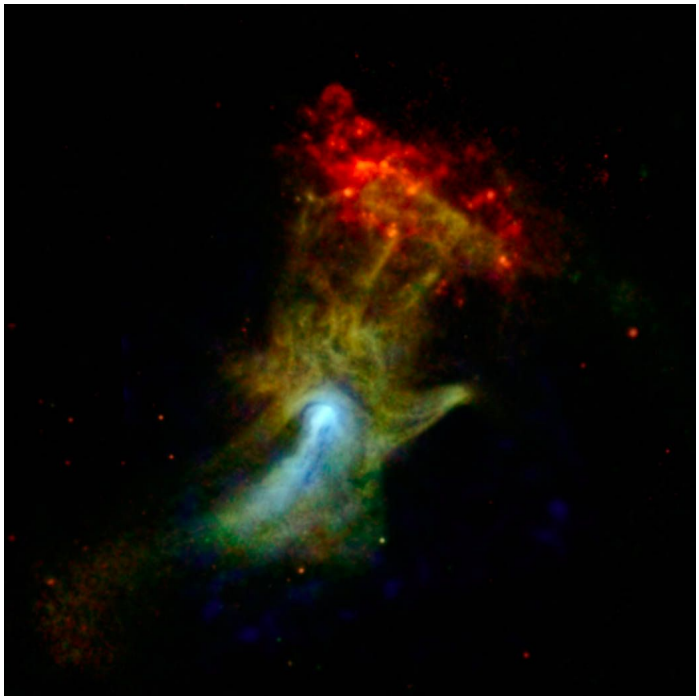
Holt Division B Science Olympiad Invitational 2017

Reach for the Stars



X-ray image of PSR B1509-58 ('Hand of God')
Credit: NASA

Written by: Pham Nguyen and Le Nguyen

Team Name and Number: (1 point)

Student Name(s):

Section I: Deep Sky Objects (4 points each)

1.
    a. What is the name for the system of objects shown in Image 1?
    b. What constellation are they located in?
    c. What region of the electromagnetic spectrum was this image taken in?
    d. What is the name of the brighter object in this region of the electromagnetic spectrum?

2.
    a. What object is shown in Image 2?
    b. What constellation is it located in?
    c. This object generates a magnetic field which accelerates surrounding particles causing them to emit radiation. What is this type of radiation called? (2 pts)

3.
    a. What object is shown in Image 3?
    b. What constellation is it located in?
    c. What makes this object unique in the Milky Way?
    d. What kind of stars are found in this object?

4.
    a. What is the name of the object circled in Image 4?
    b. What is another common name given to this object?
    c. What is this object's spectral classification?
    d. What type of variable star is it?

Section II: Stellar Evolution

Multiple choice section (2 points each)

5. Star formation occurs in molecular clouds. What is their typical temperature?
    a. < 100 K
    b. 1000 K
    c. 10^6 K
    d. 10^8 K

6. An object that is too low in mass to begin hydrogen fusion and fails to join the main sequence is called a:
    a. Neutron star
    b. White dwarf
    c. Black dwarf
    d. Brown dwarf

7. Main sequence stars fuse hydrogen into what element?
    a. Helium
    b. Lithium
    c. Carbon
    d. Oxygen

8. Stars cannot fuse materials beyond what element?
    a. Uranium
    b. Magnesium
    c. Iron
    d. Calcium

9. What prevents white dwarfs from further collapsing due to gravity?
    a. Gas pressure
    b. Electron degeneracy pressure
    c. Radiation pressure
    d. Neutron degeneracy pressure

10. What is the next step in Betelgeuse's stellar evolution?
    a. Planetary Nebula
    b. White Dwarf
    c. Supernova
    d. Betelgeuse is currently at the last stage of stellar evolution

Short answer section (3 points each)

11. What does it mean for a star to be in ‘hydrostatic equilibrium’?

12. What is the predominant fusion reaction for main sequence stars with a mass ≤ $1M_{\odot}$?

13. What is the predominant fusion reaction for main sequence stars with a mass > $1M_{\odot}$?

14. What is the Jean’s Criterion? (Tie Breaker)

15. Why are Type Ia supernova considered a ‘standard candle’. Why is this important for astronomy?

16. What is the name of the upper mass limit of a white dwarf star?

17. What is the name of the upper mass limit of a neutron star?

Section III: Calculations (5 points each)

18. Astronomers detect a type Ia supernova explosion with an apparent magnitude of 5.6. Given that the absolute magnitude is -19.4, how far away did the explosion occur? Give your answer in **kiloparsecs**. Did it occur in our galaxy?

19. A star exhibits a stellar parallax of 80 mas(milliarcseconds). How far away is it from us in parsecs? Is it in our galaxy?

20. Suppose a star has a mass of 2 $M_\odot$. Using the mass-luminosity relationship $\frac{L}{L_\odot} = \left(\frac{M}{M_\odot}\right)^{\alpha}$, and assuming that $\alpha = 4$, calculate its luminosity in $L_\odot$.

21. For the star from question #20, what would its new luminosity be if its temperature doubled? What would its luminosity be if the radius was halved?

22. Suppose a star has a temperature of 10,000 K, what is it's peak wavelength **in nm**? What spectral class is it?

23. Suppose an exoplanet receives a flux of 10 W m^{-2} at its surface from its parent star. What would the flux be if the planet were moved two times as far away from the star? How about three times closer?

Section IV: Essay Question

(20 points)

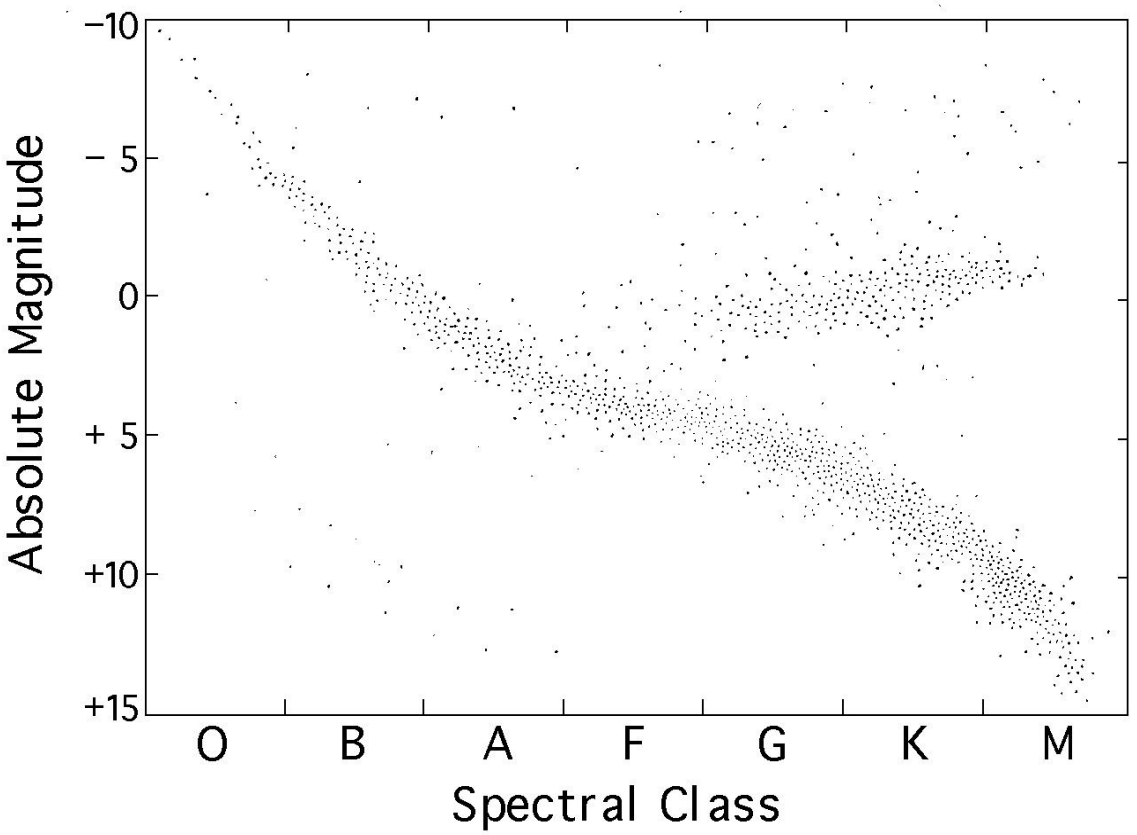
Write a response to **one** of the following:

A. Outline the basic stages of stellar evolution for stars with a mass > $8M_{\odot}$

Or

B. Outline the basic stages of stellar evolution for stars with a mass ≤ $8M_{\odot}$.

Tie Breaker: Using the HR diagram on the next page, indicate where each stage would be located (when appropriate).


−10
− 5
0
+ 5
+10
+15
Absolute Magnitude
O
B
A
F
G
K
M
Spectral Class