Name: _____

Problem Set 6

Due Friday, October 26 at 10am

Submit Parts A-B on paper in Class or to Moodle. Submit Part C via Moodle only.

Part A – Conceptual Questions

In lieu of standard conceptual questions this week, you should use the platform "Perusall" to annotate one of two papers. Both are related to the phenomenon of neutron star mergers, a violent astrophysical process that is the source of (a) many of the heavier elements in the periodic table and (b) gravitational waves!

You should arrive at class on Friday, October 26 read and annotated your assigned article and having read your groupmates' comments on your assigned reading. You and your group will have some time to confer, and will then summarize the main points and figures from the paper for the other half of the class.

Before beginning your reading of the actual science papers, please read the two "Astrobites" articles below, which give some perspective on the two results. Everyone should read both of the astrobites articles.
https://astrobites.org/2017/10/16/multi-messenger-observations-of-a-binary-neutron-star-merger/
https://astrobites.org/2018/09/14/what-you-get-when-you-throw-a-dead-star-against-another/

The two main readings are available on Perusall. You are only responsible for reading one of the two articles.

William, Julia and Amalia please read:
Abbott et al. 2017 –" GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral" (note that a huge amount of the paper is tables, acknowledgements, references, and an enormous author list – you should skim the table to determine its purpose, but the other sections you can ignore)

Jéa, Joe and David please read:
Kasen et al. 2018 –" Origin of the heavy elements in binary neutron-star mergers from a gravitational wave event"

Please focus your reading with these two main questions in mind:

1) Which of the processes and phenomena that we've talked about so far in this class are at play in this result and in what way?
2) What processes and phenomena are at play here that we have not yet discussed in class? What questions do you have about them?

Use the Perusall interface to highlight the most important pieces of text for your assigned reading and to make at least 7 comments (Perusall will score your comments automatically, and will keep the top 7). There is a small (10%) automatic penalty for concentrating your highlights and comments in one part of the text instead of distributing them around, so pay attention to all parts of the article. Please note that the structure of Nature articles is to have a short summary in the main text and an equally important "Methods" section after the references list. Please read both sections of the article.

Pay particular attention to the figures. Comments can be comments or questions. Discuss things that you thought were interesting, are confused about, etc. You can (in fact, are encouraged to!) also reply to one another's comments and questions.

Part B – Quantitative Questions
Write out your answers neatly or type them up. Show your work, and make sure all answers have appropriate units. Consider significant figures in reporting final answers.

Using what you know about radiative transport, make a quantitative estimate or calculation of how long it would take a photon to escape a star in the following situations:

a. A $1R_{\odot}$, $1M_{\odot}$ star with an opacity that is 10 times higher than the solar opacity
b. A $1M_{\odot}$ star that has half the density of the sun and the same opacity.
c. A $1M_{\odot}$, $1R_{\oplus}$ star (analagous to a white dwarf) with the same opacity as the sun.

Part C – Computational.
Submit this piece as a Jupyter notebook on the course Moodle site.

Using your code from In-Class Activity #6, determine the relationship between total linear distance traveled and the number of steps in the random walk process that we simulated in order to gauge whether the simple model that we used is a reasonable analog for radiative transport through the sun. Some guidelines/requirements:

1) Analyze the relationship between the two quantities over the range 1-100,000 steps comparing both actual data from your simulator (shown as points on the plot) and the theoretical relationship/proportionality between linear distance traveled and number of steps (shown as a line on your plot)
2) Each point on your plot should represent the average of at least 10 random walk simulations.
3) You should include a table of your averages (tips for making tables in Jupyter markdown cells are here: https://sourceforge.net/p/jupiter/wiki/markdown_syntax/#md_ex_tables)
4) Annotate/explain your reasoning at each step, comment your code, and explain your conclusion about the reasonableness of our simple model at the end of your notebook. Is the simulation we used a reasonable approximation for radiative transport in a star?