's not worth changing into
my shoes, I won't be a moment" — that moment may do harm. Please do
not be alarmed and shrivel from even attempting to star-gaze after what
I have just said. I just want to tell you that the Golden Rule of
star-gazing is "Always keep up well for the occasion, no matter how
long you want to stay outside observing".

The best way to do this is to wear some loose-fitting woollen
garments; two or three woolly pullovers are ideal, and two pairs of
gloves, woollen ones inside leather ones. I say "loose-fitting" be-
cause tight-fitting clothes will not keep you as warm, for wool works
by trapping the air around the body, and it is this trapped air in the
mesh of the wool which keeps you warm. A tight pullover will not hold
so much air and thus will not be so useful to you. If it is a damp
evening, or if you live in an exposed part of the country where mist
or cold winds are experienced, a warm woollen scarf and a balaclava
helmet would be ideal, as long as they are taken off when you get in-
doors and not before. Try to find some sort of headgear, however, for
cold wind may bring earache or colds in the head. I find a helpful
way of keeping one's legs warm is to wear two pairs of trousers, or a
pyjama pair inside the normal pair. During winter and damp nights,
two pairs of socks and strong boots or gum boots is advisable, especi-
ally if you live in the country. Pack the ends of the trousers into
the socks. Do not have a hot drink before going outside, for the cold
will cool it in the stomach and a chill may arise — have it when you
done it at the end of the observations. One other point, if you wake
early one morning and feel like looking out of the window at the morn-
ing stars before the sun rises, put some shoes and clothing on — cold
morning air and cold linen to the feet is not only uncomfortable but
risky!

The feet are most susceptible to the cold, and no account
should you stand in wet grass, on wet concrete or stone paths, or on
bare earth, at least for any length of time. Try and make an observa-
tion platform in a position where as much of the sky as possible can
be observed from the one spot. Some planks of wood covered with dry
sacking or an old door mat, and raised off the ground by blocks or
bricks is ideal. Put the boards away in the dry after observing, do
not leave them as a permanent fixture where they can get wet and damp.
For those members living in exposed areas it is a good idea to erect
some sort of shelter to act as a wind-brake. Three board frames co-
ered in canvas and hinged together is best, for it can be folded up
and stored away with the boards.

A tip now about the eyes. The eye is a window through which we
can see. It has "blinds" which are drawn when light is too bright for
us. We have all noticed how the pupil of the eye (the black spot in
the centre of the eye) contracts when bright light shines on the eye.
When we leave a bright room and go into the dark, it is difficult to
see at first for the "blinds" have to be "pulled aside" so that the
eye can become accustomed to the change from light to dark. In other
words, the pupil of the eye must expand to enable more light to reach
the sensitive "seeing" nerves inside the eye. We have all noticed this
when going into a cinema. When we first enter the hall we cannot see
properly, but after a while when the eyes have become accustomed to
the dimmer light we can see clearly the picture and the people around
us.

Before leaving the house to go into the dark to observe, it is
best to stand in a dark room for a while, about one minute at least,
with the eyes closed to let them become accustomed to the dark, as
long as a lighted room does not have to be passed again to reach the
outside. This will save getting cold standing about in the night air
waiting to see the stars.

When learning the night sky we must be able to see and read our
charts. It is no use going indoors, looking at the charts, and then
running outside again to look at the stars, for by the time our eyes
have become accustomed to the dark again we will probably have forgot-
ten the direction, etc., of the stars we want to find. In any case it
will waste a lot of time. It is best therefore to have some means of
reading the charts in the open air without using too much light. The best way to do this is to make a little board on which to fix the charts, and have a small light attached to the board which can be switched on when checking the findings in the sky with charts. The light must be masked or painted with red, for the red rays are soft and do not dazzle the eyes, and are quite bright enough to enable the charts to be seen and read and to make notes comfortably without contraction of the pupils of the eyes. The more mechanically-minded members might be able to make a proper switch-operated light for their note-board, and here I will hand over the pen to my colleague Mr. Peters who will show us how such an Observing Board may be easily made.

**HOW TO MAKE AN ILLUMINATED OBSERVERS BOARD**

by J. H. Peters

An Observers Board is a most essential piece of equipment for any observer of the night sky. As some of us have found in our early days, it is quite impossible to study a star atlas in the house, go out to find a particular object in the sky, and then come in again to make notes.

Many observers use a suitably shaded red cycle lamp, while others use the more elaborate glass-topped box illuminated from below. The latter is excellent if you make notes on translucent paper, but it is unsuitable if you wish to use a star atlas. The board illustrated incorporates the best features of several boards made by boys of the Chesterton School Group, Cambridge.

The Lamp House

This was made from a coffee tin with a lid (2½" dia. x 6" long). A ⅛" wide slot was cut by the seam with an old pair of scissors and the lid replaced. The inside including the end were covered with matt white (or red) paper which was glued in. The piece of tin removed from the slot had two holes punched in it— with a nail— towards one end, to match the securing holes in a small screwed socket lamp holder. The lamp holder was secured to the strip by wire through the holes and the strip was bent into a clip as illustrated. (Fig. 2).

As it is not possible to get uniform illumination of the board at close quarters, the lamp house provides indirect lighting, but it will be found that by rotating the lamp house in the dark with a piece of white paper on the board that there is a position which gives the most uniform illumination of the board. This position once found the lamp house should be secured by nuts and bolts along the line of contact with the board. It may be found convenient to use one of these bolts to convey an electrical connection from one side of the lamp to the back of the board.
FIG. I

TO BATTERY

RESISTANCE

SPACER

WIPER ARMS

FROM LAMP

SPACER

CYCLE LAMP

BATTERY

BOARD 9" WIDE
15" LONG

FIG. II

UNDERSIDE VIEW SHOWING DIMMER
The Dimmer

The lamp, a 2.5 volt 0.3 amp flash lamp type, was too bright when supplied by a new cycle lamp battery, and it was found by experiment that 1' 6" of 30 S.W.G. Nickel Chrome resistance wire was sufficient to reduce the lamp to a more glow. (Resistance approx. 4 ohms.) This wire was wound on a strip of rod fibre (or plywood) (1/16" x 5/8" x 2") and the end secured to bolts which were long enough to bolt the resistance to the board. The wiper contact was made from 1/16" x 5/8" x 2" brass and bent V-shaped at the end in order to provide a "line" contact on the resistance wire (see illustration, fig. 3).

Other Features

The board is less tiring to hold if the battery is fixed near the bottom edge of the board but feet will have to be provided at the lamp house end if the board is to be used on a table. Papers are best secured to the board by rubber bands cut from an old inner tube of a car tyre.

The shade above the slot is of stiff black paper or tin and is to prevent direct light from the slot reaching the eye.

I hope the board has been amply explained, but should any member have difficulty in its construction I shall be pleased to clarify any point by post.

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Lunar Observations by a Beginner

by D. Grundy

What to observe and how to draw it was the first thing that I thought of when I first looked at the moon through a telescope. It seemed impossible that I would be able to draw all of the intricacies that were before me, but I soon became used to it. Even as poor a draughtsman as myself finds it no ordeal to portray the wonders of the moon's landscape. For the first few weeks of observation I wandered here and there making no attempt to do anything of special use to selenography. Then I wished to do something that was really worthwhile and I decided to specialise in the region around the formation which is called Encymion.

In this formation there are dark spots which are thought to be areas of "vegetation" as they are noted to vary according to the time of the month. There are, of course, many other ringwalls in which these curious spots are to be found; in addition there are variable light spots which appear to undergo a monthly sequence of change.

In some craters such as Aristarchus and Dawes there are dark bands the nature of which is, as yet, unknown.
Then as a proof of the atmosphere, now and again there are clouds to be seen, especially in the ringed plain Plato. During 1945 an astronomer, F.H. Thornton, noticed a bright spot on the floor of Plato. Observing on the next evening he could not detect any trace of it, then as he was watching the floor of the plain he saw a flash that was thought to be a meteor striking the Moon's surface. As Mr Thornton himself said, "It is, I believe, a very rare thing for an observer of the moon to be fortunate enough to see something happening. But there is no doubt that things do happen, and that changes are constantly taking place..."

Moreover, if you should find this type of observing uninteresting, there are the limb regions, about which hardly enough is known. The mountains, which are seen in profile, are always changing shape due to libration. Not only the mountains, but also the formations appear to change constantly their shape and careful drawings are required.

Apart from these details there are the clefts. This type of feature is similar to the coves on the earth. The principal systems of cracks on the moon are to be found near Trianocher and Hyginus.

Lastly there are the domes, about which very little is known. They are, as the name suggests, roughly hemispherical in shape, and are to be found all over the surface.

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ASTRONOMICAL LETTERS AND NOAKES

"Festivals" on the Planet Venus

by Richard Baum, F.R.A.S.

In the year 1643 the Jesuit astronomer Riccioli observed on the planet Venus a strange phenomenon that appeared in much the same fashion as the so-called earth-light of the moon. This pulsating glow of the night side of the planet was again seen by Derham in 1715, Kirch Jr in 1721 and again in 1726, by Mayer in 1759, and by W. Herschel, M. H., Schröter, Harding, and Pasta in 1790, 1793, 1806, and 1822 respectively. Following this series of observations came the well-known German astronomer Cruithuisen of Munich, who in 1825 also witnessed this curious phenomenon.

Going over the old records of the "ashen light" of Venus, Cruithuisen noticed that between the principal observations of this appearance, those of Mayer in 1759 and Pasta in 1806, an interval of 47 years or 76 Venus years existed. In such a case of things this period did not make any sense whatsoever, but in the German professor a suggestion presented itself. He considered that from a religious point of view the period had no meaning. But if it be assumed that some mighty Cytherean lord had attained power at those times, then the time inter-
val would be comprehensible. If the life-span of a Venusian be taken as 130 Venus years, the corresponding period on earth being 80 years, then the reign of a Lord of Venus might well last 76 Venus years.

The ashen light then, to Gruithuisen at any rate, appeared to have a reasonable meaning. It was nothing more than the astronomical appearance of the general illumination of the planet through the existence of a planet-wide festival in honour of the ascension to the throne of Venus of a new emperor.

So startling did this conjecture appear that Gruithuisen modified it to a less fantastic hypothesis, though even then the new idea contained an essence of the former. Gruithuisen stated that as Venus is almost a second earth and that as it orbits the sun inside the earth's orbit, it would be generally warmer, in all possibility representing a tropical planet clothed with a luxuriant vegetation even more beautiful than the virgin forests of Brazil. With the revised suggestion, Gruithuisen considered the ashen light to be the glow from immense forest fires brought about by the inhabitants, who to make way for the growing population of the planet and also to provide new farmland, had to clear large tracts of forest land by burning it away. "Large migrations of people would be prevented and the resulting wars would be avoided by abolishing the reason for them. Thus the race would be united."

Though Gruithuisen was essentially correct in his observation of the ashen light, his hypotheses can safely be said to have gone wide of the mark in explaining away the appearance.

Recent years have shown a slight increase in our knowledge of this strange apparition, and it now seems that either one of two possibilities, or probably both, could contribute to the observed glow. On the one hand an extensive aurora, to be expected in view of the planet's nearness to the sun, and on the other a glow from volcanoes on the surface, a possibility if Venus be considered as younger than the earth. Many other theories have been put forward, but these two would appear to have the greatest chance of being nearer to the truth.

In conclusion, the writer points out that a small telescope will suffice to show the dark body of the planet at times of inferior conjunction. Indeed all the writer's observations on this phenomenon have been made with a 3" C.S., and in each instance the observations have been confirmed by other observers studying the planet quite independently.

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NOTES AND NEWS

New Planet Discovered

It has been announced by Miss J. Winton Hansen at Copenhagen that S. Arend has detected a new planet in the constellation Pisces. The object was found in 1923 September, the magnitude at this time being given as 12.
When Mercury Crosses the Sun

In a popular article on the transit of Mercury which will take place on the 16th November 1951, Mr W.B.B. Heath details the cause of the phenomenon and describes each of the five transits that have been seen in the British Isles during the present century. The circumstances of the coming transit are given and hints as to how to observe it are also included.

The Planet Venus

The mysteries of our "sister" world in space are well described in a recently published lecture originally given before the Department of Astronomy, Chester, by Mr F.A. Moore. Opening his account of the cytherican problem, Moore stated that "Venus is an almost featureless dazzling disc, either crescent or half or gibbous". As far as we can see, Venus shields her actual surface from our gaze by the dense mantle of cloud that gives her the excessive brilliance that stands her above all.

The acceleration of dichotomy and the apparent retarding of this aspect at eastern and western elongations appears as a puzzling feature to which no suitable answer can be found. The explanation of Schröter, that the phenomenon was caused by very high Venerian mountains, can with ease be considered fanciful in the extreme. Schröter's observations of detached star-like points of light at the south pole were also described, and mention made of the measured height, 27.5 miles. It seems easier to regard these as having been caused by very high clouds rather than mountains.

The controversial surface marks, the dusky shadings, the bright clouds at the "poles", and the terminator phenomena, were described, much attention being devoted to the recent studies of linear features on the planet.

The question of the oft discussed period of axial rotation was presented, and the relative merits of each deduced period considered at length.

In concluding, the speaker presented two word pictures of the cytherican scene. One showed the planet as nothing more than a vast dust bowl where rage mighty storms, sweeping the great clouds of dust along the surface and carrying them to great heights in the atmosphere. With the other picture, a moist humid world is painted. Extensive vegetation covers the land and the warm waters of the oceans teem with primitive life, perhaps similar to that which existed on earth many centuries ago.

Mars in 1952

The observations by the German astronomers on the planet Mars in 1952 were chiefly concerned with the recording of clouds over the surface. Altogether 52 objects were recorded; of these 48 were yellow clouds, those most probably associated with dust storms.

Studies of the actual markings showed that Syrtis Major and the region of Thaumasia differed in configuration from previous maps.

(Yoga, No. 5, pp. 19-20, with one map)

THE JUNIOR ASTRONOMER'S BOOKSHELF

A Christmas Book List

The Constellations and How to Find Them, by Sir W. Peck, Call & Inglis, London. Price 3/6 (northern volume) 7/6 (southern volume)
Astronomy, by W. M. Smart. Oxford University Press, Price 9/6
The Planet Mars, by G. de Vaucouleurs. Faber & Faber, London, Price 10/6
From Atoms to Stars, by M. Davidson, Hutchinson, London
Elementary Astronomy, by E. A. Beet. Cambridge University Press, Price 8/6
The Starry Heavens, by E. Hawks. Nelson & Sons, Price 5/-

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JASper's "Preludio to Observing"

No need for J.A.S. members to follow JASper's example - but they will do well to study the article on Page 47!
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