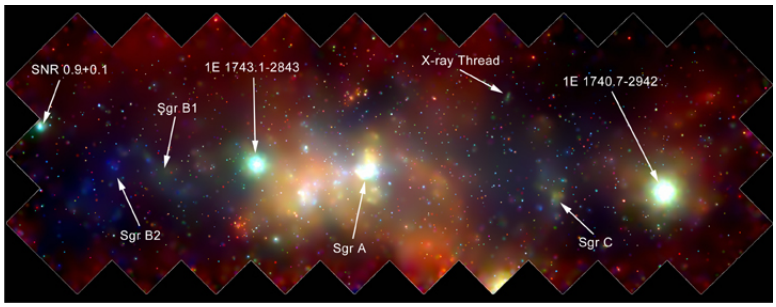
NATIONAL SCIENCE OLYMPIAD

Astronomy C Division Event

22 May 2004

Juniata College, Huntingdon, PA



TEAM NUMBER_____
TEAM NAME_____

INSTRUCTIONS:

1) Please turn in <u>ALL</u> materials at the end of this event.
2) Do not forget to put your <u>TEAM NAME</u> and <u>TEAM NUMBER</u> on both this page and at the top of the Answer Page.
3. Only answers placed on the Response Pages will be counted.
4. This event and the answer key will be available on the Wright Center website: http://www.tufts.edu/as/wright_center/fellows/sci_olympiad/sci_olympiad.html
5. Good Luck! And May the Stars be With You!

Section A: Use Image Set A to answer the questions in this section.

Use Images 1-14 to answer the following:

One of the images contains an actual spiral galaxy. Which image is it (_1_)? What is the name of this galaxy (_2_)?
Which image is the remnant of the core collapse of a massive star (_3_)? What is the name of this remnant (_4_)?
Which of the images contains the object located in the Milky Way Galaxy at the same position indicated by label C in Image 1 (_5_)?
The largest object(s) is shown in which image (_6_)? What is the name of this object(s) (_7_)?
What is the name of the object in Image 14 (_8_)? What is the end product of stellar evolution for this object (_9_)? Which two images show this end product (_10_)?
Which image shows the remnant of a thermonuclear explosion (_11_)? What is the name of this remnant (_12_)? Which image shows the object prior to the explosion (_13_)?
Which two images are examples of the object labeled B in Image 1 (_14_)? Which one of these objects is located in the galaxy in Image 11 (_15_)?
~~**Which of these images is located within the part of the galaxy labeled D in Image 1 (_16_)?**~~
Which images contain almost exclusively Population II objects (_17_)?
Which image shows an object that is used to measure the distance to a cluster of galaxies (_18_)?

Which of the images are located at position F (_19_)?
Which image is located at H (_20_)?
Image 10 is located at which position (_21_)?
Where on the diagram (two locations) are the objects in Image 7 located (_22_)?
What type of objects are in Images 4 and 9 (_23_)?
Which images contain objects that are located at position J (_24_)?
At which location would the spectra contain iron (_25_)?
Where on the diagram is hydrogen being fused into helium as the main source of energy (_26_)?
At which location is the youngest object located (_27_)?
Image 5 has a turn-off point on an H-R diagram around the position of H, however there are a few objects located in Image 5 that are located around position E. What are these objects called (_28_)? What is the most common method of measuring the distance to this object (_29_)?

In Image 15, the object labeled A is located in the constellation of Lyra. What is the name of this object (_30_)? This object is 2700 ly from Earth, has an angular diameter of 1.4 x 1.0 arcmin and is expanding at the rate of about 20 km/s. How long ago did the central star shed its layers (_31_)? A Type Ia supernova was discovered in the object labeled B and reached an apparent maximum magnitude of +10. how far away is the galaxy (_32_)?

Images 16a - 16d:
There are two types of Cepheid variables. Type I are Population I and Type II are Population II. Edwin Hubble thought the Cepheids seen in the disk of M31 were identical to those seen in objects like 16a in our own galaxy. What type of error (too close, too far?) did this lead to in Hubble's calculations for the distance to M31 (_33_)? Which spectra would be associated with Type II Cepheids (_34_)? What is the name of the object in 16a (_35_)? This object contains an object rarely found in this location. What type of object is it (_36_)?

Section B: Use Image Set B to answer the questions in this section.

***Note: The term "Apparent Luminosity" is used several times in Part B of this exam. Apparent luminosity refers to the luminosity that a star 10 parsecs away would have to be in order to appear as bright as it does in the night sky. This distinction between absolute and apparent luminosity is the same as between absolute and apparent magnitude. While, "Apparent Luminosity" is not as common a term, it was used for the simplicity of the linear luminosity scale above the logarithmic magnitude scale.**

An observer on earth observes a nearby star to have an annual parallax of 0.10'', an observer on another planet measures the same star to have a parallax of 0.15''. How far is this planet from the sun (_1_)? (The semi-major axis of earth's orbit is 1.5 x 10^8 km)

A horizontal-branch star and main-sequence star of spectral class G2 both have the same apparent magnitude. Which is farther away (_2_)? How many times farther (_3_)?

The intensity of a star's radiation is measured at various wavelengths to produce the curve in Figure I on the next page. What is its temperature of this star in units of Kelvin (_4_)? What is the temperature in solar units (_5_)? What color does this star appear (_6_)? This star is determined to have an absolute luminosity of 100 solar units, what is its radius in solar units (_7_)? This star is observed to have an apparent magnitude equal to its absolute magnitude, how far away from the observer, in parsecs, is it (_8_)? What is the angular diameter of this star (_9_)? [One parsec is equal to 3.09 x 10^13 km, and the sun has a radius of the sun is 6.95 x 10^5 km] Label the location of this star with an X on the H-R diagram <u>ON THE ANSWER SHEET</u> (_10_).

Three stars are observed in a cluster: Observations of Star A produced the light curve in Figure II. Star B is a main sequence star and produced the spectra in Figure III. Star C is observed to have a spectral class of K2 and apparent luminosity* of 500 solar units. What is the apparent luminosity* in solar units of Star B (_11_)? Plot Star B on the H-R diagram <u>ON THE ANSWER SHEET</u> (_12_). Plot star A on the same H-R diagram (_13_). Plot Star C on the same H-R diagram (_14_).

What type of variable star produced the light curve in Figure V. (_15_)? What is its period (_16_)? What is its maximum apparent magnitude (_17_)? What is this star's absolute luminosity (_18_)? The star's average apparent magnitude of +6.5 corresponds to an apparent luminosity* of 0.22 solar units, what is the distance, in parsecs, to this star (_19_)?

Galaxies A and B appear equally bright in the night sky. Galaxy A is twice as far away as Galaxy B. Which has a greater rotational velocity (_20_)? How many times greater (_21_)?

What kind of variable star produced the light curve in Figure VI (_22_)? What is this star's maximum apparent magnitude (_23_)? How far away is this star (_24_)? If the age of the universe is taken to be 13.5 billion years, what value does Hubble's law predict for the recessional velocity of the galaxy containing this star in km/s(_25_)? With this velocity, what would be the observed wavelength of the 21-cm line produced by hydrogen in the galaxy's disk (_26_)?

A study is conducted of binary star systems in which both members have the same mass and the distance between the two stars is the same for all systems in the study. The relationship between the absolute luminosities and masses of stars in the study is reflected by the graph and function in Figure VII. If a plot is made of the absolute luminosity of the binary system as a function of its period, would you expect the slope (not necessarily linear) to be positive, negative, or zero (_27_)? If that plot is described by the function Luminosity = (Period)Q , what would you expect the value of Q to be (_28_)? Consider a binary system from the study described above, and suppose that the masses of the member stars can be altered (the masses are no longer required to be equal, but the separation remains fixed). If the period of the system is reduced to the square root of one half of its original value, and the gravitational force exerted by one star on the other is 4 times its original value what is the new ratio of the masses of the member stars (_29_)? If the period of the original system is reduced to the square root of two thirds of its value and the force exerted by one star on the other is doubled, what is the new ratio of the masses to the member stars (_30_)?