

# **MCDONALD OBSERVATORY STUDENT FIELD EXPERIENCE PROGRAM**

## **PRE-VISIT ACTIVITIES**

### **Purpose**

The Student Field Experience will be most meaningful for students whose teachers have "set the stage" for inquiry before their fieldtrip. These pre-visit discussions and activities are designed to identify prior knowledge and misconceptions about astronomy and observatories. They also introduce basic principles and vocabulary related to the study of light and foster curiosity about the coming experience.

During the visit, students and teachers will build new understandings of light, astronomy, and how the observatory experience connects to everyday life. We can provide links to the Science TEKS for most of the offerings within our Student Field Experience program.

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All grades. One class period
2. Activity 2: Generating Questions  
All grades. One class period.
3. Activity 3a: Echoes of Light.  
Grades 5-8, IPC, Physics, Astronomy
4. Activity 3b: Reflection  
Grades 5-8, IPC, Physics, Astronomy
5. Activity 4a: The Community at the Observatory  
Grade 5-8, IPC, Physics, Astronomy. One class period.
6. Activity 4b: The Community at the Observatory  
Grades K-4. One to two class periods.

## An Introduction Observatories, Domes, and Telescopes

### **All Grades. One Class Period.**

Before viewing the McDonald Observatory introductory video with the class, engage them with two questions: what is a telescope, a dome, and an observatory? How are they related? Immediately following the video, break the students into groups to discuss the meanings and relationships of *observatory*, *dome*, and *telescope*. Ask them to make drawings to help explain their definitions clarify the relationships.

### **Background**

Many people (not just students) confuse these terms. Drawings may illustrate long closed tubes with a lens at one end and an eyepiece at the other, poking out of a strange shaped building. If they include the scientist, it is often a male in a lab coat.

### **Observatory**

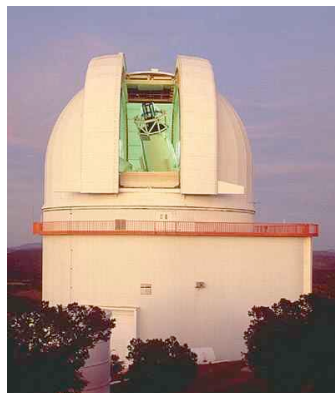


During the tour they will discover the observatory is the entire complex of buildings, both those housing telescopes and those for the support staff to live or work in. There are two large domes on Mt. Locke (foreground). On the left is Struve 2.1-meter telescope dome, and on the right is the Harlan J. Smith 2.7-meter telescope dome. The dome in the distance at the center houses the largest telescope at the Observatory – the Hobby-Eberly Telescope. It is located on Mt. Fowlkes. Look closely below the Smith dome for two more small domes on Mt. Locke along the road. These house telescopes with mirror diameters of 0.8 and 0.9 meters.

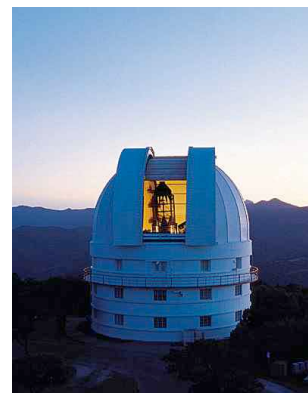
### **Dome**



Hobby-Eberly Telescope dome



Harlan J. Smith 2.7-meter telescope dome



Otto Struve 2.1-meter telescope

A dome is the individual building that houses one telescope to protect it from the weather (rain, wind, snow, and sunlight). A dome slit opens and closes, like an elevator door or mini-van sliding door, to allow light from celestial objects into the telescope. Astronomers can turn the dome and point the telescope, so that the telescope “looks” through the slit, to observe celestial objects.

## Telescope

A telescope is a scientific instrument that collects light. The telescopes at McDonald Observatory are all reflecting telescopes - that is, they use mirrors to collect the light. The number associated with the telescopes (Otto Struve 2.1-meter) indicates the diameter of the telescope's primary mirror. Just as a larger bucket collects more rainwater than a smaller one, a telescope with a large primary mirror collects more light than a telescope with a small mirror. More light collected by the telescope means that the observer can study fainter objects in space, from tiny asteroids in our solar system to distant quasars far away.

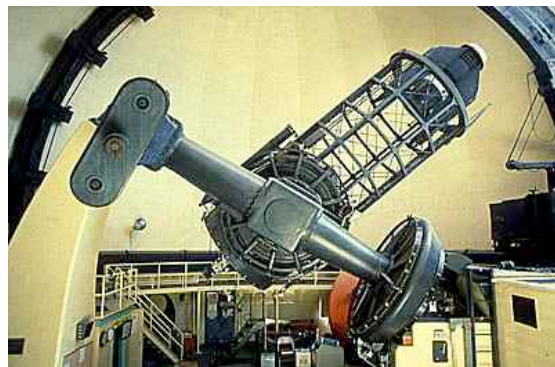
The primary mirrors of the Smith and Struve telescopes are located at the bottom ends of the tubes. These mirrors are disks with a shallow bowl-like paraboloid shape instead of a flat surface. A thin layer of aluminum overcoats the disk's paraboloid surface, which transforms the disk into a mirror. The HET primary mirror is an array of small mirrors arranged in a 10-meter by 11-meter hexagon. Each individual hexagonal mirror is 1 meter wide between the sides. Instead of a paraboloid shape, the HET mirrors have spherical curve.



Hobby-Eberly Telescope and its primary mirror



Harlan J. Smith 2.7-meter telescope



Otto Struve 2.1-meter telescope



Hobby-Eberly Telescope's primary mirror

## **Activity 2: Generating Questions**

### **One Class Period**

Allow students within small groups to generate a list of three to five driving questions inspired by their interests and current class science topics that they would like to explore during their trip. Depending upon how much time you have, they may wish to consult books, magazines, or the Internet for background information that will help them generate their questions. During the field trip, each group is responsible for gathering and synthesizing information in response to its set of driving questions. Students may want to bring cameras to the Observatory to take pictures.

Before the visit, you should make your post-visit assignment clear to the students. The information and/or pictures they gather during their visit are the material they will use in the post-visit activity. For example, you may offer a variety of post-visit assignments: a poster, radio commercial, PowerPoint presentation, or even a video documenting their trip and what they learned.

See Explore McDonald Observatory: Activity 2 post-visit activity.

### **Background**

Show the McDonald Observatory Video that you received with this package. Ask students to look for familiar objects, places, or people that remind them of their own community and everyday life.

### **Related TEKS**

Science Process Skills: Science as Inquiry

Pre-Visit

(A) Plan and implement an investigation

At McDonald Observatory:

(B) Collect data by observing and measuring

(C) Organize, analyze, evaluate, make inferences from direct and indirect evidence

Post-Visit:

(D) Communicate valid conclusions

(E) Construct graphs, tables, maps, charts using tools including computers to organize, examine, and evaluate data.

## Activity 3: Echoes of Light and Reflection

### Grades 5 – 8, IPC, Physics, Astronomy

**Reflection:** We have available experiment activities “Echoes of Light” and “Reflection” concerning reflection that you may choose to do in the classroom prior to the visit. During the activity, students construct the law of reflection, note that there are TWO reflections, and briefly indicate the difference between them (one has graphing). Since McDonald Observatory telescopes are reflecting telescopes (curved mirrors that gather and focus light), this pre-visit activity will help students understand the way the telescope primary mirror works based on the reflection principle.

Note about refraction:

**Refraction:** We recommend the Lawrence Hall of Science GEMS activity book “More than Magnifiers” to engage students science process skills and concept skills regarding refraction, lenses, and properties of light. Telescope eyepieces, binoculars, and astronomical instrumentation are technological applications of the principle of refraction. Carefully designed systems of lenses inside these instruments direct light to an electronic detector, or an observer’s eye.

### Background

In both “Echoes of Light” and “Reflection” students construct the law of reflection using flat mirrors. “Reflection” further challenges students to extend the law of reflection to curved mirrors. Since telescope primary mirrors are curved (paraboloid or spherical), this extension will help students understand how modern research telescopes work when they encounter them during their exploration of McDonald Observatory. The telescope mirrors are hidden from view, and the curve is very slight. However, The HET mirror array is in plain

view and is so big that students should notice the curve. Remind them that each mirror has the same spherical shape (not flat). Also, ask students where the reflective coating is. It is not on the back of the mirror segment, like a bathroom mirror, but on the front side with the spherical curve.

You may want to try a simple thought experiment to clarify why the telescope primary mirrors are curved: imagine a flat telescope mirror. Would the telescope work? Where would the light go? The incident light would reflect off the primary mirror a travel away, back into space. No light would reach the astronomer’s instrument.

### Related TEKS

*Please note that the telescopes at McDonald Observatory are reflecting telescopes.*

Grades 5 – 8, IPC, Physics Process Skills:

Scientific Inquiry

(B) collect information - measure and observe

(C) analyze, interpret, make inferences

(D) communicate valid results

Grade 5, Concept Skills:

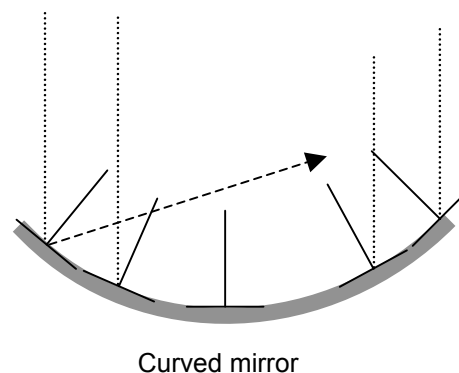
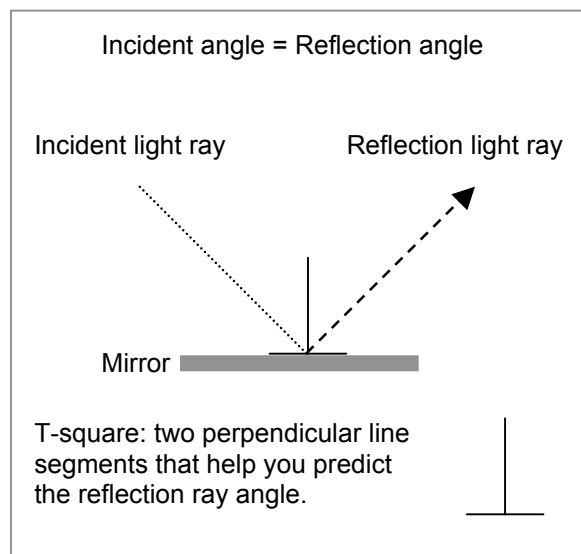
5.8 The student knows that energy occurs in many forms:

(B) identify and demonstrate everyday examples of how light is reflected such as from tinted windows, and refracted such as in cameras, telescopes and eyeglasses.

IPC, Concept Skills:

5. The student knows the effects of electromagnetic waves in everyday life.

(C) identify uses of electromagnetic waves in various technological applications such as fiber optics, optical scanners, and microwaves.





## **Activity 4a: The Community at the Observatory**

### **Grades 5-8, IPC, Physics, Astronomy One Class Period**

Engage students with a KWL discussion: what do I know, what do I want to know, and what have I learned. During this pre-visit stage, gather prior knowledge (what do I know) and help students generate driving questions (what do I want to know). Help students plan their Observatory investigation. For instance, given “what do I want to know”, what information should students gather and how?

During your visit to the Observatory, keep and review the list of the driving questions that you and the students generated. It will serve as a guide for their investigation at the Observatory. Note any new questions that arise during the investigation. Encourage students to take pictures and field notes.

After your Observatory visit, review the driving questions and focus on “what have I learned”. Challenge students to transfer their experience to the science they have learned in class.

Here are some questions to help students generate questions about what they want to know.

1. If you were in charge of picking out a site for a future observatory, what would be the most important characteristics to consider about the observatory's location?
2. Who would you expect to work at an observatory?
3. What do you think an astronomer's typical day at an observatory would be like?
4. What do you think astronomers are trying to learn at an observatory?
5. Who lives at an observatory? Is life at an observatory different than life in your community?

### **Background**

1. Consider the environmental characteristics on Earth that would yield the best astronomical observing conditions. Some important characteristics are:
  - a. altitude
  - b. latitude
  - c. weather patterns
  - d. atmosphere clarity
  - e. access to the site (roadways, train, etc.)

Someone may simply suggest a space-based telescope like the Hubble Space Telescope, or perhaps a telescope located on the Moon!

2. Astronomers are not the only folks working at McDonald. In fact, when you visit, they will probably be asleep! Some McDonald Observatory staff members operate and maintain all the equipment, cook meals, or

ensure the safety of everyone working and visiting the Observatory.

- a. observatory superintendent
  - b. electrical engineer
  - c. mechanical engineer
  - d. systems analyst
  - e. chef
  - f. sheriff
  - g. EMS and Fire Team members
3. Usually, an astronomer will work at night and sleep during the morning and afternoon. Late in the evening, or early morning (still very dark outside) an astronomer might get hungry and eat a “night lunch”.
  4. Astronomers specialize in gathering information from celestial objects like stars, nebulae, galaxies, and planets, then making physical sense out of their observations. Light is their only contact with these objects.
  5. The people who live at the Observatory are the vital staff members who know how the Observatory works, and how to fix equipment when it breaks or malfunctions. They are also people who are natural leaders during a crisis. Visitors to the Observatory may need emergency medical attention. Sometimes, nearby towns and ranchers need help if they are threatened by wildfire. And, sometimes McDonald Observatory EMS staff respond to emergencies away from the Observatory. Everyone has a memorable story to tell! Living at the Observatory is in many ways like living in a small town.

Astronomers visit the Observatory for days or sometimes weeks at a time during their “observing run”. They stay in the Transient Quarters, which is set up like a mini-hotel located a short walking distance from the Harlan J. Smith and Struve telescope domes. But the Hobby-Eberly Telescope (HET), due to its unique design and scheduling system, requires an on-site astronomer to manage telescope observations. HET collects data for many different astronomers using a schedule that allows the telescope to be efficient as the sky rotates above throughout the night. Since it is a large telescope, less time needs to be spent on astronomical objects compared to the smaller telescopes. Therefore, HET can observe many objects requested by many different astronomers in a single night. They receive their data over the Internet the next morning.

### **Related TEKS**

Scientific Inquiry, Critical Thinking

## **Activity 4b: The Community at the Observatory**

**Grades K-4 One or Two Class Period**

### **KWL discussion (one class)**

Engage students with a KWL discussion: what do I know, what do I want to know, and what have I learned. During this pre-visit stage, gather prior knowledge (what do I know) and help students generate driving questions (what do I want to know). Help students plan their Observatory investigation. For instance, given “what do I want to know”, what information should students gather and how?

During your visit to the Observatory, keep and review the list of the driving questions that you and the students generated. It will serve as a guide for their investigation at the Observatory. Note any new questions that arise during the investigation. Encourage students to take pictures and field notes.

After your Observatory visit, review the driving questions and focus on “what have I learned”. Challenge students to transfer their experience to the science they have learned in class.

Here are some questions to help students generate questions about what they want to know.

1. Who would you expect to meet working at an observatory?
2. What do you think an astronomer's typical day at an observatory would be like?
3. What do you think astronomers are trying to learn at an observatory?
4. Who lives at an observatory? Is life at an observatory different than life in your community?