Chapter III: Observing Programs

The A.L.P.O. remote planets section is interested in the meteorology of Uranus, Neptune and Pluto along with the color, brightness and shapes of the satellites of these planets. The existence of additional rings around Neptune (or Uranus) is also of interest. Seasonal changes in the brightness, color and appearance of the remote planets and their moons is of great interest to the section, and finally changes caused by the 11 year solar cycle are of interest as well. All of these are opportunities that the observer can participate in to advance science. There are eight areas where the observer with modest equipment can make a contribution.

A. Drawings

The discs of Uranus and Neptune have angular sizes of about 3.7 and 2.3 arc-seconds respectively and so excellent seeing conditions, high magnifications and excellent telescopes are all a must for having any chance of sighting detail on these remote worlds. Since the author has only looked at Uranus and Neptune through about a half dozen different telescopes, he will not comment on what the "minimum aperture" should be to have any hope of seeing detail on these planets. Magnifications of at least 200X and 350X are recommended for Uranus and Neptune respectively. Observers with large telescopes should attempt to use color filters to observer these two planets. The recommended filters for starting out are: #23 (orange), #15 (yellow) and #82 (blue). The darker #25 (red) and #58 (green) could be added as one gets used to the other filters. If an albedo feature is detected on either Uranus or Neptune, try to get a friend to examine the disk (but do not tell them what you saw) and then ask them what they see. If they describe what you saw then you have independent confirmation of the feature. The A.L.P.O., I.A.U. and B.A.A. remote planets coordinators should be contacted as soon as possible. With current technology, it is not possible to make drawings of Pluto or the moons of Uranus and Neptune. It may however be possible to see the shadows of the moons as they transit Uranus or the shadows of the rings on the disc of Uranus.

Drawings serve three purposes: 1) they show cloud changes, 2) they aid in the interpretation of brightness and color measurements and 3) they can yield information on rotation periods.

B. Eyeball Magnitude Estimates

Eyeball magnitude estimates of Uranus, Neptune and Pluto can be made by comparing their magnitudes to those of nearby stars. CAUTION: one should not use Johnson V-filter magnitudes in place of eyeball magnitudes; see Stanton (1999). The author has used the eyeball magnitudes of stars in the AAVSO star atlas. Active observers receive a finder chart for Uranus and Neptune every year showing the eyeball magnitudes of nearby comparison stars; these charts can be obtained from the author. Eyeball magnitudes are reported to the nearest 0.1 magnitudes.

Eyeball magnitudes serve two purposes: 1) they serve as an approximate indicator of brightness and 2) historical continuity. By historical continuity it is meant that data in 2000 can be compared to data made in the 19th century. If it is possible, the observer should try to use the same set of comparison stars for several years especially for Neptune.

C. Photoelectric Photometry

Photometry is a branch of astronomy that deals with the brightness of objects. The present coordinator has placed a large emphasis on photoelectric photometry. This technique can yield brightness or color values to an accuracy of 1% under ideal sky conditions. An instrument called a photoelectric photometer is needed in making accurate brightness measurements. The basic idea of photoelectric photometry is to measure the light coming from a star of known magnitude, measure the amount of light coming from the target object, and then compute the magnitude of the target object using an equation. A worked example is presented in Chapter V. Two corrections must be made to all magnitude measurements which are: extinction and color corrections; these are described in Chapter V.

Specific questions that accurate brightness and color measurements can answer include:

1) Do Uranus and Neptune change in brightness and color as a result of changing season?

2) Is the color and/or brightness of Pluto's surface changing?

3) Are there any short bursts of color or brightness changes taking place on Uranus or Neptune?

4) What is the shape and orientation of Nereid?

5) Do the polar caps on Triton get bigger and smaller with the seasons?

6) Does the 11 year solar cycle influence the brightness of Uranus and Neptune?

D. Charged Coupled Device (CCD) Photometry

The author has never made a photometric measurement using a CCD camera but he has attended a course on this procedure.

The CCD camera is an electronic camera that requires a computer and software. This instrument is ideal for carrying out precise brightness and color measurements of objects fainter than magnitude +12. Stray light from a nearby bright object can be subtracted out in a CCD image. The day may even come when A.L.P.O. members may be able to measure the brightness of Pluto and Charon separately using CCD cameras and adaptive optics. The benefits of CCD photometry are similar to those of photoelectric photometry.

E. Occultations

The astronomer may be able to contribute to our knowledge of the rings of Neptune by monitoring stellar occultations. A stellar occultation occurs when an object moves in front of a star and blocks out the star's light. One essential piece of equipment for occultation work is a time piece which is calibrated to the time signal of the United States Naval Observatory. This signal can be picked up with a short wave radio at frequencies of 2.5, 5.0, 10.0 and 15.0 megahertz. One may also get the time signal by accessing the U.S. Naval observatory web time signal through the URL: http://tycho.usno.navy.mil/cgi-bin/timer.pl or call the Naval Observatory at: 1-900-410-8463.

Occultation data may reveal new undiscovered ring arcs around Neptune or any changes occurring in the rings of Uranus and Neptune. If the star is bright enough, one may also want to watch it as it passes through the atmospheres of Uranus, Neptune and Pluto. The observer should however be forewarned that professional astronomers generally study occultations very well and so the scientific contribution of the amateur may be minimal in this area.

F. Spectroscopy

Spectroscopy is that branch of science that deals with the individual frequencies of light. Spectroscopy is a powerful technique which professional astronomers have used to determine the chemical composition, temperature and magnetic environment of planets and stars. Frank Melillo succeeded in photographing the spectrums of both Uranus and Neptune in 1999.

G. Historical Data

Old drawings, photographs and other measurements are always welcomed. The author strongly believes in historical continuity and will incorporate older data into recent reports. A second reason for the importance of historical data is the fact that Uranus, Neptune and Pluto have such long periods of revolution. Data spanning several decades are needed to understand seasonal changes on the remote planets.

H. Color Estimates

Observers are encouraged to describe the colors of Uranus and Neptune. Any strange changes should be immediately confirmed by a friend and reported to the coordinator. One of the goals of the author is to collect both eyeball and electronic data and then compare the two sets of data; in this way, data from the 19th and early 20th centuries can be compared to more recent data.

Chapter IV: Remote Planets Observing Form

The official A.L.P.O. remote planets observing form is shown on the following page. The form covers six types of observations which are: drawings, color estimates, photoelectric magnitude measurements, eyeball magnitude estimates, photographs/CCD images and occultation/near misses. If possible, please fill in as much information as possible, and if there is anything that you do not understand then leave it blank.

If you are making a drawing it is critically important to circle the N or S and P or F. The N or S means north or south; I want to know whether the top part is the north or south limb. The limb is the edge of the planet's disk. The P or F means preceding or following; I want to know whether the left limb is the preceding or following limb. The recorder is hoping that observers will orient their drawing so that the preceding/following goes along the horizontal and that north/south goes along the vertical. One can determine which side of the disk is north by nudging the telescope towards the south and the limb that approaches the edge of the field of view is the north limb. Similarly turn off the clock drive of the telescope and watch the disc appear to move; the preceding limb is that part which will move out of the field of view first.

Please also be aware that I would like the Universal time if possible. Universal time is computed by adding 4, 5, 6, 7 and 9 hours to the local standard daylight time for the eastern, central, mountain, pacific and Hawaii time zones. If observations are made during standard time then 5, 6, 7, 8 and 10 hours must be added for the eastern, central, mountain, pacific and Hawaii time zones to obtain Universal time. Daylight savings time begins at 2:00 am on the first Sunday in April and ends at 2:00 am on the last Sunday in October for most of the United States.

The seeing blank in the top blank of the observing form refers to how steady the atmosphere is; seeing is estimated on a scale of 10 = very steady air to 1 = very turbulent air. The transparency refers to how clear the air is; it is measured by reporting the faintest star magnitude that is visible to the naked eye. The telescope type blank refers to weather a refractor, Newtonian, Schmidt-Cassegrain, etc. was used in making the observation. For eyeball estimates in the bottom section, please indicate the magnification and aperture of your binoculars or telescope in the "Instrument" blank.

ALPO Remote Planets Section Report Form

General Information

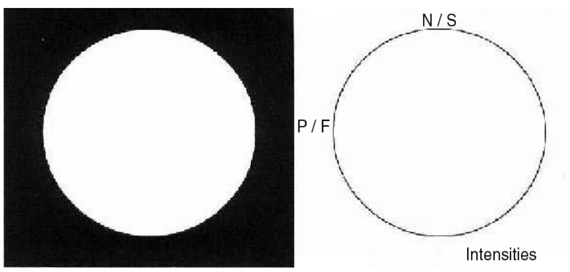
Name: ____ Location: ___________________________

Date (UT): _______________________ Start: _________________(UT) Finish _________________ (UT)

Telescope: Type: ________________ Aperture: _______________ Magnification: __________________

Seeing: _____________ Transparency:___________________ Your Latitude: ______________________

A. Visual Observations



Planet: __________________________________

Circle N (North) or S (South)
P (Preceding) or F (Following)

Comments: ________________________
____
____
____

C. Color Estimate

Planet: __________________________________

Color description: _________________________
____
____

B. Photography / CCD Imaging

Method (circle your choice):
Prime Focus / Eyepiece Projection / CCD / Film

Exposure time: _______________________________

f / ratio: ____________________________________

Developer: ___________________________________

Comments: ___________________________________
____

D. Occultations / Near Misses

Planet: _____________________________________

Star occulted: ______________________________

Planet: RA _______________ Dec _____________

Star: RA _______________ Dec ______________

Comments: __________________________________
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E-1 Photoelectric Photometry (use separate sheet for reduction calculations)

Time (UT)	Star/Planet	Filter U B V R I	Scale	Integration Time	Count	Sky Brightness

E-2 Visual Photometry

Comparison Star 1 (HD or SAO#) ____________ Mag. ___________ Source_________________
Comparison Star 1 (HD or SAO#) ____________ Mag. ___________ Source_________________
Planet ________________________ Estimated Mag. ___________ (Note: "Mag." = Magnitude)