Contents

1 Introduction

These simulations are created to study the phenomenon of common envelops, where a massive point-like star (such as a white dwarf or neutron star) companies a red giant star. and both stars lies in the "atmosphere" of the red giant.

At frame 0, both runs only have a red giant with a core that is considered to be a point mass, the radius of the red giant is 3.35×10^{12} cm

At later frame, we added a second 'point mass' to be the secondary, the location of the second mass is 3.409×10^{12} cm from the center of the right giant

A rough comparison between the runs is shown is the following table

run#	accretion	box size	Damping	refinement region	softening length
143	No	8×10^{13} cm	No	Large	$2.4R_\odot \rightarrow 1.2R_\odot$
132	Yes	4×10^{13} cm	Yes	Small	$2.4R_\odot$

1. Accretion determines if we allow matter to 'accrete' on the point mass
2. Damping: The damping term is added to the entire box. When turned on, Some time are allowed in the simulation to cancel slight fluctuation in the box (especially inside the red giant) by adding a damping term to wherever the system has an unexpected fluctuation.
3. refinement region: The radius where the simulation grid are smaller, indicating the simulation being more precise (and more time-consuming)
4. softening length: The length where we manually change the effect of gravity by setting the gravitational force inside the softening length radius to be a certain value rather than calculated using Newton's law. We used 5 softening lengths in this simulation. Such manipulation will help us to avoid the effect that a particle get scattered too much if it get too close to the point mass. In addition to the softening length, some methods are used at the boundary to ensure energy conservation during spiral-in

2 Some Information About Method Used

I used VisIt and python to generate the frames.

The Pseudocolor slices are cut along the y axis. The reason being two stars can be seem together in the same figure.

Run 132 and run 143 has different box sizes, so to produce a more direct comparison, the figures for run 143 has been cut into the same size as run 132.

The lineouts also have the box size problem. The way I used to compensate for this effect is to subtract every x-value for run 143 by 2×10^{13}, so the center of the box align with each other. When reporting the exact value, I reported the original data.

Two y-axis scales for each quantity was provided: One using linear scale, the other use Log scale. Linear Scale for pressure and density has been zoomed into the star because the exterior of the most inner region is barely noticeable in the linear plot but can be compared easily using the log plots.

I reported the maximum values for pressure and density. For Mach, there are multiple peaks, and the patterns can be easily seen from the figures.

3 Pseudocolor

3.1 Pressure Pseudocolor

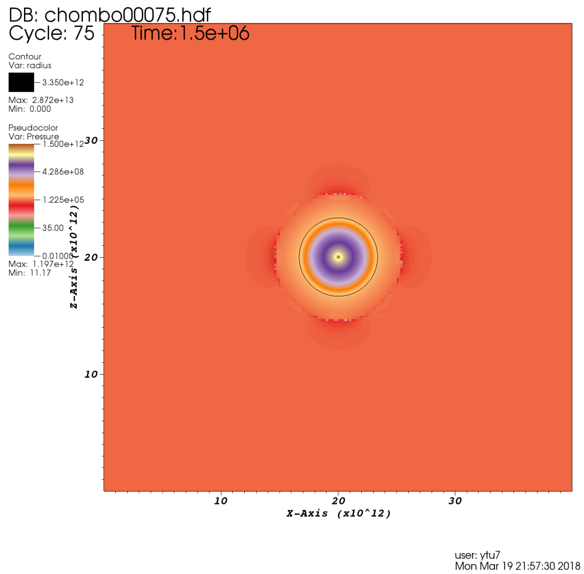


Figure 1: Pressure 132 frame 0

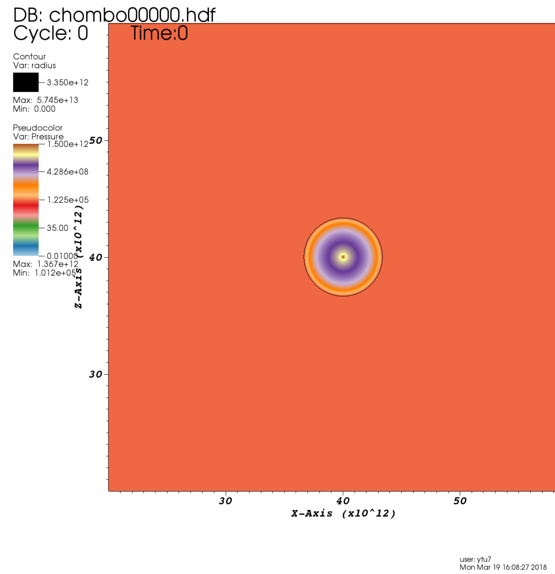


Figure 2: Pressure 143 frame 0

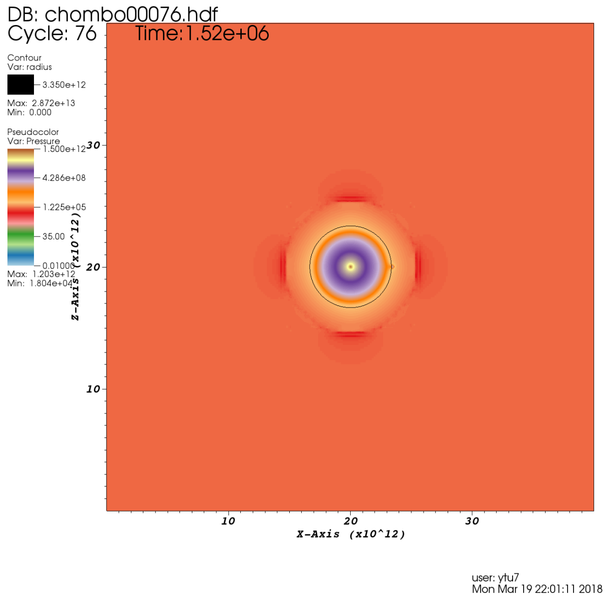


Figure 3: Pressure 132 frame 1

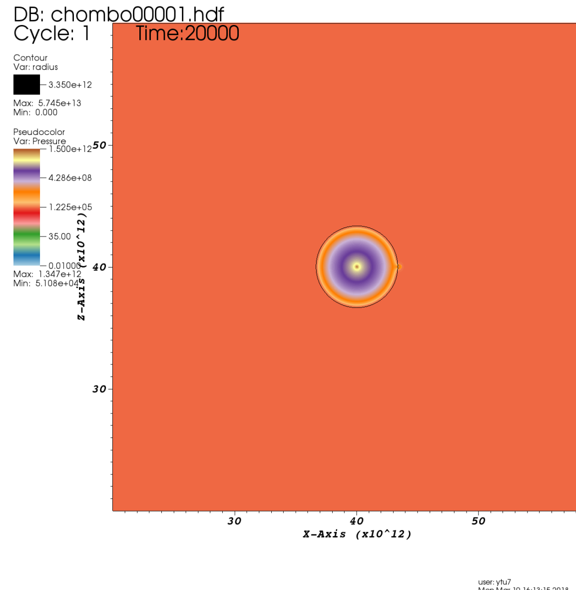


Figure 4: Pressure 143 frame 1

3.2 Mach Pseudocolor

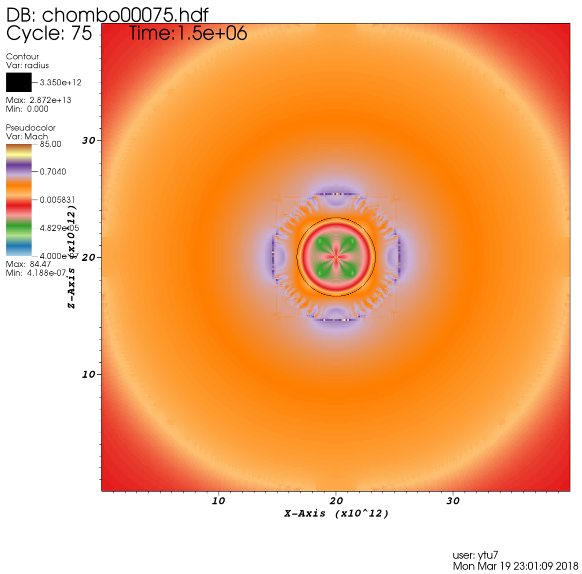


Figure 5: Mach 132 frame 0

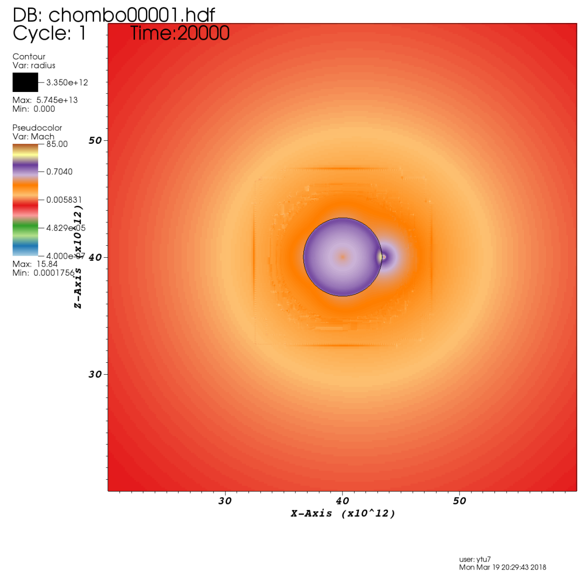


Figure 6: Mach 143 frame 0

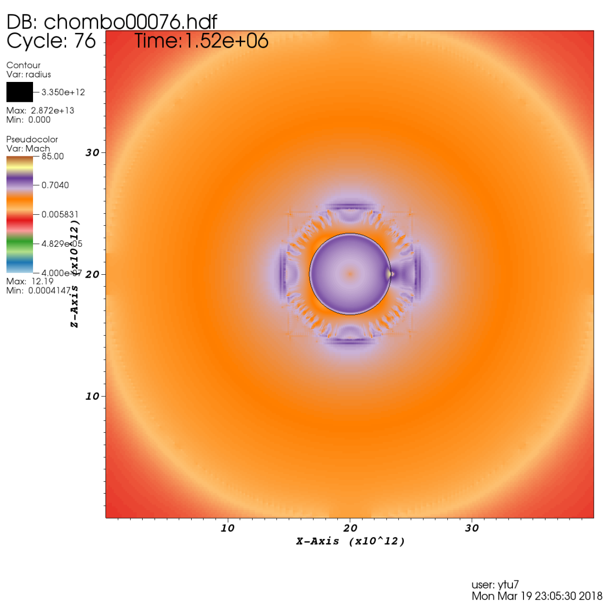


Figure 7: Mach 132 frame 1

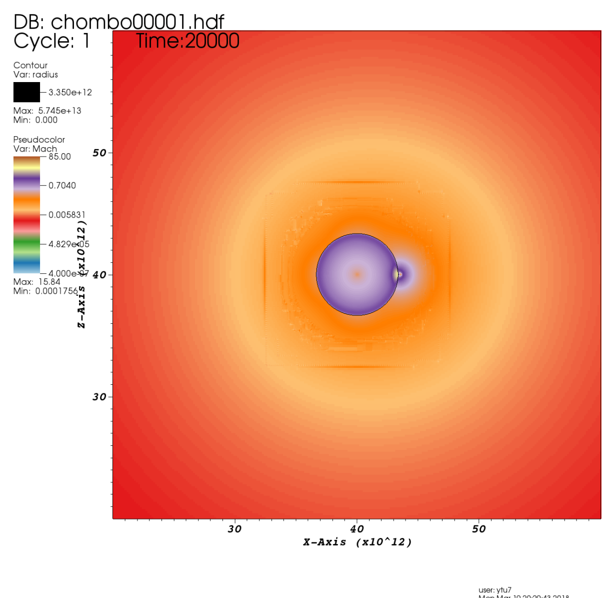


Figure 8: Mach 143 frame 1

3.3 Density (Rho) Pseudocolor

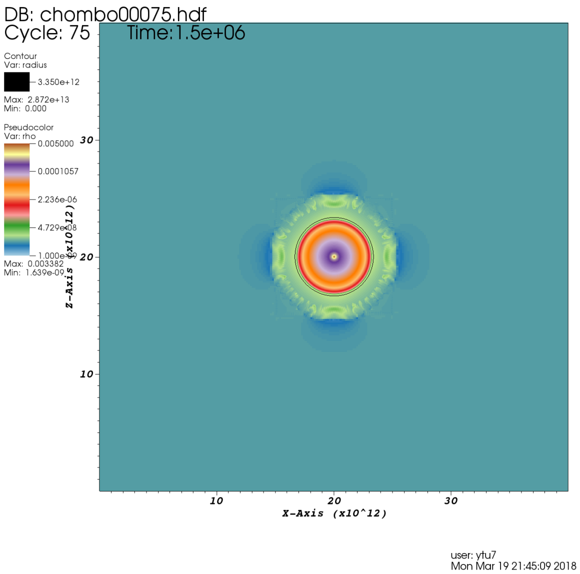


Figure 9: Density 132 frame 0

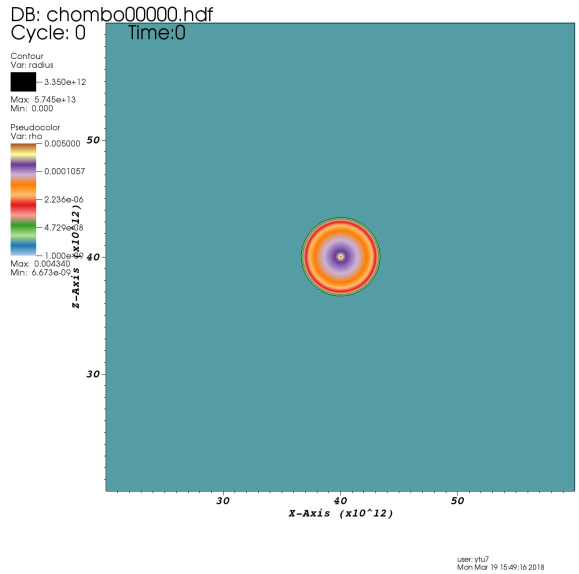


Figure 10: Density 143 frame 0

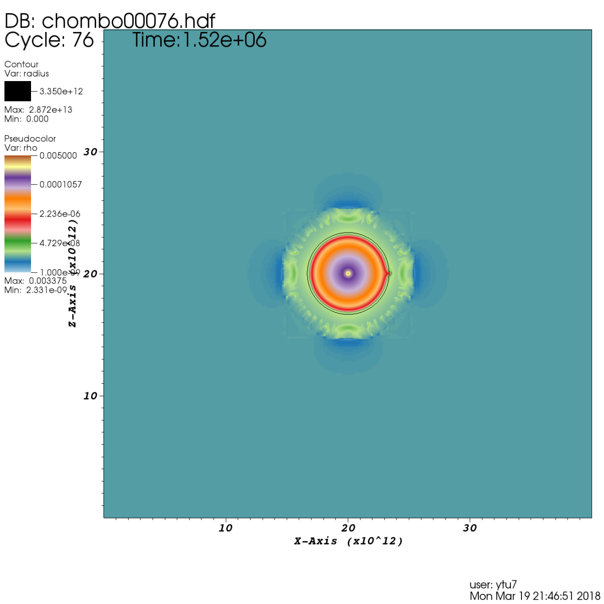


Figure 11: Density 132 frame 1

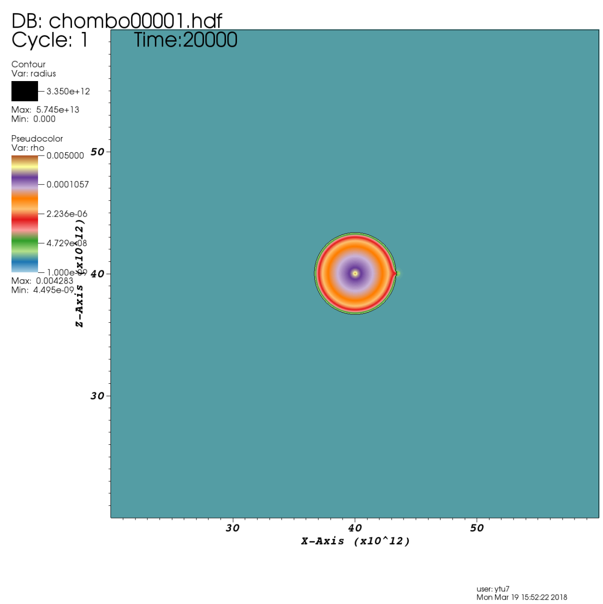
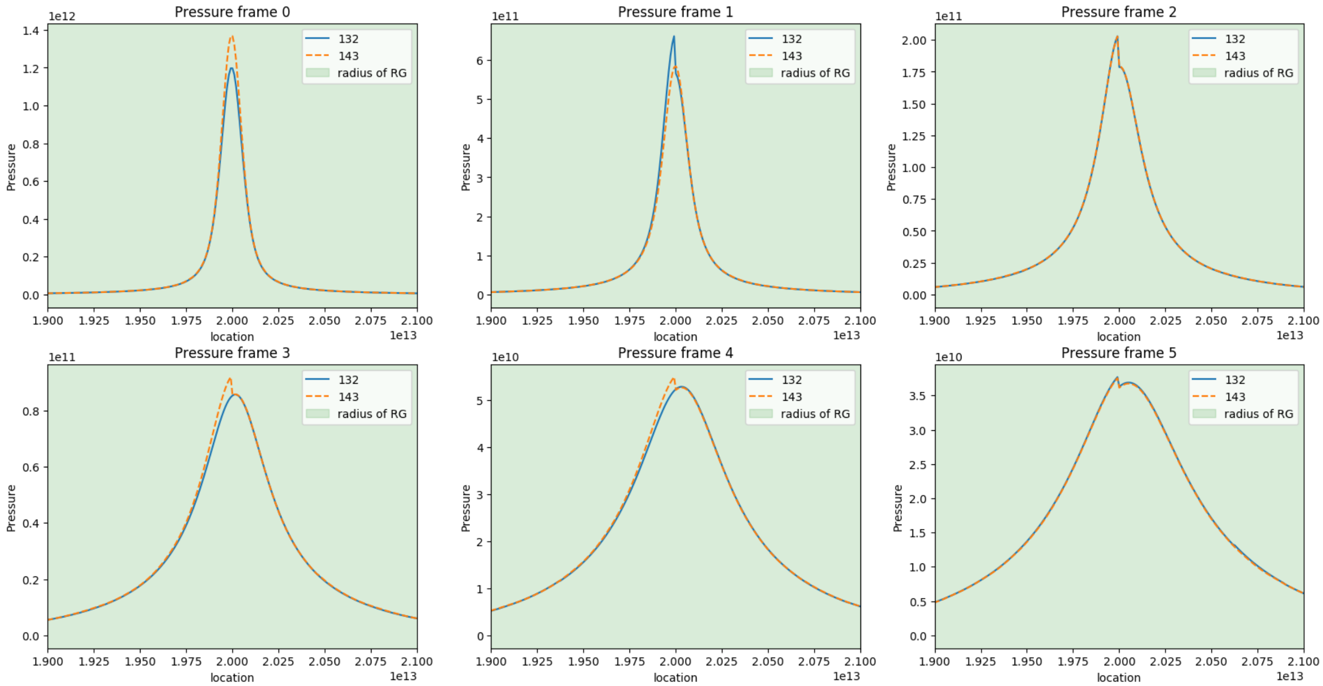
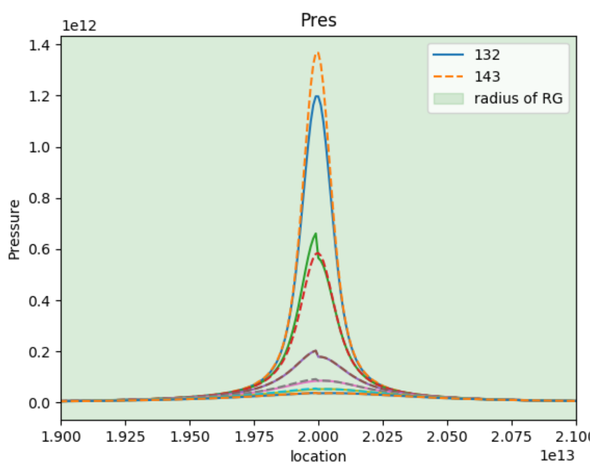


Figure 12: Density 143 frame 1

4 Linear Line outs

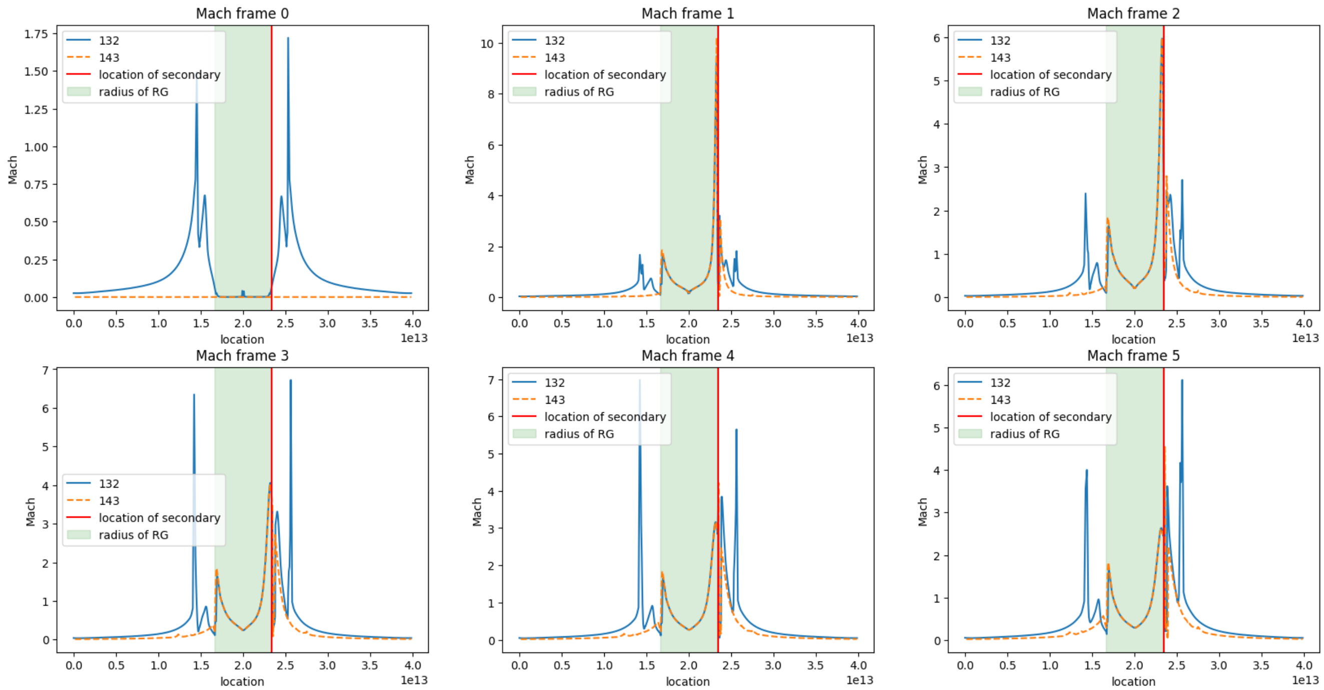
4.1 Pressure Line outs

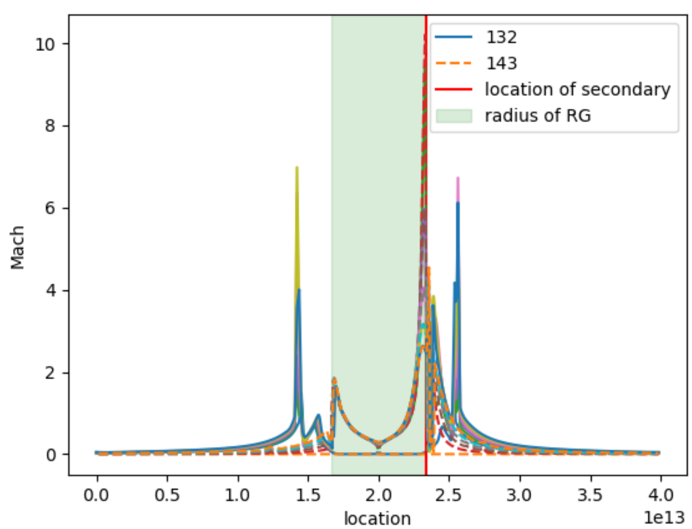




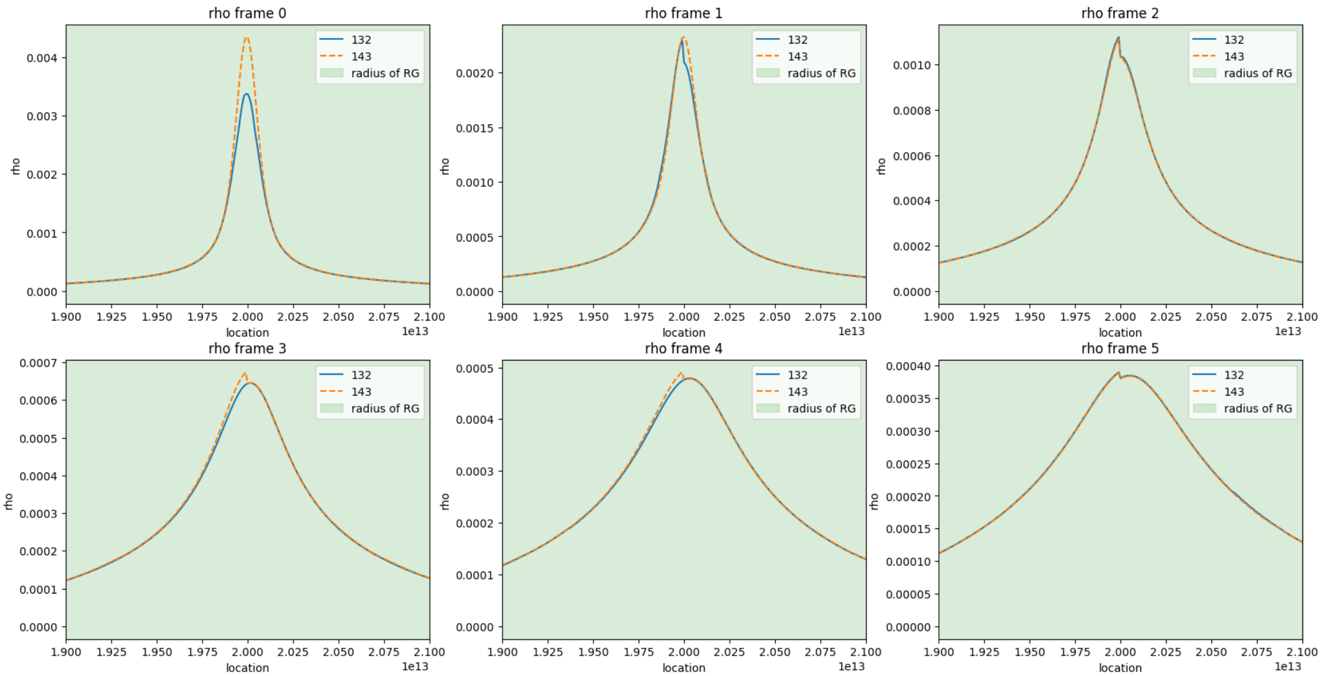
	Run #	location	pressure value
Frame 0:	132	2×10^{13}	1.20×10^{12}
	143	4×10^{13}	1.37×10^{12}
Frame 1:	132	2×10^{13}	6.60×10^{12}
	143	4.0010×10^{13}	5.84×10^{12}
Frame 2:	132	2×10^{13}	2.03×10^{11}
	143	4×10^{13}	2.03×10^{11}
Frame 3:	132	2.003×10^{13}	8.56×10^{11}
	143	4×10^{13}	9.19×10^{11}
Frame 4:	132	2.0039×10^{13}	5.28×10^{10}
	143	4×10^{13}	5.49×10^{10}
Frame 5:	132	2×10^{13}	3.77×10^{10}
	143	4×10^{13}	3.75×10^{10}

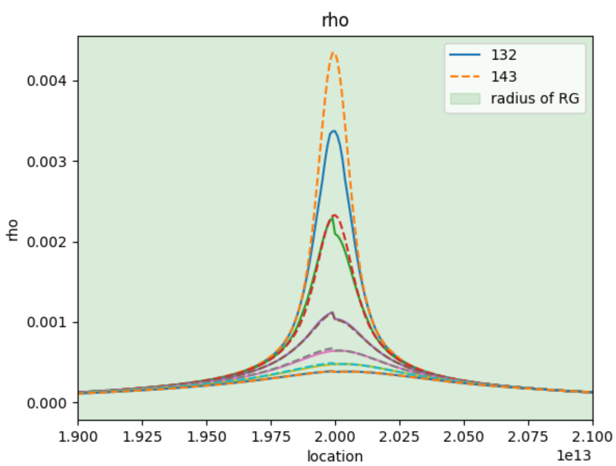
4.2 Mach Line outs





4.3 Rho Line outs





	Run #	location	rho value
Frame 0:	132	2.0010×10^{13}	0.0034
	143	4×10^{13}	0.0043
Frame 1:	132	2×10^{13}	0.0023
	143	4.00098×10^{13}	0.0023
Frame 2:	132	2×10^{13}	0.0011
	143	4×10^{13}	0.0011
Frame 3:	132	2.0029×10^{13}	0.00065
	143	4×10^{13}	0.00067
Frame 4:	132	2.0039×10^{13}	0.00048
	143	4×10^{13}	0.00049
Frame 5:	132	2×10^{13}	0.00039
	143	4×10^{13}	0.00039

5 Log Line outs

5.1 Pressure Line outs (Log scale)

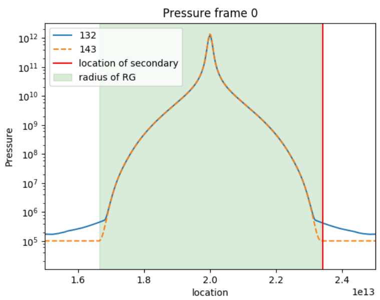


Figure 13: Pressure frame 0

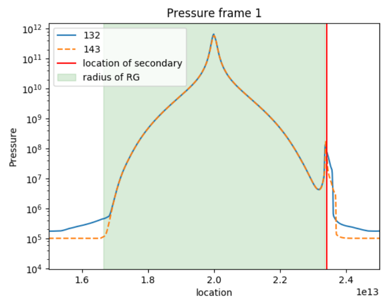


Figure 14: Pressure frame 1

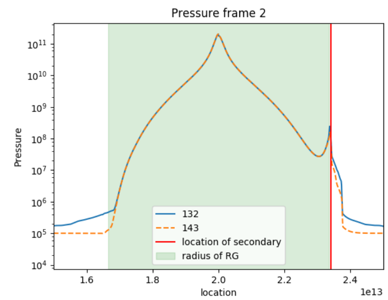


Figure 15: Pressure frame 2

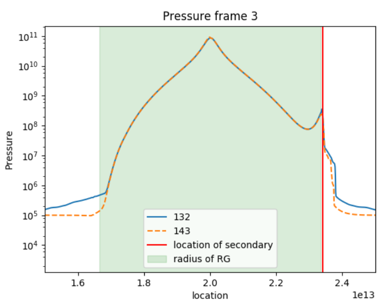


Figure 16: Pressure frame 3

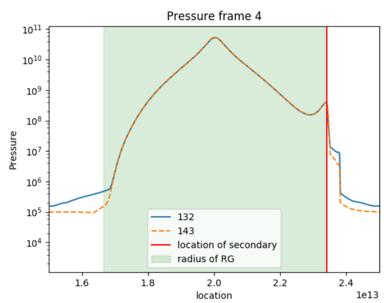


Figure 17: Pressure frame 4

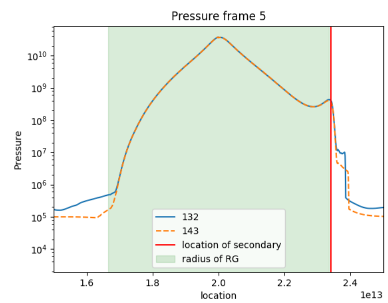
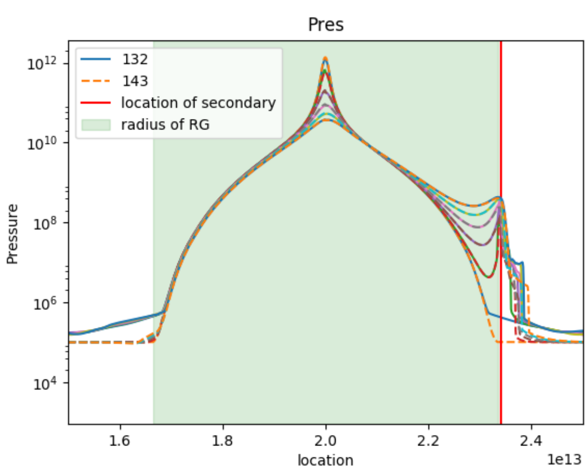


Figure 18: Pressure frame 5



	Run #	location	pressure value
Frame 0:	132	2×10^{13}	1.20×10^{12}
	143	4×10^{13}	1.37×10^{12}
Frame 1:	132	2×10^{13}	6.60×10^{12}
	143	4.0010×10^{13}	5.84×10^{12}
Frame 2:	132	2×10^{13}	2.03×10^{11}
	143	4×10^{13}	2.03×10^{11}
Frame 3:	132	2.003×10^{13}	8.56×10^{11}
	143	4×10^{13}	9.19×10^{11}
Frame 4:	132	2.0039×10^{13}	5.28×10^{10}
	143	4×10^{13}	5.49×10^{10}
Frame 5:	132	2×10^{13}	3.77×10^{10}
	143	4×10^{13}	3.75×10^{10}

5.2 Mach Line outs (Log scale)

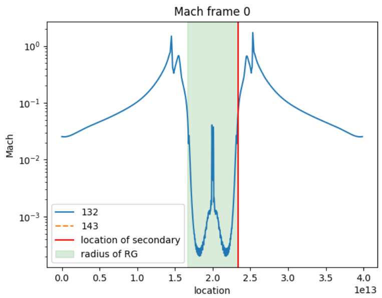


Figure 19: Mach frame 0

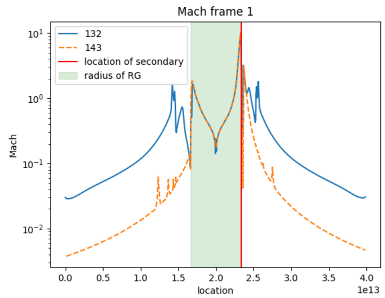


Figure 20: Mach frame 1

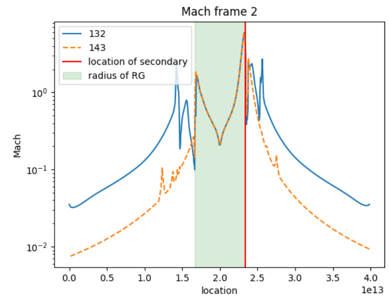


Figure 21: Mach frame 2

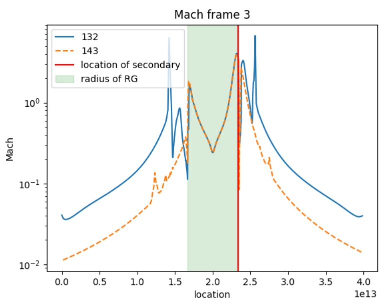


Figure 22: Mach frame 3

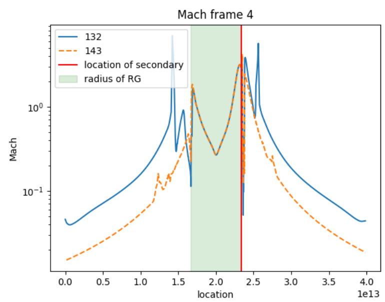


Figure 23: Mach frame 4

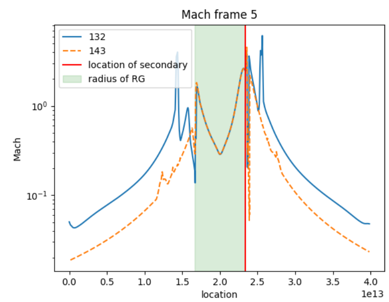
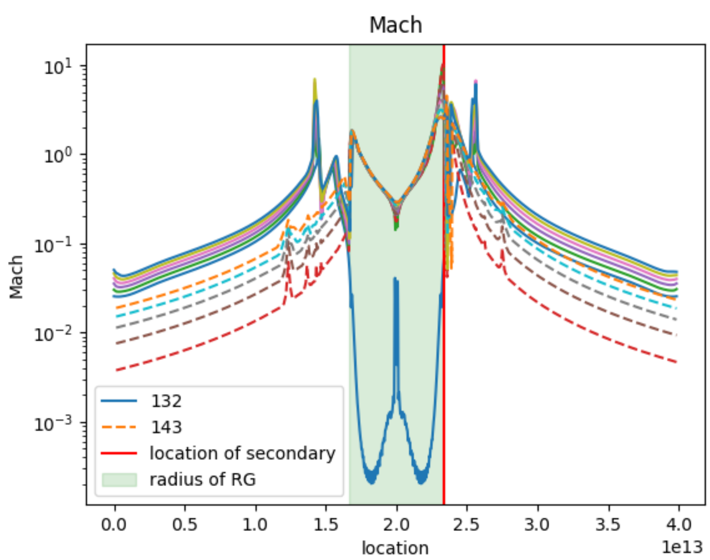


Figure 24: Mach frame 5



5.3 Rho Line outs (Log scale)

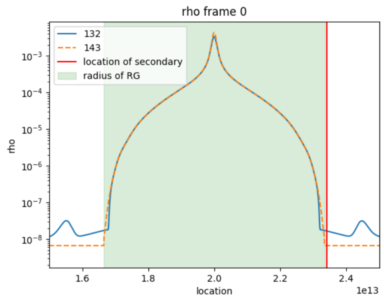


Figure 25: Rho frame 0

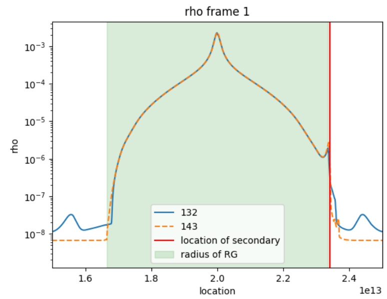


Figure 26: Rho frame 1

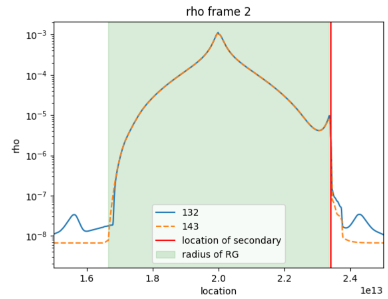


Figure 27: Rho frame 2

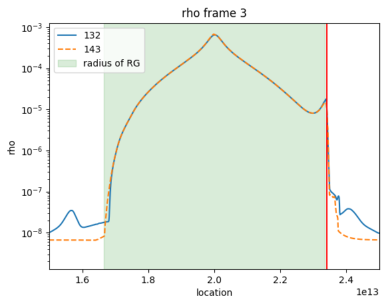


Figure 28: Rho frame 3

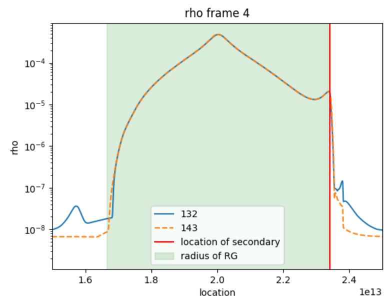


Figure 29: Rho frame 4

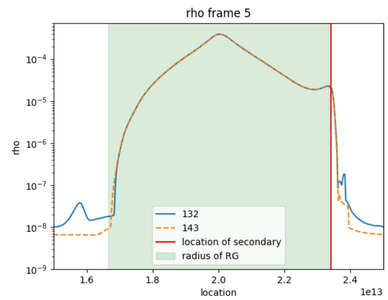
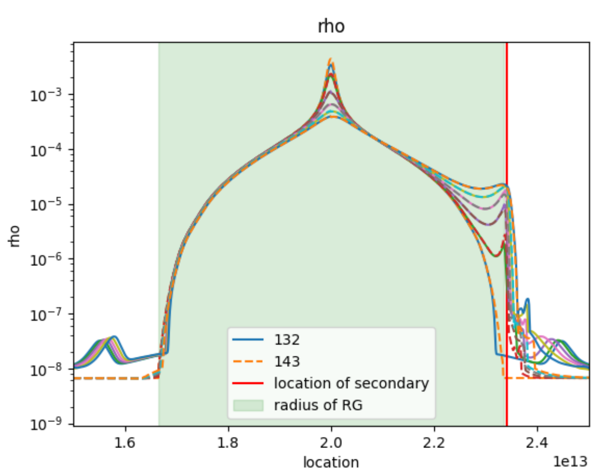


Figure 30: Rho frame 5



	Run #	location	rho value
Frame 0:	132	2.0010×10^{13}	0.0034
	143	4×10^{13}	0.0043
Frame 1:	132	2×10^{13}	0.0023
	143	4.00098×10^{13}	0.0023
Frame 2:	132	2×10^{13}	0.0011
	143	4×10^{13}	0.0011
Frame 3:	132	2.0029×10^{13}	0.00065
	143	4×10^{13}	0.00067
Frame 4:	132	2.0039×10^{13}	0.00048
	143	4×10^{13}	0.00049
Frame 5:	132	2×10^{13}	0.00039
	143	4×10^{13}	0.00039

6 Maximum Scatter Point Plots

6.1 Pressure Maximum Scatter Point Plots

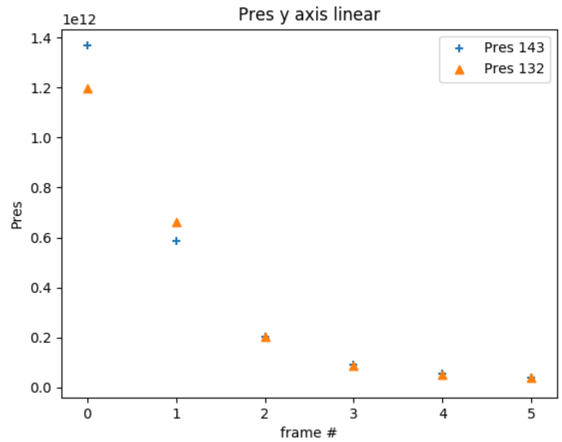


Figure 31: Pressure y-axis linear

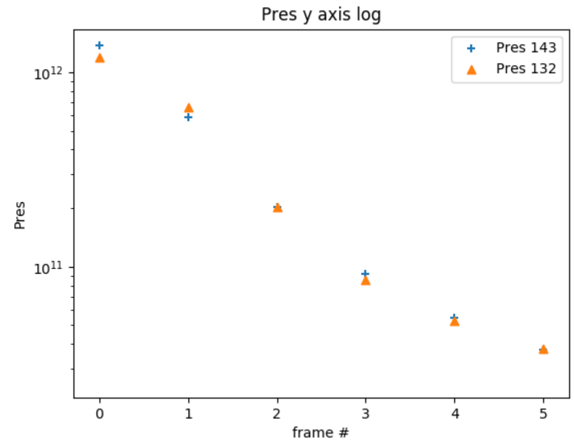


Figure 32: Pressure y-axis log

6.2 rho Maximum Scatter Point Plots

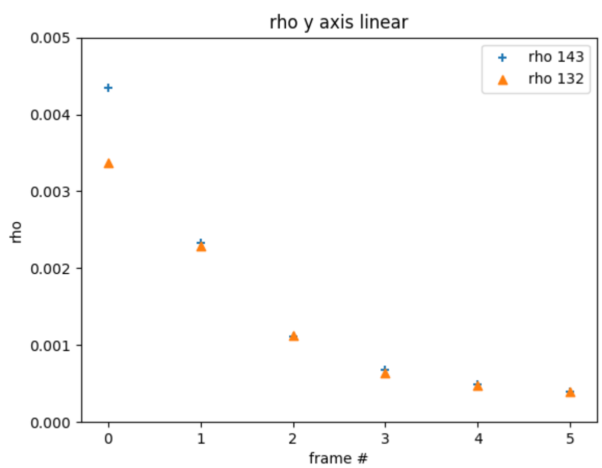


Figure 33: rho y-axis linear

7 Percent difference between Maximum Plots

The following plots plot $\frac{\max_{143} - \max_{132}}{\max_{143}}$ versus frame number

7.1 Percent difference between Maximum Pressure

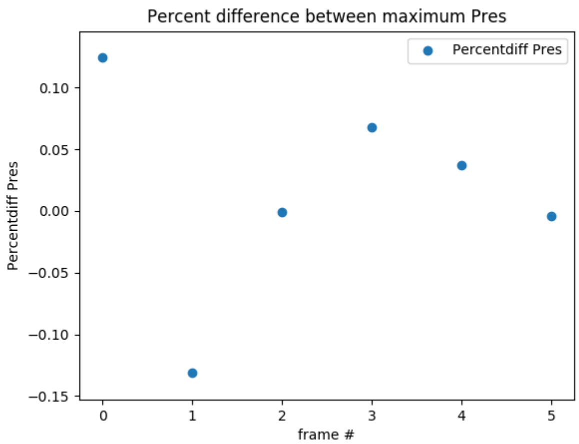


Figure 34: Pressure y-axis linear

7.2 Percent difference between Maximum rho

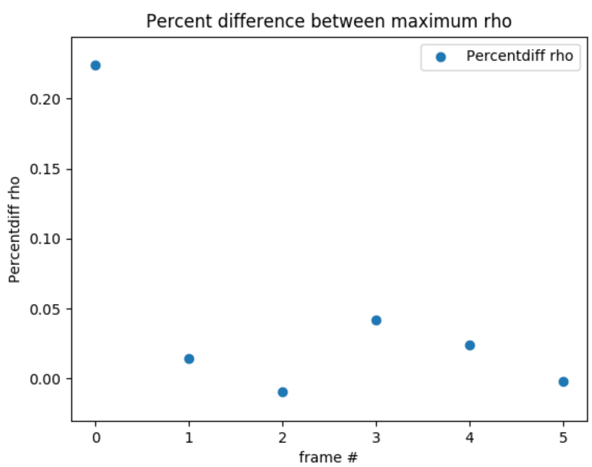


Figure 35: rho y-axis linear