Homework #6

Classical Novae, Monte Carlo Error Propagation

Assigned: March 31, 2021 Due: April 14, 2021

Percentages for each problem of the total grade (100%) as given. Sub-problems, if present, split the problem's percentage equally. Please show your work!

Problem 1 Proper Pressure and Mass Ejections (20%)

a. For a white dwarf with a fixed size of $\approx 0.01\,R_\odot$, plot the accreted mass (M_accr) as a function of the white dwarf mass (M_WD) in the range $1\,M_\odot \leq M_\mathrm{WD} \leq 1.4\,M_\odot$. Assume a proper pressure of 10^{19} Pa. What is the trend and how do you interpret it?

b. What is the total accreted mass for a $1.2\,M_\odot$ white dwarf that is necessary for the thermonuclear runaway to occur? What is the average density of this white dwarf compared to the Sun's average density?

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Problem 2 Recurrent Timescale for Classical Nova (20%)

Using the accreted mass calculated above for the $1.2\,M_\odot$ white dwarf and mass accretion rate of $10^{-11}\,M_\odot\,\mathrm{a}^{-1} \leq \dot{M} \leq 10^{-7}\,M_\odot\,\mathrm{a}^{-1}$, calculate how often you would expect such a nova to occur. How is it possible that recurrent nova happen with time intervals of 10 a to 100 a?

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Problem 3 Classical Novae versus Type Ia Supernovae (20%)

We have seen that classical novae and type Ia supernovae have very similar origins. Both events take place in binary star systems. Discuss the difference between a classical nova and a SN-Ia, assuming the latter takes place in the framework of the single-degenerate scenario.

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Problem 4 Monte Carlo Error Propagation (40%)

In the GitHub repository for the class you can find a Jupyter notebook in the `hw6` folder. The notebook is named `Introduction to MC in Python.ipynb`. Here is also a direct link to the notebook. This notebook gives an introduction to Monte Carlo error propagation. Follow through the notebook.

At the end of the notebook there are three exercises, the third one being a bonus exercise. Solve these exercises in Python. Feel free to submit your solution as a Jupyter notebook.

If you are having problems running the provided Jupyter notebook on your own computer, you can use the Astrohub[1] that you already used for homework #4. You can upload the provided Jupyter notebook there via drag-and-drop into the file menu. Please let me know if you encounter any issues!

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[1] `https://astrohub.uvic.ca`