Studying White Dwarfs at McDonald Observatory

Event Lesson Plan for Argos Online Lock-in

Lesson Goals

*To guide students' videoconference interaction with astronomers at McDonald Observatory who are studying white dwarfs.

*To provide students a flexible structure of activities, dialog with facilitators and astronomers, and use of computers that supports their investigation of white dwarfs.

*To show students connections between scientific research and the science they do at school.

Lesson Objectives:

The student will:

*Meet an astronomer who studies white dwarfs;
*Ask questions about the astronomer and his/her research project;
*Participate in observing and studying white dwarfs:
*Analyze white dwarf data produced by the Argos instrument; and
*Participate in short activities about astronomy and concepts of waves.

Target Grade Level: IPC, Physics, and Astronomy, Science TEKS

IPC, Astronomy, Physics 2: Scientific Inquiry

A. Facilitators will guide students through an investigation of white dwarfs.
B. Collect data and make measurements with precision.
C. Organize, analyze, evaluate, make inferences, and predict trends from data.
D. Communicate valid conclusions.

IPC 5: Characteristics of Waves

A. Demonstrate wave types and their characteristics.
B. Demonstrate wave interactions.
D. Demonstrate the application of acoustic principles (seismology and astroseismology).

IPC 6: Energy Transformations

B. Investigate and demonstrate heat - the movement of thermal energy through solids, liquids, and gas by convection, conduction, and radiation.

Physics 8: Characteristics and Behavior of Waves

A. Examine and describe a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, and behaviors such as reflection, refraction, and interference.
B. Identify the characteristics and behaviors of sound and electromagnetic waves.

Astronomy 6: Characteristics and Life Cycles of Stars

A. Describe nuclear reactions in stars.

B. Identify characteristics of stars: temperature, age, relative size, composition, and radial velocity using spectral analysis.

C. Identify the stages of the lifecycle of stars by examining the H-R diagram.

Materials Needed:

*Laptop computer and video projector, *PowerPoint* files (See **Elaboratation**)
*Computer workstations for students
*Internet access
*Videoconference unit
*Props for the Explore section: several slinkies, Audacity software, chimes
*Activity handouts: *Star Maps*, *Interview with a White Dwarf*, *Laser Jello*, *Corner Reflector*, white dwarf light curves + Fourier transforms (FT).

Star Maps	**Interview with a White Dwarf**	**Properties of Waves**
-Uncle Al's star wheel template or planispheres. -*StarDate* magazines w/ star maps, or other online star maps (see activity for more detail)	Per student: Activity script and plots Whole group: *PowerPoint*, computer, and video projector.	Per group: *Slinky* Demo station: Computer running *Audacity*, Wind chime pipes, or xylophone

Engagement:

- Students go outside to do basic astronomy using Uncle Al's star wheels and look through telescopes.
- Facilitators lead a presentation about what research in astronomy is all about.
- Facilitators show an example via the *What Are Astronomers Doing at McDonald Observatory?* website. Students may explore this website throughout the evening.
- Initiate a videoconference to introduce the astronomer(s) at the 2.1-meter telescope.
  1. What is being studied and why?
  2. Why are you using the 2.1-meter telescope at McDonald Observatory?

Do the condensed *Interview with a White Dwarf* activity.

Exploration:

- Properties of waves: students work in pairs with a *Slinky* to explore wavelength, frequency, modes.
- Properties of waves: students analyze wind chime sound waves using free software *Audacity*. They study the sound's waveform (intensity over time) and Fourier transform (intensity over frequencies 20 to 20,000 Hz).
- Give students time to journal about what they have learned.
- Practice Run: Students learn what data Argos collects and how the control software displays the data (focus on the image, light curve, and FT).
- Students visit with astronomer(s) at the 2.1-meter telescope via videoconference and study the incoming data and images from Argos.

Explanation: Analyze data

- Students identify the white dwarf target in the Argos image frame.
- Students study the white dwarf light curve and compare it to known pulsating white dwarfs.
- Students identify dominant modes in the white dwarf light curve and FT as Argos collects and processes each image.
- Facilitators help students connect the white dwarf light curve and FT their experiences of making *Slinky* waves and analyzing wind chime sound waves.
- Students should be allowed time to journal on a computer or in a notebook about what they have learned.

Elaboration:

- Facilitators present a *PowerPoint* about white dwarf research and results. During the presentation facilitators relate current big questions in astronomy to white dwarf research.
- Facilitators help students connect their Argos Online experience with concepts such as conservation of energy, force, and states of matter.
- Facilitators and students identify examples of these concepts in our daily lives.
- Give students time to journal about what they have learned.

Evaluation:

- Students and their teacher will do post-event activities in class to further reinforce new concepts.
- Students fill out a one-page questionnaire about their Argos Online experience.
- Facilitators fill out a short evaluation form to document: number of students, school, grade level, and the events of the Argos Online session.

Background for Teachers:

What is a White Dwarf?

The basics:

- http://www.whitedwarf.org/index.html?education/&0
- http://imagine.gsfc.nasa.gov/docs/science/know_l1/dwarfs.html

Chandra X-Ray Observatory

- http://chandra.harvard.edu/chronicle/0400/sirius.html
- http://chandra.harvard.edu/xray_sources/white_dwarfs.html

Hubble Space Telescope: Sirius B (a white dwarf)

- http://hubblesite.org/newscenter/newsdesk/archive/releases/2005/36/

What Are Astronomers Doing at McDonald Observatory?

- http://mcdonaldobservatory.org/research/

Research of White Dwarfs

- http://www.whitedwarf.org/

