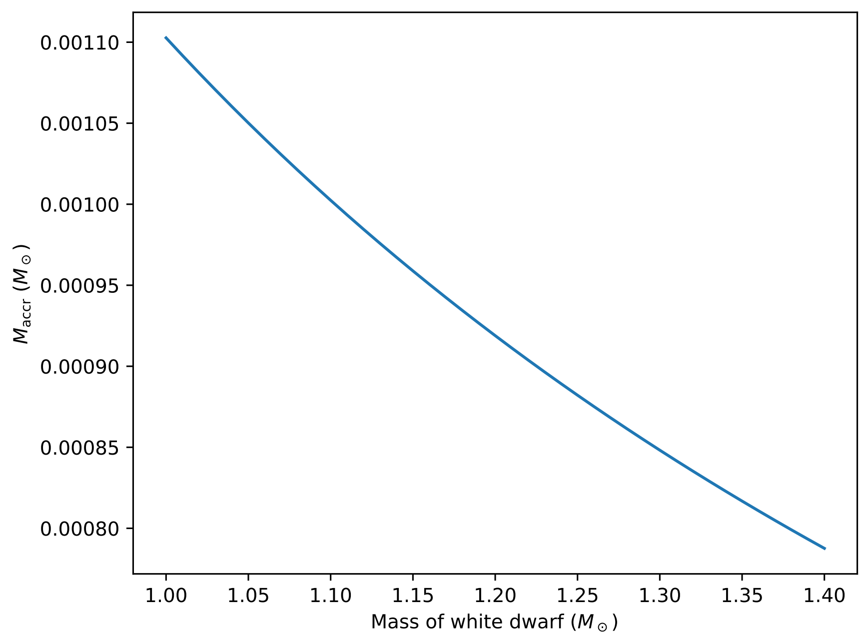
Homework #6 – Solution

Classical Novae, Monte Carlo Error Propagation

Problem 1 Proper Pressure and Mass Ejections

a. A plot of the accreted mass as a function of the white dwarf mass can be found below.



With increasing white dwarf mass, the required mass to be accreted decreases. At higher white dwarf masses, the proper pressure is higher and therefore, nova explosions can happen earlier, i.e., at less total accreted mass.

b. The accreted mass for a white dwarf of $1.2\,M_\odot$ required for it to explode is $9.2 \times 10^{-4}\,M_\odot$. At a radius of $0.01\,R_\odot$ the white dwarf will be 1.2 million times denser than the Sun.

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Problem 2 Recurrent Timescale for Classical Nova

For the given mass accretion rates, the time scales for a nova to recur is between 9.2×10^7 a and 9.2×10^3 a. In order for recurring novae to explode in time intervals of 10 a to 100 a, such a system must either have a higher mass accretion rate or a lower required proper pressure for the thermonuclear runaway to occur.

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Problem 3 Classical Novae versus Type Ia Supernovae

In both scenarios, matter from a main-sequence companion star is accreted onto a white dwarf. In the case of the SN-Ia however, the white dwarf's mass must already be close to the Chandrasekhar mass of around $1.4\,M_\odot$. Once that mass limit is exceeded, the star undergoes a core collapse and explodes as a supernova. For lower mass white dwarfs, this limit is not exceeded and the star accretes mass until a classical nova explosion takes place.

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Problem 4 Monte Carlo Error Propagation

See solutions notebook online.

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