Week 2 and 3 – Discussion Questions and Homework
Melanie Zaidel - 2/22/2024
Due 3/7/2024

During our mentoring meeting this week and next week's Polaris class, we'll be talking about these questions and trying to come up with some answers. We may or may not get through all of them, but hopefully they will inspire discussion.

For homework, I would like both of you to type up ~5 sentence long answers to each these questions. You may ask me for help and use the Internet, but I would like both of you to first work together on answering these questions as best you can. You may compare answers and help each other, but please type up your own responses.

Please send me your completed homework by our mentoring meeting on 3/7 (two weeks from now).

1. What is a simple argument for why so much energy from supernovae goes into the production of neutrinos?

2. If neutrinos and photons are produced at the same time in a supernova, why do we detect the neutrinos first?

3. What are the two main types of supernovae and what separates them?

4. What is the typical density of a neutron star? How does this compare to the density of the Earth?

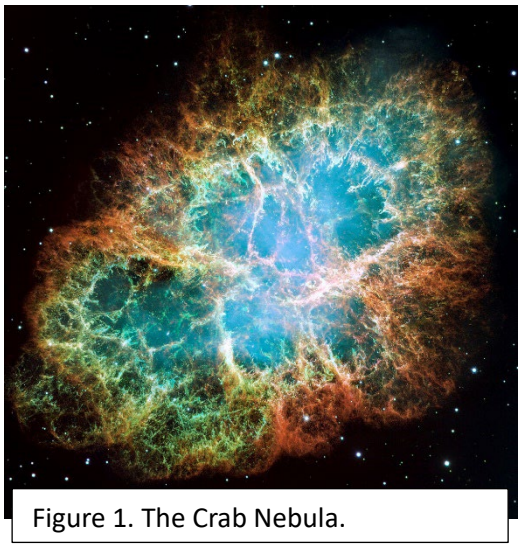

Figure 1. The Crab Nebula.

5. The Crab Nebula (Figure 1) is a "supernova remnant". How would you describe the remnant in terms of composition and temperature? What's with the blue glow near the center of the image?

6. What's the difference between a Planetary Nebula and a Supernova?

7. What is the flux of solar neutrinos at the Earth? In other words, how many neutrinos from the Sun get to you, per cm^2 per second?

8. Why are neutrinos interesting particles as fundamental particles? How about as astrophysical messengers?

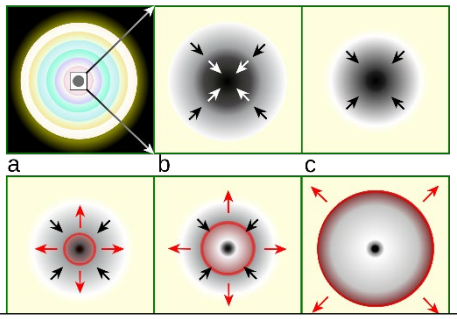

Figure 2. Core collapse scenario.

9. During a core collapse supernova, what causes the implosion? What causes the explosion? Explain Figure 2 in your own words, using as many sentences as necessary.

10. Supernova 1987A is the subject of both of your projects. Using Internet resources (YouTube, Wikipedia), take some time to learn about SN1987A, then write a 250–500-word essay about the characteristics of the event and it's detection.

    I recommend the following places to start:
    - Wikipedia page for SN1987A
    - Aavso page for SN1987A

    In your essay, discuss the following general items:
    - Where did SN1987a occur (distance and host galaxy)?
    - What star was the progenitor (cause) of SN1987A? What kind of star was it?
    - Is there observational evidence that SN1987A produced a neutron star?

    In addition to the above general characteristics, I would like each of you to dedicate part of your essay to answering a question about your astrophysical messengers and how they relate to SN1987A. I'll also pass along some Internet sources that may be good to investigate.

    - How has radioactive decay and gamma-rays impacted the luminosity of SN1987A?
        - Supernovas Create Radioactive Titanium

    - What did the detection of neutrinos from SN1987A mean for our understanding of both supernovae and neutrinos?
        - SN1987A heralds the start of neutrino astronomy