Case Teaching Notes
for
"Mask of the Black God: The Pleiades in Navajo Cosmology"

by

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Introduction / Background

This case is an exercise in star map skills as applied to observations of the Pleiades in the context of Navajo cosmology. It is suitable for an observational astronomy class or an introductory astronomy class with a strong observational component. Students are introduced to a Navajo legend about the Pleiades and read about how this cluster may be used to tell time. Some background reading about the celestial sphere, its apparent motions, and change with latitude is needed. Students also need star maps and prior knowledge about how to use them. In this case study, students construct a working model of the celestial sphere for an observer in Window Rock, Arizona, and use the model to make predictions about the Pleiades and about the identity of a mysterious star.

Objectives

By the end of the case, students should be able to use star maps to locate celestial objects in the local sky for any given location (latitude) in the northern hemisphere at any time. They should also be quite familiar with the location of the Pleiades in the winter sky. Specifically, students should be able to do the following:

- Determine celestial coordinates (right ascension and declination) of a given celestial object.
- Locate the Sun on the celestial sphere for any day of the year.
- Calculate the altitude of Polaris above the northern horizon and the altitude of the celestial equator above the southern horizon for any latitude in the Northern Hemisphere.
- Predict the approximate rise, transit, and set times for a given celestial object from a specific location on a specific date.
- Describe the location of the Pleiades relative to other prominent nearby constellations.

Classroom Management

Since this case study is an application of star map skills, successful completion of the case requires that the students have already studied the celestial sphere and have had some initial instruction in the use of star charts. Depending on their degree of preparedness, this case may take between 60 and 90 minutes to complete. Students may be given the case and instructed to answer the first five questions for homework, and then complete the last five questions in groups in class. The answers are provided in a separate password-protected Answer Key (see below).

The best way to begin this exercise is to observe the Pleiades in the night sky with the students. Generally, students enjoy learning how to identify celestial objects so they can proudly show them to others (like a Saturday night date). Perhaps you already have a student who can point out the Pleiades to the others. However, outdoor stargazing may not be possible for several reasons: your class meets during the daytime and students cannot get away to meet with you during a special evening session; clouds or severe light pollution may obscure the stars; or the Pleiades may be too close to the Sun to see (which is most of the spring and summer months). Alternatively, you can star gaze in a planetarium, where the sky is dark, the weather is fair, and the Pleiades are always visible. This is my approach. If this isn't possible, an instructor can show the Pleiades in a virtual sky using astronomy software or just show pictures (for example, see Gendler, 2003).

An observing session in a real or simulated sky is a good time and place to begin the discussion of questions 1–5. Question 1 opens the floor to other creation stories. Question 2 brings the focus back to the Navajo legend. Questions 3 and 4 refer the students to their star maps, and question 5 puts us in Window Rock, Arizona. This can be a pure star map exercise, but if you are lucky enough to be teaching in a planetarium, you could actually change the latitude and be there.

To help my students connect to the unfamiliar context of the Navajo legend, I composed a PowerPoint program containing pertinent images and sounds. Excerpts of Native American flute music play while pictures of the Pleiades, the Mask of Black God, traditional and modern hogans, and Window Rock are projected. It also includes a map of the Navajo Nation and an image of its flag. All images and sounds are credited.

The final five questions in the case are best suited for small group work. As students juggle the data and their maps, they may find the interaction of a peer-teaching environment helpful. While the last five questions can be answered directly, students may realize that there are other phenomena affecting their answers. These are primarily atmospheric extinction and twilight (see the Answer Key), although moonlight and topography may also affect seeing. These considerations introduce some "gray areas" into the discussion and indicate that their answers are, at best, estimates.

A great conclusion to the case is to set the planetarium to the location, dates, and times that correspond to the case study. Students can see the rising of the Pleiades after sunset for the date of first frost; they can note the local time of Pleiades transit for January 5th and their approximate set date; and they can look for their Coyote star. Alternatively, if astronomy software was not used to solve the case, then it can be used to simulate the answers on a computer.

Blocks of Analysis

Pleiades in Navajo Cosmology

Navajo cosmology parallels Navajo philosophy with its emphasis on balance between order and disorder. In this creation story, Black God places the Pleiades on his temple after stamping his foot four times. This ritual action symbolizes his authority to decorate the dark sky with the major constellations. In this legend, the Pleiades, with their fine and compact arrangement, represent the entire universe—a microcosm whose deliberate placement by Black God symbolizes the order of the cosmos.[1] This is balanced by the chaos introduced by the Coyote, the Trickster, who strews the sky with unnamed star crystals. Thus, the constellations are the embodiment of the harmony in the natural world that is a part of everyday Navajo life.

The Pleiades are generally well known and recognized, even if today few people know the old Navajo legends.[2] The Pleiades appear in mid-autumn, when one might expect the first frost in northern Arizona, and are up all night throughout the winter. The winter is the season to tell the creation stories of the Diné and the season for all the great nine-day ceremonies, like the Nightway (Matthews, 1995, p. 4). According to Hasteen Klah, the telling of these stories releases so much power that it is not safe to tell them when there may be thunder; thus, they should only be told in the wintertime (1942, p. 11). Although anyone can determine the seasons without the help of the Pleiades, in the old days this constellation was used to predict the arrival of winter. Furthermore, as the chanter sang the stories of creation throughout the frosty night, he could tell the time using the Pleiades, pacing the chants so that he ended at dawn. Thus the Pleiades play a role in the creation stories and in their telling.

Star Map Skills

Part of my astronomy class covers observational and star map skills. We use two basic constellation charts: north circumpolar and equatorial (see References). Commercially available mid-latitude planispheres may also be used for this case; however they do not have the flexibility to adjust to different observing latitudes. In addition, various astronomy software packages may also be used; however, they are much more expensive and much less portable. The basic star map skills that the students will develop in this case study are listed below.

- *Determine the coordinates of right ascension and declination of a celestial object.*
  Right ascension is the west-to-east coordinate (analogous to longitude on Earth) measured eastward in hours from 0 to 24 along the celestial equator from the vernal equinox. Declination is the north-south coordinate (analogous to latitude on Earth) measured in degrees from 0 to 90 from the celestial to either celestial pole.
- *Determine the location of the Sun on the celestial sphere for any day of the year.*
  The location of the Sun relative to the background stars is the same for all observers worldwide. Students locate the Sun's position for any day of the year by examining the dates along the ecliptic. For example, the Sun moves through the region of the sky called Sagittarius from mid-December through mid-January, and its coordinates for any date can be read right off the chart (i.e., January 1st: RA 18h 46m, Dec -23°).
- *Determine the orientation of the celestial sphere for an observer at a specific location.*
  As the observer moves north in latitude on the Earth—for example, from Mexico to Canada—he/she sees much more of the north celestial hemisphere. Canadians see Polaris higher in the sky than Mexicans. Similarly, Canadians see stars along the celestial equator lower in the south. Simple geometry shows that the altitude of Polaris above the northern horizon for an observer in the Northern Hemisphere is the same as the latitude of the observer. For example, in Lansing, Michigan (latitude 42°N), Polaris always appears due north at 42° altitude. Similarly, the altitude of the celestial equator above the southern horizon is the complimentary angle to the latitude; that is, 90°-latitude. Thus, Mintaka (in Orion's belt and located on the celestial equator) never gets higher than 48° altitude for observers in Lansing.
- *Determine the location of the local horizon on the star chart as observed from this specific location.*
  Our star charts have no horizon markers; therefore, students must construct their own out of paper and place them on their charts to obscure those stars below the horizon. On a circumpolar map, an observer in Lansing would place a straight-edged piece of paper over their star map 42° below Polaris. This would simulate the northern horizon. Similarly, on an equatorial map, an observer in Lansing would place a piece of paper over their star map 48° below the celestial equator. This would simulate the southern horizon. If this same sheet were cut in the shape of a wide bowl that was 12 hours of right ascension wide and 48° deep, it would also simulate the eastern and western horizons where the paper intersected the celestial equator. This horizon tool enables the students to estimate rise and set times, as well as search for a candidate for the Coyote Star.

- *Determine the local time that an object is visible and its location in the sky on any day of the year from a given location.*
  In this case, students will predict the first autumn frost from Window Rock by calculating the date that the Pleiades rise after sunset. They will also calculate the time the Pleiades transit and set.

Answer Key

Answers to the questions posed in the case study are provided in a separate answer key to the case. Those answers are password-protected. To access the answers for this case, go to **the key**. You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our **password policy and then apply online** or write to **answerkey@sciencecases.org**.

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End Notes

[1] Although the mask of Black God drawn by Haile (1977, p. 3) shows the Pleiades on his left forehead, that recorded by Matthews (1995, p. 27) shows no such decoration. Griffin-Pierce also observed that the Pleiades were not visible on the mask she saw. One chanter explained to her that this was "because Black God's face represents the entirety of the heavens, and the Pleiades is very small in proportion to the entire sky" (1992, p. 86).

[2] … but "the few that know treasure it as distinctly personal knowledge" (Haile, 1977, p. 5).

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