Studying White Dwarfs at McDonald Observatory

Post-Event Argos Lesson Plan

Post-Argos Event Lesson Goals

Provide activities for students to connect scientific research and the science they do at school.

Lesson Objectives:

The student will:

*Complete an activity to discover the exotic properties of white dwarfs.

*Perform an activity that extends their understanding of white dwarfs as a way to determine the age of the galactic disc.

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 4: Force and Motion

B. Investigate and describe applications of Newton's Laws (which may be used to derive Kepler's Laws of orbital motion).

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 3: Critical Thinking and Scientific Problem Solving

A: Analyze, review, and critique scientific explanations
C: Evaluate the impact of research on scientific thought, society, and the environment.
E: Research and describe the history of physics and contributions of scientists.

Physics 4: Motion

B. Analyze uniform and accelerated motion.

Physics 5: Conservation of Energy and Momentum

D. Demonstrate conservation of energy and momentum.

Physics 6: Forces

A. Identify the influence of mass and distance on gravitational forces.

Physics 7: Thermodynamics

A. Analyze and explain everyday examples that illustrate the laws of thermodynamics.

B. Evaluate different methods of heat transfer that result in increasing amounts of disorder.

Astronomy 3: Critical Thinking and Scientific Problem Solving

A: Analyze, review, and critique scientific explanations.

C: Evaluate the impact of research on scientific thought, society, and the environment.

E: Research and describe the history of astronomy and contributions of scientists.

Astronomy 4: Scientific Information about the Universe.

B. Describe characteristics of galaxies.

Astronomy 5: Scientific Theories about the Evolution of the Universe.

A. Research and analyze scientific empirical data on the estimated age of the universe.

C. Interpret data concerning the formation of galaxies and our solar system.

Astronomy 7: How Mathematical Models, Computer Simulations, and Exploration can be Used to Study the Universe.

A. Demonstrate the use of units of measurement in astronomy such as light year and astronomical units (AUs).

C. Analyze a model that simulates planetary motion and universal gravitation.

Materials and Instructional Technology:

*Index cards: one for each student
*Instructional Technology: Internet access, computers, video projector, *PowerPoint*, Internet browser
*Activity materials & handouts: *Properties of White Dwarfs*, *What is the Age of the Milky Way?*

Engagement:

*Fast write: What new questions do you have about white dwarfs?
*Give students three minutes to write a response to this question on a three by five inch index card. Ask or select students to share their responses, and summarize them on the board or overhead. Tally repeated responses.

Exploration:

Select an activity for students to do.

- **Properties of White Dwarfs**: Students discover the key properties of Sirius B, a white dwarf orbiting Sirius A (brightest star in the night sky). They examine some empirical data and make a model of the orbits of Sirius A and B to calculate Sirius B's mass, volume, density, and temperature.
  - 1 to 2 class periods
- **What is the Age of the Milky Way?** Students apply their knowledge of heat and temperature to discover how astronomers use cool white dwarfs to calculate the age of our galaxy, the Milky Way.
  - 1 to 2 class periods

Explanation:

White Dwarf Astronomy: What's it Worth?

Think

5 minutes: Ask students to think about a response to the following question:
How do you think astronomers contribute to the body of scientific knowledge by studying white dwarfs?
Consider:

- data and information from astronomical observations and analysis
- testing and improving scientific theories in physics and cosmology
- improvements to our everyday lives

Pair

20 minutes: Students work in teams of two to discuss their responses to the question and elaborate to write their team's response.

Share

Select teams to briefly share their team response. Summarize responses on the board or overhead projector.

Whole Class

Discuss as a whole class, based on teams' responses, the main ways astronomers contribute to science by studying white dwarfs. You may choose to segue into the Elaboration assignment to wrap up the discussion.

Elaboration:

You Ask the Question

In groups, students produce a class presentation. They use PowerPoint to help them make a case to support their choice of the big question astronomers should pursue.
The current Big Questions:

- What is the nature of Dark Matter?
- What is Dark Energy?
- Does life exist elsewhere in the Universe?
- What technology will astronomers need and apply in the 21st century?
- What astronomy can be done to resolve the nature of neutrinos?
- **Write your own Big Question here.**

As student groups make their case, they also explain the relationships between the important science concepts of their Big Question and what they are learning in science class.

Evaluation:

You Ask the Question Rubric

Criteria for maximum score	Score
Clearly and accurately communicates relevant information about their Big Question choice, and their research.	0 2 4 6 8 10
Logical organization of information.	0 1 2 3 4 5
Creative design, easy to follow. No distracting graphics, noises, or slide transitions – these distract the audience.	0 1 2 3 4 5
Each group member clearly contributed to the research. Each group member plays a different and critical role in communicating what the group learned.	0 2 4 6 8 10
Group members describe the relationship between important science concepts related to their Big Question and your science curriculum.	0 2 4 6 8 10
Clearly and accurately cites information sources.	0 1 2 3 4 5
Answers questions from other students clearly and accurately.	0 1 2 3 4 5
Total Points out of 50:	

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/

