Nearby Stars Lesson Plan

Time: 50 minutes

Goals: To gain an understanding of the distance to nearby stars and the methods used to calculate distance.

Objectives: Students will:

- Watch the "Nearby Stars" segment of the "How far away is it" video book
- Optionally, if there is access to the internet, build the Hipparcos Star Globe
- Calculate a star's luminosity
- Take a short quiz

Materials:

- Internet connection with a computer for viewing "Nearby Stars" segment on YouTube

Directions:

- Introduce the Nearby Stars segment as our first step out of the Solar System. Point out that we'll be enhancing the parallax rung on our distance ladder with a version called 'stellar parallax'.
- Show the video.
- Review what they saw:
    - How the first stellar parallax was done.
    - How a star's proper motion is measured.
    - What a debris ring around a star looks like.
    - How to calculate a star's luminosity via the inverse square law.
    - The amazing power of the Sun.
    - How we get outside the Earth's atmosphere to measure parallax.
    - How we calculate the mass of a star.

- Print the Hipparcos Star Globe.
    - With a computer connection: Using Internet Explorer, go to the Hipparcos website: http://sci.esa.int/hipparcos.
    - Click on 'Hipparcos science home page' on the left side of the screen.
    - Click on 'The Hipparcos Star Globe' on the right side of the screen.
    - Right click on the 'Star Globe Images' and 'Folding Instructions (Star Globe) to download these two files.
    - Print, cut, fold and glue the Hipparcos star map as called for in the instructions.

Assessment options: Here are two assessment options based on prerequisites:

1. Without Geometry: Take a simple quiz. Print and distribute the quiz on page 3. Here are the answers:

    - What are the two factors that determine a star's apparent luminosity? **Answer**: a) intrinsic luminosity, and c) distance.
    - What is the name for the motion of stars across the sky over time? **Answer:** b) Proper Motion
    - What kind of star systems enabled us to calculate star mass? **Answer**: a) Binary star systems

2. With Geometry: Using the inverse square law calculate the intrinsic luminosity for the following star:

    - The distance to the star is 25 light years = 25 x 94.6 x 10^{15} meters
    - The apparent luminosity of the star here on Earth is 21.8 x 10^{-11} watts/meter^2
    - Solution:

    $L_{appaent} = L_{intrinsic} / 4\pi r^2$
    $L_{intrinsic} = 4\pi r^2 L_{apparent}$
    $= 4 \times 3.14 \times (25 \times 94.6 \times 10^{15} \text{meter})^2 \times 21.8 \times 10^{-11}$ watts/m^2
    $= 1.54 \times 10^{28}$ watts

    Note that this is 40 times the luminosity of the Sun. This is the star Vega.

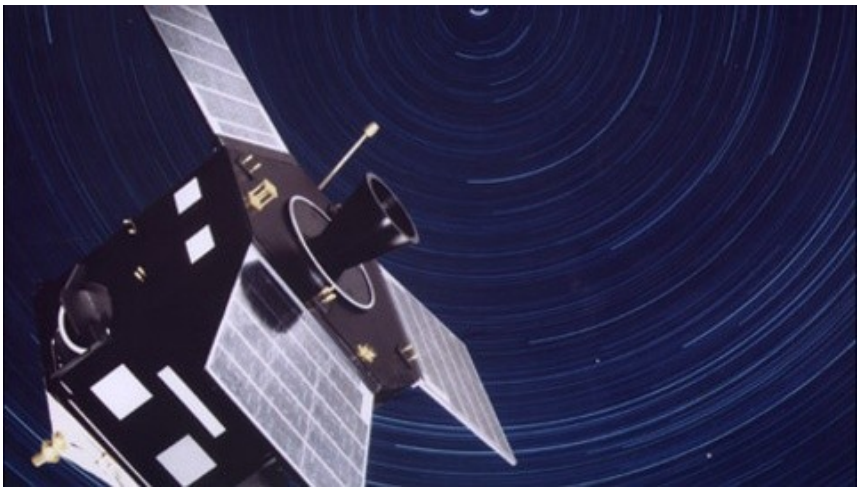
    This exercise is repeated without the solution on page 4.

Nearby Stars quiz

- What are the two factors that determine a star's apparent luminosity?
    a) Intrinsic luminosity
    b) Proper motion
    c) Distance
    d) Rotational velocity

- What is the name for the motion of stars across the sky over time?
    a) Doppler shift
    b) Proper motion
    c) Radial motion
    d) Rotational motion

- What kind of star systems enabled us to calculate star mass?
    a) Binary star systems
    b) Open star clusters
    c) Globular star clusters
    d) Nearby star systems



Nearby Stars Exercise

Using the inverse square law, calculate the intrinsic luminosity for the following star:

- The distance to the star is 25 light years = 25 x 94.6 x 10^{15} meters
- The apparent luminosity of the star here on Earth is 21.8 x 10^{-11} watts/meter^2

The luminosity of the Sun is 3.84 x 10^{26} watts. How many times more luminous than the Sun is this star?