Ford Amateur Astronomy Club

STAR STUFF

Volume 1 Number 4

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The Spectral Classes

submitted by Joseph Sprys

Stars can be identified and catalogued in a multitude of ways. One method is called spectral class and will be the topic for this article.

The spectral classes of the stars will be mentioned regularly in astronomy, requiring even the most casual observer to have some understanding of their meaning. The spectroscope is an instrument which analyses light. The ultimate nature of light may remain one of nature's mysteries; but as a useful analog we may imagine that a light beam consists of a series of wave-like ripples moving outward at tremendous velocity from the light source, much the same as the ripples on a pond when a stone is dropped into the water. The color of the light is a function of the crest-to-crest distance or wavelength of these ripples calibrated in angstrom units of one ten-millionth of a millimeter and identified by the symbol lambda preceding the number. The longest visible wavelengths (about 7600 angstroms) produce the sensation of red and the shortest (about 3900 angstroms) produce the sensation of violet. All the other visible colors lie between these two extremes.

The spectroscope analyses light by sorting out all the wavelengths from the longest to the shortest and presenting them in systematic order in the form of a long colored band called the spectrum which may be seen visually or be photographed. The most familiar example of a natural spectrum is the rainbow. In this case the dispersion of the light is accomplished by water droplets in the atmosphere each acting as a tiny prism. In the spectroscope the light is passed first through a fine narrrow slit, generally less than 1/500 inch in width, and then, through a prism or series of prisms. In some models, a diffraction grating may take the place of a prism. The resulting spectrum may be directed into an eye-lens for actual viewing or projected onto a photographic plate_ Professional spectroscopes are often equipped with a calibrated scale so that the wavelength of any spectral feature may be determined; in astronomical photography of spectra the calibration is obtained by photographing a comparison spectrum from an artificial light source on the same plate.

Since the colors of the spectrum are arranged according to wavelength, they always appear in the same order, with red at one end and violet at the other. beyond both ends of the visible spectrum are other wavelengths, infra-red and ultra-violet, which cannot be seen by the eye, but which may be recorded with special equipment or with certain photoelectric devices.

There are three basic types of spectra:

1. A glowing solid, liquid, or gas under high pressure emits the

full range of all wavelengths, producing a complete band of colors. This is the continuous spectrum. An ordinary electric light shows a spectrum of this type since the light source is an incandescent solid.

2. A glowing gas under low pressure radiates only in certain frequencies, producing an emission spectrum, a pattern of bright lines at cerain definite positions in the spectrum. The reason for this is found in the actual structure of each type of atom; thus the pattern of lines produced by each element or compound is as unique as a fingerprint and positively identifies the type of atom which is emitting the light. Some elements have a very simple pattern consisting of a few lines while others produce patterns containing many dozens of lines.

3. A rarified gas, when at a lower temperature than the light source, absorbs the same frequencies which it would emit if it were hot and glowing. Thus when light passes through such gas, various wavelengths are absorbed and appear as dark lines or bands in the spectrum. This is called an absorption spectrum.

A typical star spectrum is of the third type, because the dense glowing mass of the star produces a continuous spectrum, but the various wavelengths are absorbed by the thinner gasses of the stars's atmosphere. The spectrum of our nearest star, the Sun, contains thousands of dark lines, and in this way most of the elements known on Earth have been identified in the Sun. The Sun is not, however, one of the hottest stars or one of the coolest; it is a rather average type called class G2 by astronomers. Stars can be arranged in various classes by their spectral characteristics, and this classificatin system is the central subject of this discussion.

The vast majority of stellar tpes may be arranged in a logical sequence, each spectral class gradually merging into the next. The chief classes now recognized are identified by the letters O, B, A, F, G, K and M. Each class contains ten subdivisions numbered from 0 to 9. Thus a B5 defines a temperature sequence, or color sequence, which amounts to the same thing. Stars of type O and B are blue-white stars; A stars are white; F and G stars are yellowish; K stars are orange and M stars are red. Three additional classes, R, N, and S are used for stars which resemble type M but show certain spectral differences, as described in ths short summary in Table 1. Stars of type N are the reddest known.

Prefixes and suffixes are often used to further define the status of a star. Some typical examples are:

dM2	Prefix d indicates ordinary dwarf star.
gM5	Prefix indicates giant star.
DA	Prefix capital D indicates white dwarf (degenerate star)
B2e	Suffix e indicates emission spectrum, bright lines replacing certain dark absorption lines.
A5p	Suffix p indicates spectral peculiarities.

The spectral classes will be valuable when analysing the compositions of stars within certain regions of the sky and for understanding the color and its relationship to surface temperatures of stars and elements present within the star.

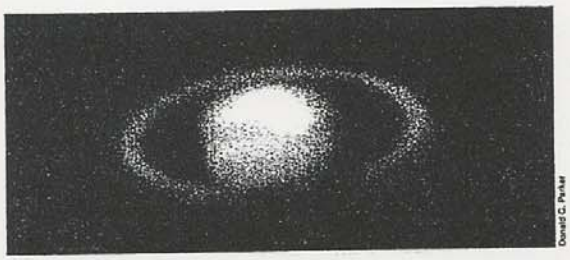
From Burnhams Celestial Handbook

Newcomers Corner
by Dave Garrett

Contrast

When Amateur Astronomers talk about contrast they are usually talking about the difference in brightness(intensity) between two features on an object being viewed. A more precise definition is:

$$\text{Contrast} = \frac{I_1 - I_2}{I_1 + I_2}$$



Suppose the White Spot on Saturn (I_1) had a value of 1 and the rest of the planet (I_2) had a value of 0.75. The contrast between I_1 and I_2 would be:

$$\text{Contrast}_{\text{object}} = \frac{1.00 - 0.75}{1.00 + 0.75} = 0.143$$

Similarly the contrast of the image you observe through your telescope may be calculated. Let us assume that the I_1 region has a value of .95 and the I_2 region has a value of .83. $\text{Contrast}_{\text{image}}$ would be:

$$\text{Contrast}_{\text{image}} = \frac{0.95 - 0.83}{0.95 + 0.83} = 0.067$$

At this point we introduce a new definition, Contrast Transfer Coefficient or CT for short. Contrast Transfer is the change of contrast that results from using the telescope to observe any particular object.

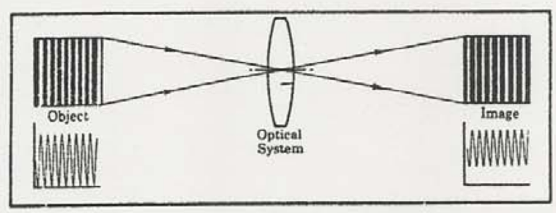
It is:

$$CT = \frac{\text{Contrast}_{\text{image}}}{\text{Contrast}_{\text{object}}}$$

For the example with Saturn the CT would be:

$$CT = \frac{0.067}{0.143} = 0.469$$

In practice Contrast Transfer is measured by putting a mask (diffraction grating) on the object side of the telescope and measuring the contrast of the resulting image. A combination of a bright line and a dark line is called a line pair (lp). A coarse grating has very few line pairs per millimeter. A fine grating may have up to 180 line pairs per millimeter.



Contrast Transfer by an Optical System.

Telescope Optics

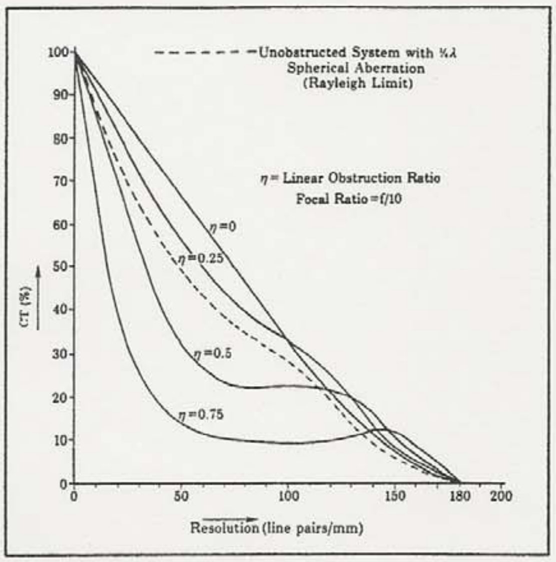
As evaluators use gratings with successively more line pairs per millimeter, diffraction and scattering cause all the lines to achieve a uniform grayness (loss of contrast).

One of the factors that affects diffraction is the size of any obstructions in the optical system (secondary mirror in Newtonian & Schmidt-Cassegrains). The Linear Obstruction Ratio is a measure of this obstruction and is expressed by:

$$n = \frac{Area_{primary}}{Area_{secondary}}$$

A typical f/10 Schmidt has a n=.11. Refractors have a n=0. Newtonian have n values in the range from .1 to .25. If you were to plot a series of Contrast Transfer coefficients (CT) for various line pairs/millimeter and a series of Obstruction Ratios (n) you would have the following graph.

If you look carefully at the graph you will notice that for 0 - 100 line pairs/millimeter the unobstructed telescope(n=0) yields more contrast (higher CTs) than any of the obstructed telescopes. When the resolution exceeds 100 lp/mm the obstructed telescopes become better than the obstructed(refractor).



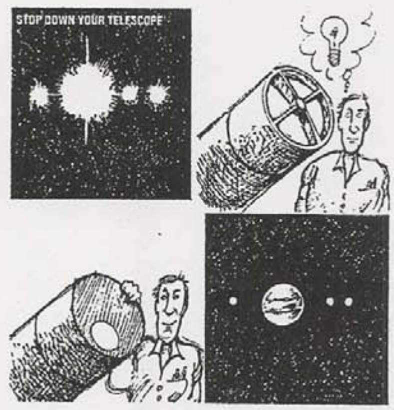
Telescope Optics

You could summarize this graph by stating:

1. an unobstructed telescope will give more contrast for objects (moon,planets) whose features are (relatively) large and may be resolved (easily).
2. an obstructed telescope will give more contrast for objects (double stars) whose features are more difficult to resolve.

Most of us only have one telescope - how do we go about improving the contrast of its images?

Contrast Improvement
The most cost effective way I know to improve contrast in obstructed telescopes is to make an aperture mask. This mask can be nothing more than a circle of poster board. Measure the distance from the edge of the telescope tube to the edge of the secondary mirror and cut a hole of that diameter in the posterboard. This turns your 8" obstructed telescope into a 3" unobstructed telescope(n=0). An aperture mask like this works well on bright objects (moon, Jupiter,Saturn). The dimensions on an aperture mask are NOT critical...but do your best to make the cutout reasonably circular.



Astronomy

If you put a second hole in the aperture mask you have an excellent focussing aid. The two offset holes create a double image that join only if the telescope is exactly in focus. If you are doing eyepiece projection photography, the mask may be removed after focussing. The second hole reduces contrast slightly and may be covered with a flap of cardboard to restore the improved contrast that results from one opening.

If anyone has a refractor, I would be interested to know if an aperture mask [that puts a central obstruction in optical system] improves the resolution of double stars.

A polarizer is useful to improve contrast on bright planetary images(moon, Jupiter, Saturn).

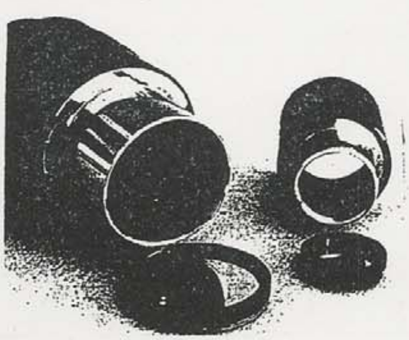
Sometimes going to a higher power eyepiece will improve contrast for planets/the moon. The images are fairly bright...going to a higher power produces a larger image for the eye and acts on more cones/rods.

Owners of newtonian telescopes can

usually improve the image contrast of their telescopes by replacing the secondary mirror with a smaller one. Commercially made newtonian telescopes come with a secondary mirror may be 25% the size of the primary mirror. The secondary has to be that size for good photographic images. For good visual images the recommended secondary size is 10%. Secondary mirrors are about $25. Looking at the Contrast Transfer Functions for n=.25 and 0 and you can project a definite improvement in contrast for this action.

Another good way to improve contrast is to minimize stray light. Techniques to do this include dewcaps, wrapping open trusswork reflectors with black cloth, and covering your head with a hood. Collimating/cleaning your telescope's optics falls into this category too, along with local heaters/hairdryers to keep your optics dew-free.

A very effective way to improve contrast on deep sky objects is to use nebula filters. These are selective optical bandpass filters... they only let through a narrow range of light wavelengths. Since these filters block so much of the available light, they produce the best results when teamed up with lower magnification eyepieces. I have successfully used some of the broadband nebula filters (Orion SkyGlow) on the moon/Jupiter/Saturn when skyline light pollution was rather high.

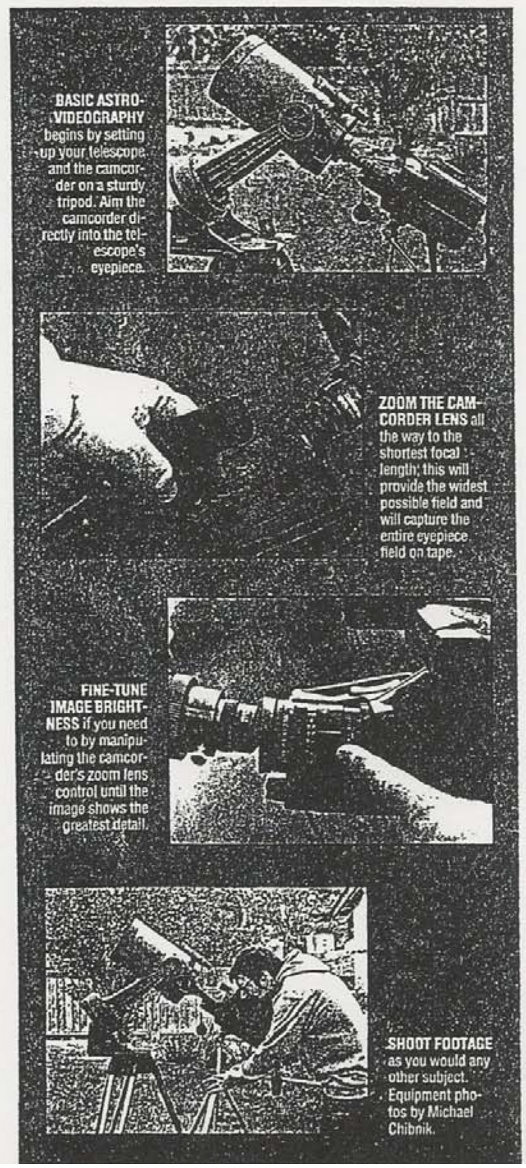


Backyard Astronomer

The least effective way I know to improve image contrast is colored filters. They work...a little...but my recommendation is to try a friend's set before buying your own.

The last contrast improvement method is probably best left for a winter project. Most people have an extremely high contrast imaging device in their houses that they take for granted...their TV!
Remove the star diagonal from your telescope, plug in an eyepiece, and aim a camcorder into the eyepiece. Either roll the TV next to the telescope for real-time observing or make a tape and play it back on your VCR. Because of the amount of equipment involved I recommend doing this in the winter time, inside the house through an open window.

Next month: Mars



Planetary Plotters and Retrograde Motion

by J.W. Sprys

One way to plot the motion of planets to track their progress across the sky , study their passage through the constellations or get a good idea of retrograde motion, is to build and use a planetary plotter.

The planetary plotter is made of a wooden or cardboard frame with either glass, plastic sheet or a transparent film such as that used for overhead projections. Because of the non-rigid behavior of these films a frame of some sort would be most advantageous. The plotter should be mounted on a rigid support or stand similar to that shown in Figure 1.

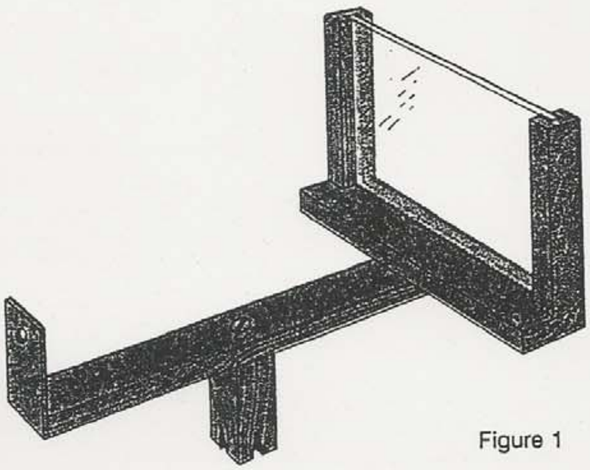
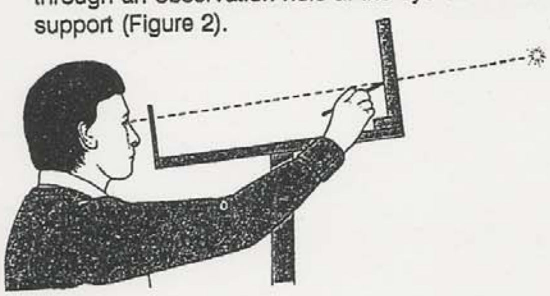


Figure 1

The center support holding the frame and track should be further mounted on a column to allow ease of observation. With the frame and support fixed, the separate star positions can be marked on the transparent film while being sighted through an observation hole at the eye end of the support (Figure 2).



To use the planetary plotter, first mark some bright stars for reference; then mark the planet, perhaps in a different colour. For subsequent observations line up the plotter with the fixed stars and plot the new position of the planet.

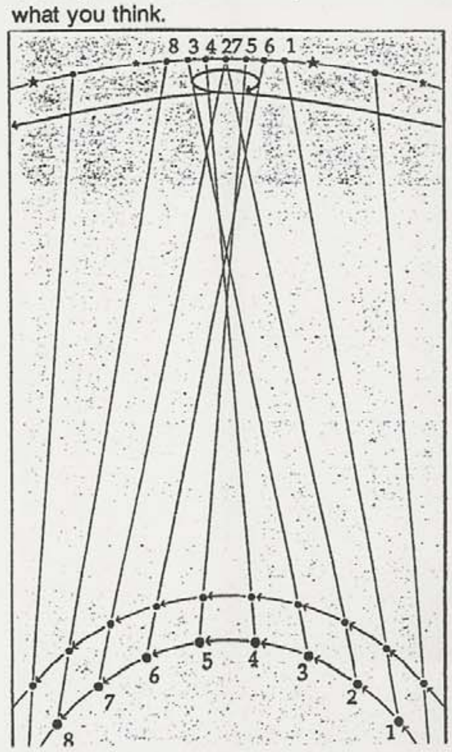
Figure 2

Once the star positions around the planet have been plotted, the position of the planet is in turn plotted and tracked on the same film over several successive nights preferrably several days apart for a few monthts. The result should show the track of the planet within the fixed star positions.

The use of such a device should be very useful in this period in which the planet Mars is in its period of retrograde motion. As you may recall, retrograde motion is the apparent impression that the planet is backtracking within the planetary track. The apparent backtracking was considered to be an epicycle by the early astronomical investigators. The truth is that the retrograde motion occurs because of the different speeds of rotation of any two planets in the solar system and the observationof that motion from the inner of those two planets. Your chart will show loops in the planetary paths for the outer planets. The reason for this is that the farther away from the sun the slower the planet moves in its orbit. If we plot the movement of the Earth and Mars the retrograde motion will begin to be understood. "The Earth takes a year to complete an orbit about the Sun but Mars takes nearly two: in other words, Mars only moves about half as fast as the Earth.

In Figure 3, successive positions of Mars and the Earth are plotted, and the appearance of Mars in the sky against the background of stars is shown. You can see that after the Earth reaches position 4, it overtakes Mars, and this gives the loop as shown in the drawing. A similar effect happens with Jupiter, Saturn, Neptune, Uranus and Pluto because all these planets orbit more slowly than the Earth does."

The planet Mars will be providing the viewer the opportunity to practice with such a device as described above. It is enterig its retrograde motion at this time and plotting of the path would be both exciting and educational. Try it out and let us know what you think.

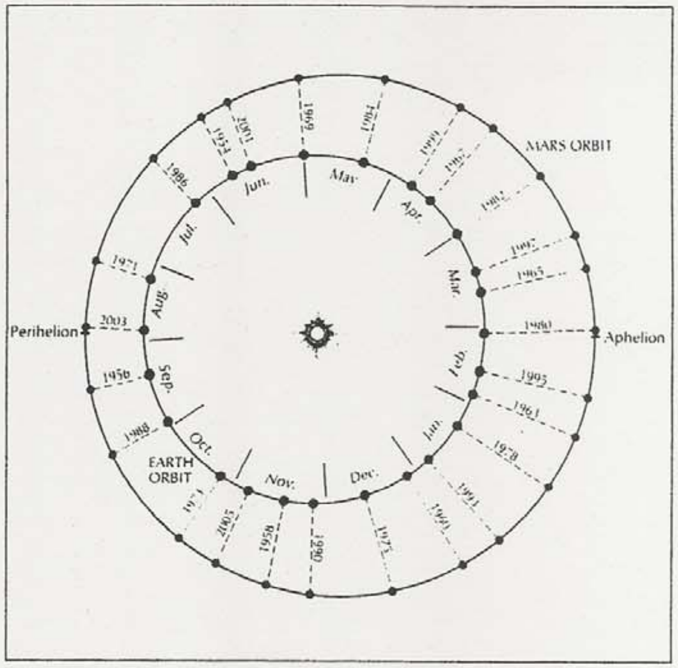


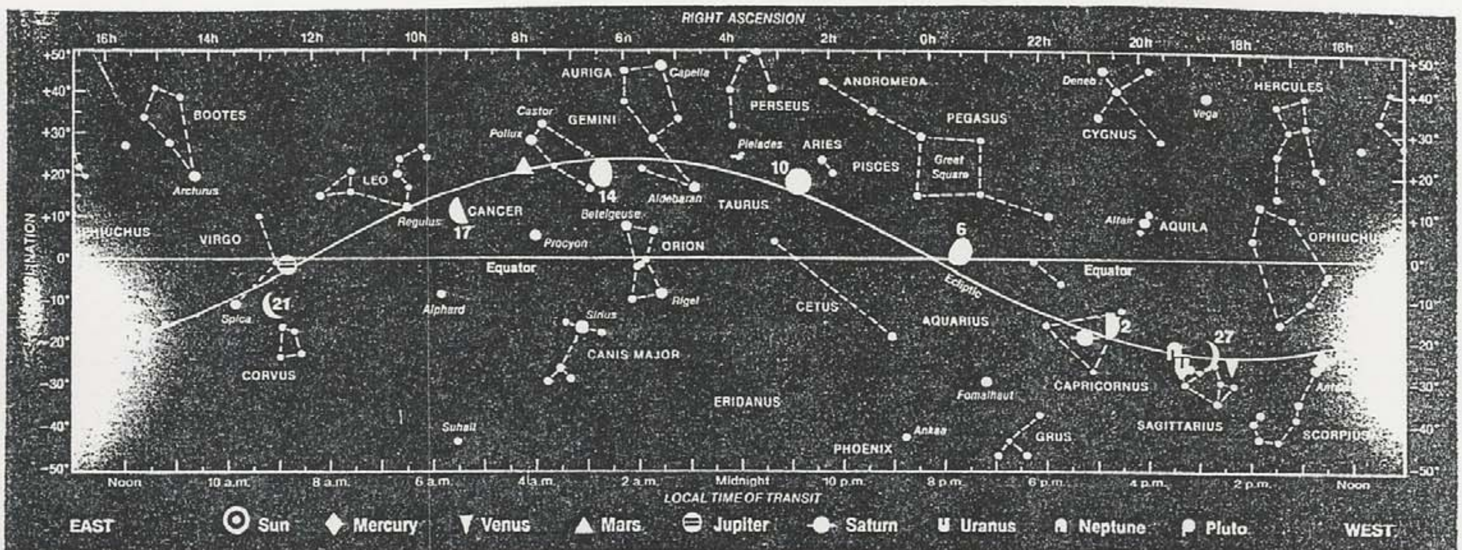
Various positions of the Earth on its orbit round the Sun are numbered, as are positions of Mars in orbit. If lines joining the positions of Earth to those of Mars are projected to the stars (as indicated by the numbers on the skyline), a loop seems to appear in Mars's path across the sky. This is because Earth moves faster and overtakes Mars in orbit.

Figure 3

MARS

Mars, the fourth planet from the sun, will make a opposition ("closest approach") to the Earth in January 1993. It will be further away than it was for the 1990 and 1988 oppositions. Mars can be seen in the morning sky to the northeast of Orion. This planet is never an easy target for observation. Two months of observation are recommended to permit the eye to extract the most detail from the telescope's image.



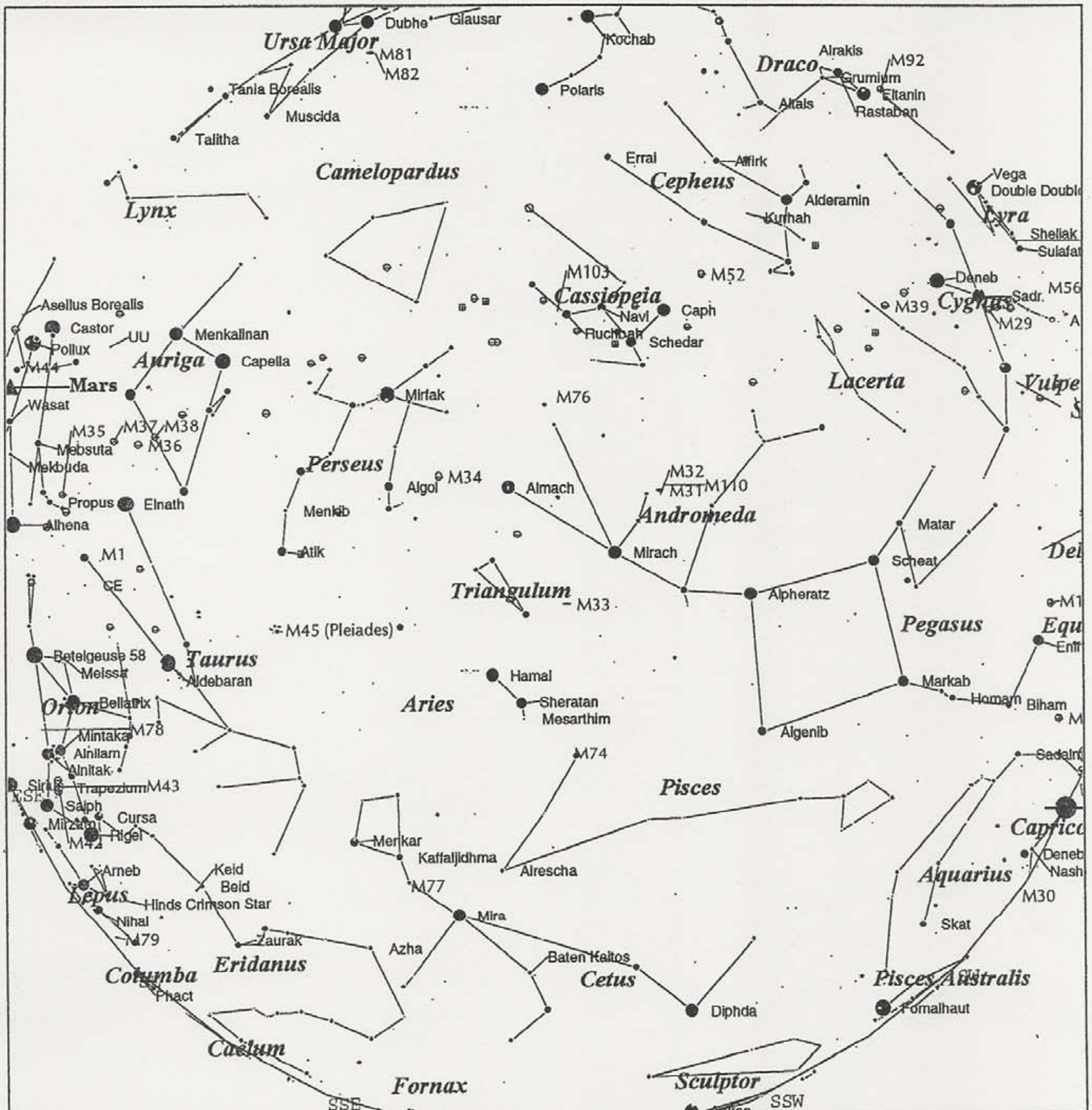


The Sun, Moon, and planets against the stars. Positions are for midmonth unless another date is given. The Moon's position and phase are shown for 0h Universal time every few days. *Local Time of Transit* tells when objects cross the meridian (are due south) at midmonth. Transits occur an hour later on the 1st and an hour earlier at month's end. Gray shading indicates the glows of sunset (right) and sunrise (left).

PLANETARY DATA FOR NOVEMBER, 1992

Object	*Date*	*R. A.* h m	*Dec.* ° ′	*Elong.* °	*Mag.*	*Diam.* ′ ″	*Illum.* %	*Dist.* (a.u.)
Sun	Nov. 1	14 25.7	−14 26	—	−26.8	32 13.9	—	0.992
	16	15 26.0	−18 45	—	−26.8	32 20.9	—	0.989
	Dec. 1	16 29.4	−21 48	—	−26.8	32 26.5	—	0.986
Mercury	Nov. 1	15 58.7	−23 26	24 Ev	−0.1	6.7	62	1.010
	11	16 24.9	−24 00	20 Ev	+0.4	8.3	32	0.807
	21	15 56.2	−20 03	2 Ev	+5.0	9.9	0	0.678
	Dec. 1	15 22.0	−15 50	17 Mo	+0.5	8.3	29	0.806
Venus	Nov. 1	16 53.6	−24 08	36 Ev	−4.0	13.5	80	1.236
	16	18 13.1	−25 30	39 Ev	−4.0	14.6	76	1.142
	Dec. 1	19 31.8	−24 08	42 Ev	−4.1	16.0	71	1.043
Mars	Nov. 1	7 40.0	+22 46	106 Mo	−0.1	10.1	89	0.926
	16	7 55.8	+22 41	117 Mo	−0.4	11.4	91	0.824
	Dec. 1	8 00.9	+23 09	131 Mo	−0.8	12.8	94	0.732
Jupiter	Nov. 1	12 17.9	−0 43	34 Mo	−1.7	31.6	100	6.231
	16	12 28.3	−1 48	47 Mo	−1.8	32.4	100	6.074
	Dec. 1	12 37.6	−2 45	59 Mo	−1.8	33.5	99	5.881
Saturn	Nov. 1	20 59.2	−18 10	93 Ev	+0.6	16.9	100	9.772
	16	21 01.6	−18 00	79 Ev	+0.7	16.5	100	10.020
	Dec. 1	21 05.3	−17 44	65 Ev	+0.7	16.1	100	10.255
Uranus	Nov. 16	19 06.4	−22 59	51 Ev	+5.8	3.5	100	20.167
Neptune	Nov. 16	19 12.6	−21 42	53 Ev	+8.0	2.2	100	30.774
Pluto	Nov. 16	15 36.2	−4 51	14 Ev	+13.8	0.1	100	30.673

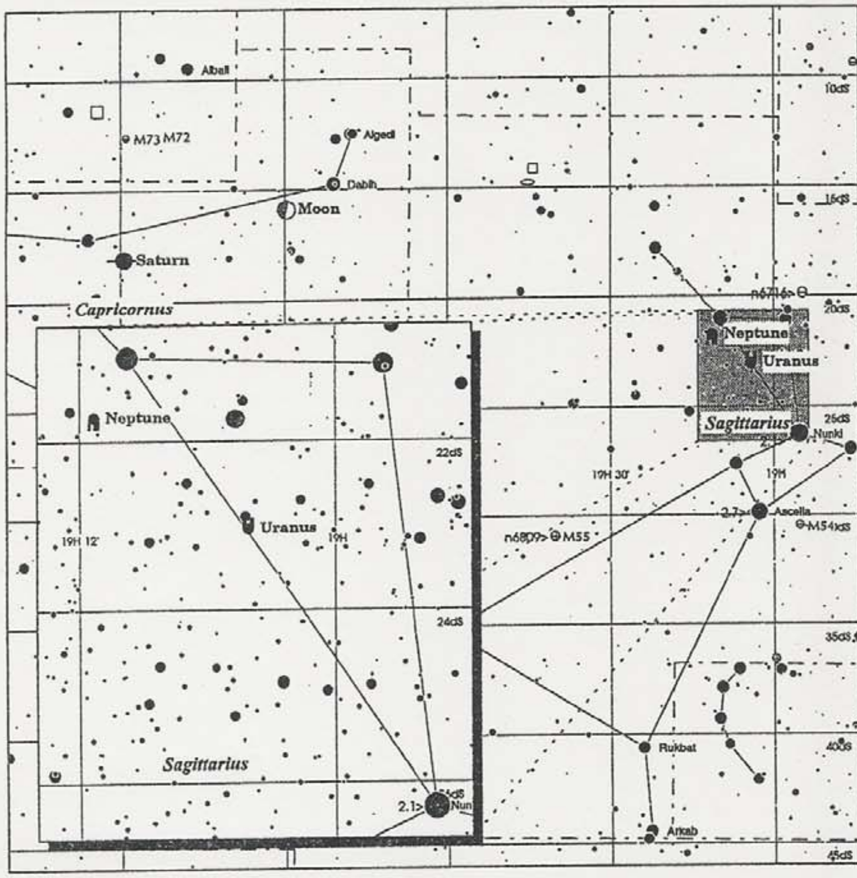
For the principal members of the solar system, this table gives the right ascension and declination (equinox of date) at 0h Universal time on selected days. Elongation is the angle in degrees between a planet and the Sun, in the morning (*Mo*) or evening (*Ev*) sky. Next are the object's visual magnitude, and apparent equatorial diameter in arc minutes and seconds (neglecting phase). Saturn's rings extend 2.25 times Saturn's equatorial diameter. Next is the percentage of the disk diameter illuminated by the Sun. Finally, distances from Earth are given in astronomical units. (One a.u. is 149,597,870 km, or 92,955,621 U. S. statute miles (92,955,807 international miles).



True Spherical View, November 1992 - Ford Amateur Astronomy Club

Stars:		NGC Objects:	Solar System Objects:	
9.5	5.0	Galaxy	Sun	Uranus
9.0	4.5	Open Cluster	Mercury	Neptune
8.0	3.8	Globular Cluster	Venus	Pluto
7.5	3.1	Planetary Nebula	Mars	Moon
7.0	2.8	Nebula	Jupiter	Comet
6.0	2.5	Cluster+Nebulosity	Saturn	Asteroid
5.6	2.0	Star		
5.3	1.0	Other NGC Objects		

Center @ RA: 1h44m39s Dec:+35d00'00"
Date:11/01/1992 Time: 23:30



Finding Saturn, Uranus, Neptune, November 1992 - Ford Amateur Astronomy Club

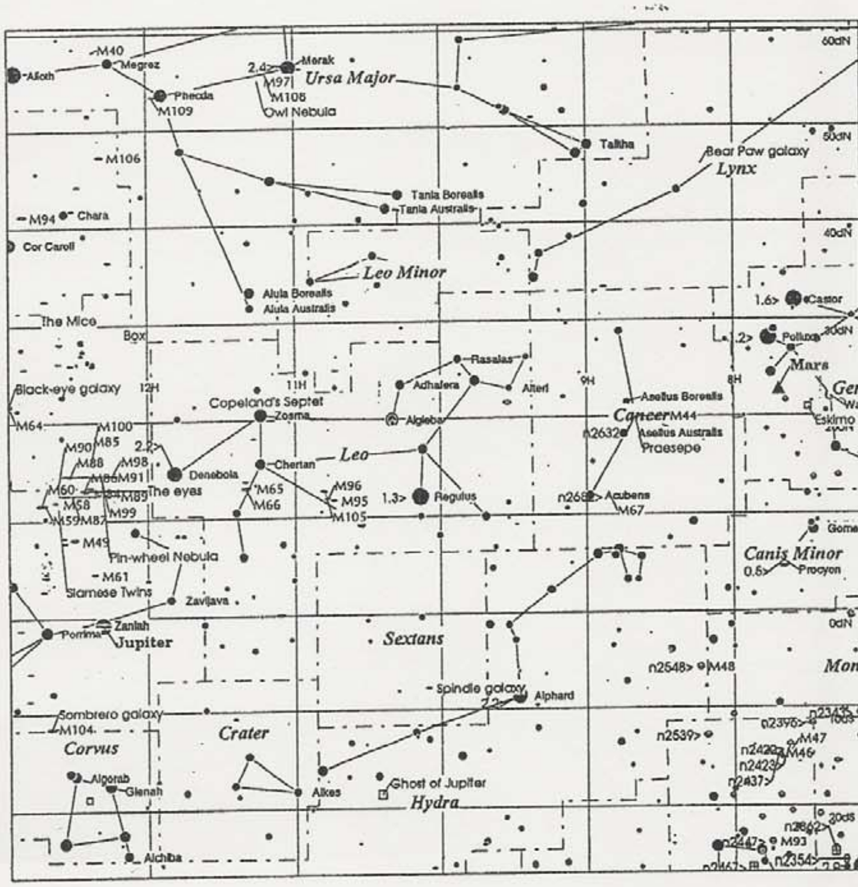
Stars:

9.5	5.0
9.0	4.5
8.0	3.8
7.5	3.1
7.0	2.8
6.0	2.5
5.6	2.0
5.3	1.0

NGC Objects:
- Galaxy
- Open Cluster
- Globular Cluster
- Planetary Nebula
- Nebula
- Cluster+Nebulosity
- Star
- Other NGC Objects

Solar System Objects:
- Sun
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto
- Moon
- Comet
- Asteroid

Center @ RA:20h02m40s
Dec: -26d23'16"
Date:11/01/1992 Time: 20:30



Finding Jupiter and Mars, November 1992 - Ford Amateur Astronomy Club

Stars:

9.5	5.0
9.0	4.5
8.0	3.8
7.5	3.1
7.0	2.8
6.0	2.5
5.6	2.0
5.3	1.0

NGC Objects:
- Galaxy
- Open Cluster
- Globular Cluster
- Planetary Nebula
- Nebula
- Cluster+Nebulosity
- Star
- Other NGC Objects

Solar System Objects:
- Sun
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto
- Moon
- Comet
- Asteroid

Center @ RA:10h02m08s
Dec: +16d57'24"
Date:11/01/1992 Time: 20:30

REQUEST FOR ARTICLES/PICTURES

We are not *Sky & Telescope*, *Astronomy*, or the *Astronomical Society of the Pacific*. We are The Ford Amateur Astronomy Club newsletter.The newsletter staff is in need of articles (from members or astronomy magazines) and pictures (photographs, cartoons,...). Our primary interest is **to publish articles/pictures that were done/made by our members.** Articles/pictures for the newsletter should be sent to any of the newsletter staff members or brought to the monthly club meetings. Any article/picture submitted by this meeting deadline will be considered for potential publication for the following month. Local events, announcements, and classified items may be submitted up to one week prior issue and will be printed if layout space is available. All originals will be returned as soon as possible. Preferably, articles should be typed with WordPerfect 5.1 and submitted on disk. The newsletter staff members do have access to optical scanners and can convert typed articles/pictures to WordPerfect 5.1 format. Hoping to hear from you!

Your Photograph Could Be Here!

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