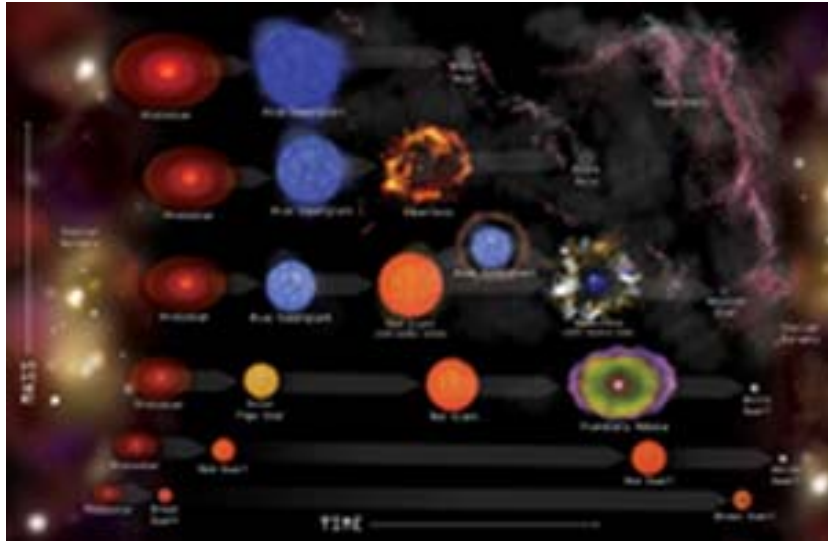


NATIONAL SCIENCE OLYMPIAD
Astronomy C Division Event
21 May 2005
University of Illinois, Urbana-Champaign



TEAM NUMBER _____

TEAM NAME _____

INSTRUCTIONS:

- 1) Please turn in ALL materials at the end of this event.
- 2) Do not forget to put your TEAM NAME and TEAM NUMBER 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_astro.html
5. Good Luck! And May the Stars be With You!

Section A: Use Image Set A (numbers 1 – 30 on Page 3) to answer the questions in this section.

Image 6 shows two interacting galaxies. What are they called (_1_)? Which image shows the star formation taking place in these galaxies (_2_)? Which image shows the constellation these galaxies are located in (_3_)? What is the name of this constellation (_4_)?

Which of the images shows a Type Ia supernova remnant (_5_)? Which image shows the stage immediately preceding the Type Ia supernova event (_6_)?

What is the name of the object in Image 23 (_7_)? What object(s) will result during the next stage of stellar evolution (_8_)?

Which image contains the youngest stars (_9_)? What type of object is in this image (_10_)?

Which two images show the results of the core collapse of massive stars (_11_)?

What is the name of the object in Image 8 (_12_)? Which image shows a close-up of star formation in this object (_13_)?

Which image contains an object whose distance would be determined using RR Lyrae stars (_14_)?

What specific type of object is in Image 19 (_15_)?

Which image shows a close-up of the activity at the center of Image 19 (_16_)?

Which image shows the constellation in which Image 19 is located (_17_)?

Section B: Use Image Set B (letters A – Z on Page 4) and Image Set A to answer the questions in this section.

The unstable star in Image 3 produced which light curve from Image Set B (_18_)?

The light curve in Image K would be produced by an object located on which part of the H-R diagram (_19_)?

Image C contains a plot of which image in Image Set A (_20_)?

A plot of the objects in Image 10 is shown by which image on Image Set B (_21_)?

Plot G shows the spectra produced by what type of event (_22_)?

The object in Image 29 will produce which type of light curve on Image Set B (_23_)?

Which spectra on Image Set B is produced by an object located at position Z on the H-R diagram (_24_)?

Image B is a light curve produced by what type of object (_25_)? Where would this object be located on the H-R diagram (_26_)?

Section C: DS 9 image processing questions

(_27_) An image processing pixel is:

- a) the location in the sky where the object viewed is located
- b) the color or shade of gray chose to represent the brightness of a pixel
- c) the smallest part of the image over which the brightness does not vary
- d) an area the size of a photon

(_28_) The “Value” number displayed in ds9 represents:

- a) the number of photons that arrived at that pixel
- b) the color of the object being viewed at that pixel
- c) the temperature of the object being viewed at that pixel
- d) the position of that pixel

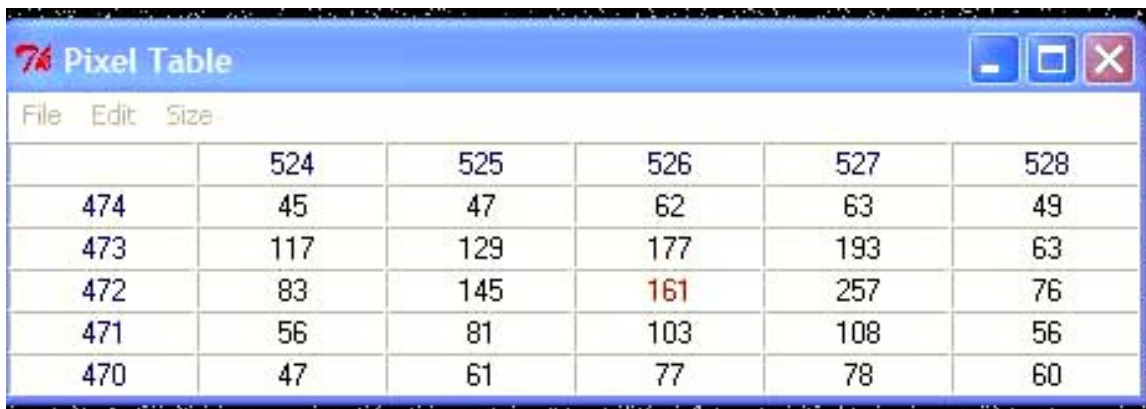
(_29_) If you Zoom In on an image:

- a) the telescope taking the image gets larger
- b) the pixel Values become larger
- c) the pixel areas become larger
- d) the position of the pixels changes

(_30_) The picture below represents the pixel table for a portion of a CCD image.

The blue numbers in the left column and in the top row represent:

- a) the temperature of the object being viewed at that pixel
- b) the color of the object being viewed at that pixel
- c) the number of photons that arrived at that pixel
- d) the position of that pixel



| File | Edit | Size | | | | | |
|------|------|------|-----|-----|-----|-----|-----|
| | | | 524 | 525 | 526 | 527 | 528 |
| 474 | | | 45 | 47 | 62 | 63 | 49 |
| 473 | | | 117 | 129 | 177 | 193 | 63 |
| 472 | | | 83 | 145 | 161 | 257 | 76 |
| 471 | | | 56 | 81 | 103 | 108 | 56 |
| 470 | | | 47 | 61 | 77 | 78 | 60 |

(_31_) The resolution of the Chandra x-ray telescope is 0.5 seconds of arc/pixel.

The resolution measures:

- a) the angel covered by one pixel on the CCD
- b) the distance to the object observed
- c) the size of the telescope
- d) the number of pixels on the CCD

(_32_) The pixel table below represents a portion of a CCD image. Which TWO of the following statements are true?

- a) the right side of the image portion is brighter than the left side of the image
- b) the bottom of the image portion is brighter than the top of the image
- c) the left side of the image portion is brighter than the right side of the image
- d) the top of the image portion is brighter than the bottom of the image

| | 528 | 529 | 530 | 531 | 532 |
|-----|-----|-----|-----|-----|-----|
| 472 | 76 | 88 | 51 | 27 | 10 |
| 471 | 56 | 62 | 41 | 24 | 8 |
| 470 | 60 | 42 | 27 | 11 | 14 |
| 469 | 47 | 27 | 14 | 14 | 12 |
| 468 | 22 | 20 | 18 | 10 | 10 |

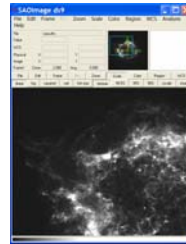
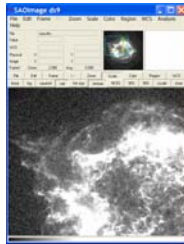
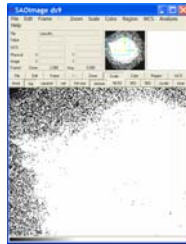
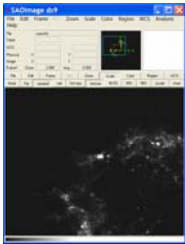
(_33_) Which image shows a log scale?

a)

b)

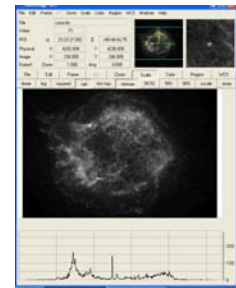
c)

d)



(_34_) In the image to the right:

- a) moving the cursor back and forth displays the values in the x-axis lines of pixels
- b) the resulting plot shows the location of the elements
- c) the resulting plot shows the amount of energy in each pixel
- d) moving the cursor up and down displays the values in the x-axis lines of pixels



(_35_) A radial profile is: Which of the TWO following statements are true?

- a) an energy distribution curve
- b) a graphical plot of the brightness of x-ray emission
- c) the total number of photons within each pixel
- d) the average number of photons per unit area

(_36_) The analysis tool used to study the distribution of elements within different regions of a supernova remnant:

- a) radial profile
- b) energy spectrum plot
- c) histogram
- d) quick light curve

Section D: Use the Figures on Image Set D, Page 9 to answer the questions in this section

(_37_) An observer on Earth measures Star A to have a parallax of 0.002'' what is the distance to Star A (in pcs)?

(_38_) An observer on Mars measures Star B to have a parallax of 0.002'', what is the distance to Star B (in pcs)?

(_39_) An observer on Earth measures the position Star C on June 3rd 1985, she measures it again 3 months later and observes it's position to have changed by 0.002'', what is the distance to star C (in pcs)?

[Use the following information for Questions 40-46]

Two main sequence stars appear equally bright in the night sky. Star D has a spectral class of M2 and Star E has a spectral class of B8.

- (_40_) Which has a greater absolute magnitude?
- (_41_) How many magnitudes greater?
- (_42_) Which is hotter?
- (_43_) Which emits more energy per unit surface area?
- (_44_) How many times more?
- (_45_) Which is farther from the observer?
- (_46_) How many times farther?

[Use the following information for Questions 47-55]

Galaxy I has a recessional velocity of 1267 km/s and a distance of 59.4 million light-years. Observations of the radio spectrum of Galaxy II indicate that it has a rotational velocity of 350 km/s. A 1 square-meter sensor on earth measures 5.28×10^{10} watts/second of radiation from Galaxy II. The spectrum in Figure 4 measures the 486 nm hydrogen line from Galaxy III. A star in Galaxy III is observed to produce the light curve in Figure 5.

Using only the information from Galaxy I [Questions 47-48]

- (_47_) What is the value of Hubble's constant, H_0 (in its traditional units)?
- (_48_) What is the age of the universe (in billions of years)?

Using your answers from Question 47 and/or the information from Galaxies II [Questions 49-51]

- (_49_) What is the luminosity of Galaxy II (in solar-units)?
- (_50_) What is the distance to Galaxy II (in Mpc)?
- (_51_) What is the radial velocity of Galaxy II (in km/s)?

Using only the information from Galaxy III [Questions 52-53]

(_52_) What is the recessional velocity of Galaxy III (in km/s)?

(_53_) What is the distance to Galaxy II (in Mpc)?

According to your answers to questions 54-55

(_54_) What is the fate of the universe?

(_55_) How does your answer compare with the current majority position of the astronomical community?

Match the type of object from column A to figure or description from column B [Questions 56-60]

Column A

Column B

(_56_) parallax = 0.003", apparent magnitude = +2.6, Figure 6

(_57_) apparent diameter = 0.009", temperature = 20,000 K, distance = 10^{14} km

(_58_) apparent magnitude = +10, distance = 10 pcs, Figure 7

(_59_) energy flux = 1/16 times Star Q (Figure 1), radius = 40 times Star Q

(_60_) luminosity = 0.01 times Star Q, high carbon content

i) Figure 8

ii) Figure 9

iii) Red Dwarf Star

iv) Figure 10

v) Figure 11

Two binary star systems are observed with separations of 2.0 A.U. and contain a 1.0 solar-mass main sequence star. *System I* has a period 1.7 years and *System II* has a period of 1.9 years.

(_61_) What is the mass of the heavier member of *System I* (in solar-masses)?

(_62_) What type of object is the heavier member of *System I*?

(_63_) What will happen to *System I* as the lighter member evolves off the main sequence?

(_64_) What is the mass of the heavier member of *System II* (in solar-masses)?

(_65_) What type of object is the heavier object in *System II*?

(_66_) What will happen to *System I* as the lighter member evolves off the main sequence?

Section E:

(_67_) How can planetary nebulae be used to calculate intergalactic distances?

(_68_) How can the age of a globular cluster be determined using a H-R diagram?

(_69_) Stars of the spectral class A have the strongest hydrogen lines. Why do both hotter and cooler stars have weaker lines?

(_70_) What is the difference in chemical composition between Population I and Population II stars?

Use the animation clip to answer the following questions:

(_71_) What specific type of event is being shown?

(_72_) Name the two major types of end products for this type of event.