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Common Envelope Evolution Involving a Jet

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1 INTRODUCTION

This document summarize runs simulating CEE involving a red giant branch (RGB) primary star and a secondary companion star that is launching a bipolar jet. The runs that will be performed with the remainder of the allocation (about 75,000 SUs) are detailed in Table 1.

Amy: With the remainder of our current XSEDE allocation, we plan to study the effect of introducing a jet around the secondary in the CEE simulations. Planned runs are listed in Table 1. *Amy: Fig. 1 shows the separation between the primary core and secondary for a comparison between* the fiducial run of Chamandy et al. (2018); Chamandy et al. (2019) *Amy: and a run including a strong jet around the secondary.* Both runs end at $t = 40\,\mathrm{d}$ to allow us to see the jet progress dynamically after it enters denser regions. *Amy: The strong jet is chosen at a high mass loss rate of $\dot{M}/\dot{M}_{\rm Edd} = 1000$. The proposed runs 1 and 2 test the the effect of a wider separation when the secondary starts orbiting at 1.5 the radii of the RGB envelope. Both runs last for a duration of $80\,\mathrm{d}$, or 400 frames to allow time for the evolution of a wider binary. Run 3 tests a more physical jet with $\dot{M}/\dot{M}_{\rm Edd} = 1$, which can be compared with the previous strong jet runs. In Runs 4 and 5, the simulation is restarted from first periastron, or a late time through the fiducial run.*

We will also explore the dependence of jet activity on secondary mass. Since we have already performed a simulation identical to the fiducial run but with a secondary mass equal to $0.5\,\mathrm{M}_\odot$ instead of $1\,\mathrm{M}_\odot$, we will restart with a jet from snapshots of that simulation.

1.0.1 Common Envelope Evolution Involving a Jet

We are presently modeling CEE with a jet emanating from the companion star (represented by a point particle in the simulation owing to its relatively small size as compared to the primary giant star). Thus far, we have performed one complete jet run. The orbital evolution is shown in Figure 1.

2 CE JET ON STAMPEDE2 - STATUS UPDATE FROM OCTOBER 28, 2019

2.1

Submit job, run_dir_002_second, linked to source code `/HOME/astrobear_1008`.
Recompiled to use scrambler.f90 to restart every 5 frames.

2.2

Submit job, run_dir_003_ptclbuff, linked to code `/HOME/astrobear_1014_C`.
Recompiled to use scrambler.f90 to restart every 2 frames. Restart from frame 11 (till frame 46, on refinement 4d12). This run has particle buffer around P1, AMR=4. Check mesh in VisIT!

- NOTE: no particle buffer version has 8 frames, in run_003_run_dir, linked to `/HOME/astrobear_1008` as well. Run completed last week, so not using scrambler restart feature. Need to check mesh in this version as well!!

2.3

The code with particle buffer
`astrobear_CEJet_Stampede2_1014_C`
is not committed to Git. Copy of the code is on both Bluehive and Stampede2.

REFERENCES

Chamandy L., et al., 2018, MNRAS, 480, 1898
Chamandy L., Tu Y., Blackman E. G., Carroll-Nellenback J., Frank A., Liu B., Nordhaus J., 2019, Monthly Notices of the Royal Astronomical Society, 486, 1070–1085

Table 1. Remaining simulation runs and projected node-hours assuming an average of 50 node-hours per frame. Quantities are: M_2: Mass of secondary; $\dot{M}/\dot{M}_{\rm Edd}$: Accretion rate relative to Eddington value for a $1\,{\rm R}_\odot$ main sequence, if a jet is present; *Initial separation*: Separation between primary and secondary at the beginning of the simulation; *Restart frame*: Frame at which the simulation is restarted from the fiducial RGB simulation or the AGB simulation with no jet; *SUs*: Projected number of service units (node hours); *Data*: Projected storage requirement for simulation output.

		M_2 ($M_\odot$)	$\dot{M}/\dot{M}_{\rm Edd}$ ($M_\odot$)	Initial separation ($R_\odot$)	Restart frame	Number of frames	SUs	Data (TB)
1	RGB+Jet	1	1000	73.5	0	400	20,000	20
2	RGB	1	–	73.5	0	400	20,000	20
3	RGB+Jet	1	1	49.0	0	200	10,000	10
4	RGB+Jet	1	1	$a(t_{\rm restart})$	50	150	7,500	7.5
5	RGB+Jet	1	1	$a(t_{\rm restart})$	150	50	2,500	2.5
6	RGB+Jet	1/2	1	49.0	0	200	10,000	10
Test runs and convergence studies						100	5,000	–
Totals						1500	75,000	70

Table 2. Status of the planned runs.

Model		M_2 ($M_\odot$)	$\dot{M}/\dot{M}_{\rm Edd}$ ($M_\odot$)	Initial separation ($R_\odot$)	Restart frame	End frame	Status	Ambient
0	RGB+Jet	1	1000	49.0	0	173	completed	high
1	RGB+Jet	1	1	73.5	0		to be submitted	low
2	RGB	1	–	73.5	0		to be submitted	low
3	RGB+Jet	1	1	49.0	0	142	completed	high
4	RGB+Jet	1	1	$a(t_{\rm restart})$	50		working on the code	high
5	RGB+Jet	1	1	$a(t_{\rm restart})$	150		working on the code	high
6	RGB+Jet	1/2	1	49.0	0	73	completed	high
7	RGB+Jet	1	10	$a(t_{\rm restart})$	50		working on the code	high
8	RGB+Jet	1	10	$a(t_{\rm restart})$	150		working on the code	high

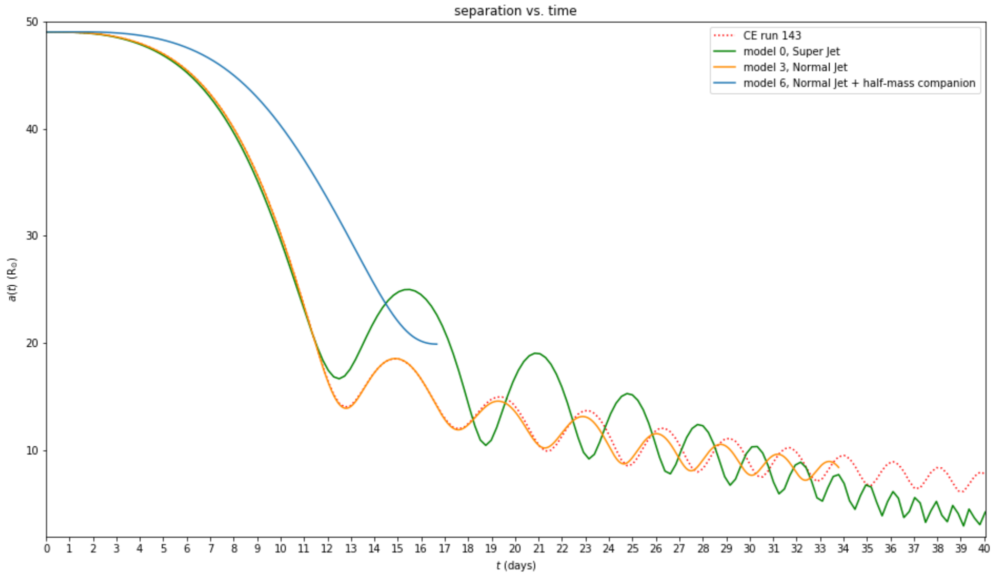

Figure 1. Separation between primary core and secondary for runs with (green) and without (orange) jet. The jagged red line shows the radius of the volume refined at the highest AMR level. The jet run has initial separation at 49 $R_\odot$ and mass loss rate at 2 $M_\odot$/year. This figure is preliminary and the curves will become smoother once the full data set (which has higher time-sampling) is incorporated.

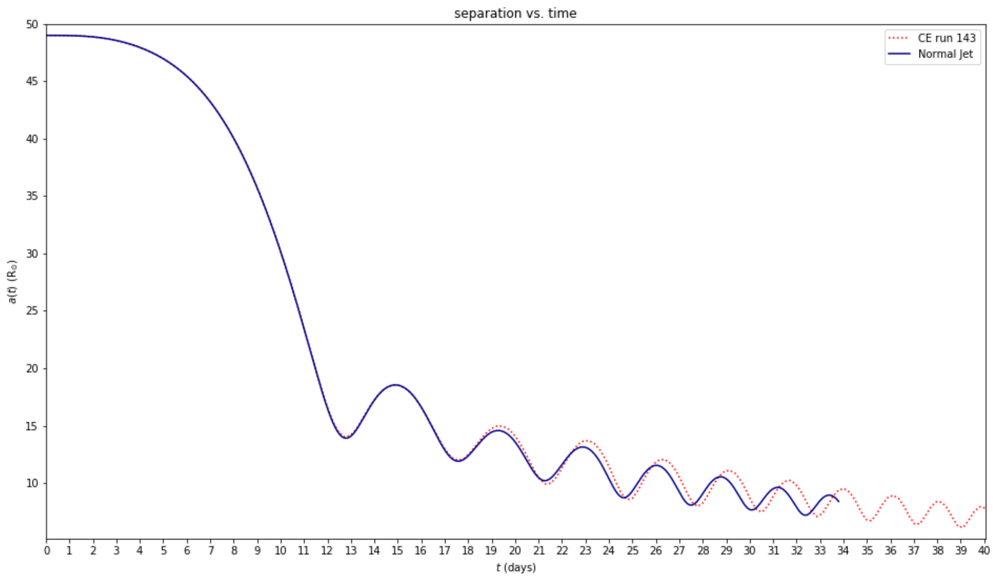

Figure 2. Compare CE run 143 with Jet model 3.

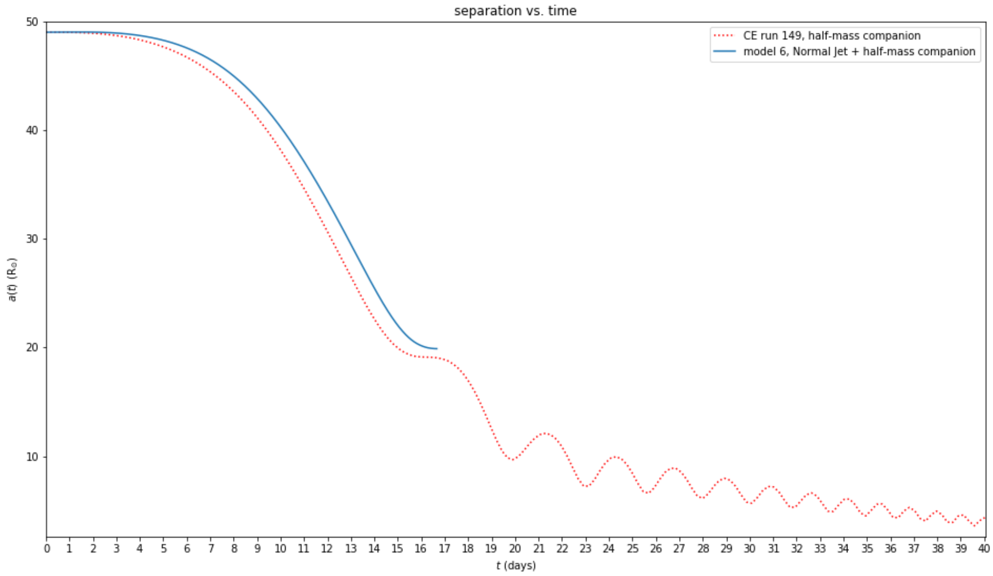

Figure 3. Compare CE run 149 with Jet model 6.