Nucleosynthesis in White Dwarf Collisions: FLASH versus SNSPH

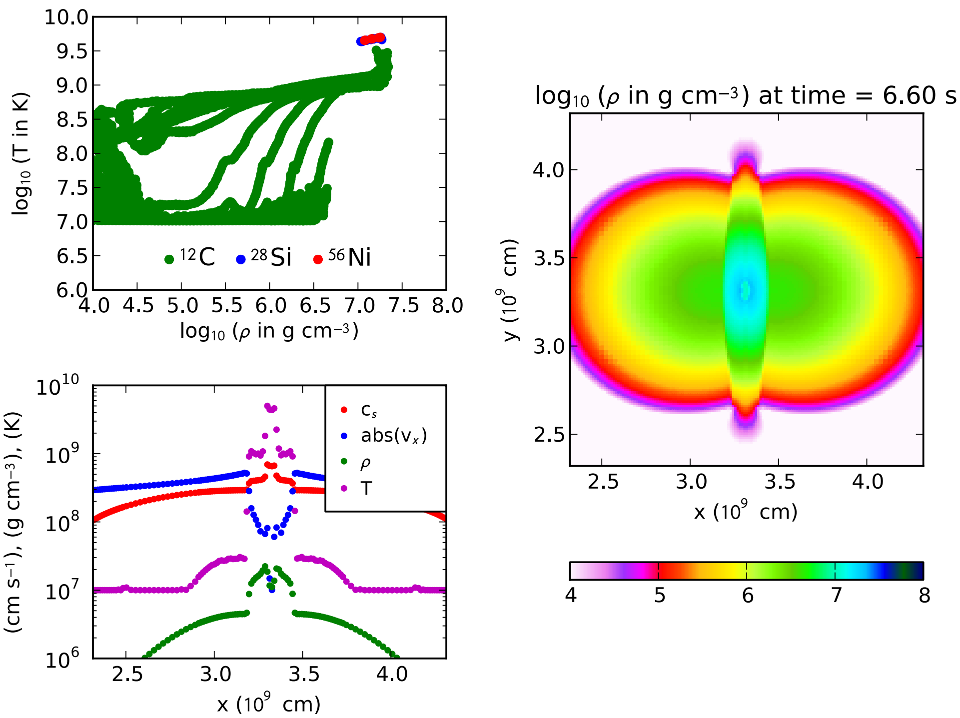

Fig 1 - Images of the 3D 2×0.64 collision at t=6.60 s, immediately after ignition.

Top-left: Locations of all cells in the density-temperature plane. The color of the points represents the primary composition of the corresponding cell: green for ^{12}C, blue for ^{28}Si, and red for ^{56}Ni. The data are binned into 100 equally spaced bins in logarithmic density and temperature.

Bottom-left: Temperature, x-velocity, density, and sound speed along the x-axis.

Right: A 2D slice of density in the x-y plane through z=3.32×109 cm, which is half the maximum z value.

We explore zero impact parameter 3D collisions of white dwarfs using the Eulerian adaptive grid code FLASH for 0.64-0.64 $M_\odot$ and 0.81-0.81 $M_\odot$ pairings spanning a range of maximum spatial resolution from 5.2×10^7 to 1.2×10^7 cm. We find that the 2×0.64 head-on collision produces 0.32 $M_\odot$ of ^{56}Ni, and the 2×0.81 head-on collision produces 0.39 $M_\odot$ of ^{56}Ni. Both simulations also yield ~0.2 $M_\odot$ of unburned ^{12}C+^{16}O. A parallel study carried out using a Lagrangian particle code SNSPH for the same configurations show larger 56Ni production, 0.48 $M_\odot$ of ^{56}Ni for the 2×0.64 collision and 0.84 $M_\odot$ of ^{56}Ni for the 2×0.81 collision. How energy is transported in FLASH and SNSPH is the most likely cause of the differences in ^{56}Ni production.

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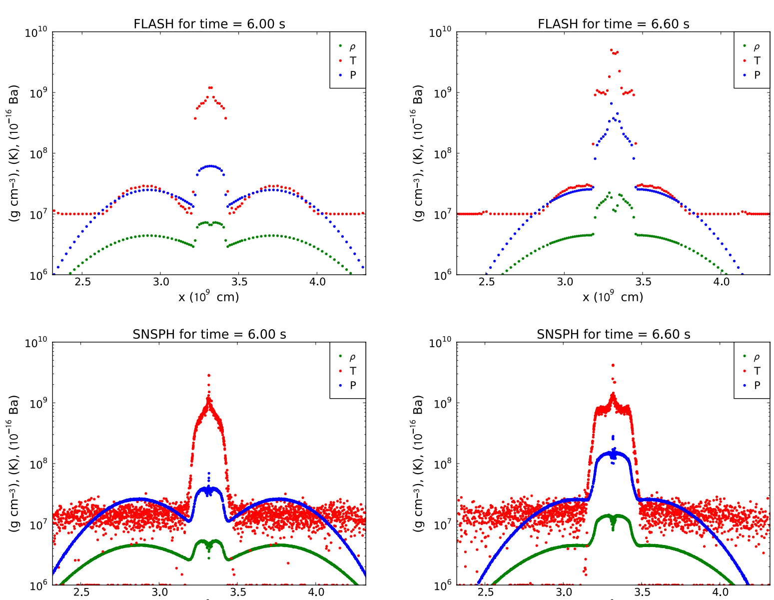

Fig. 2 - Comparison of the pressure (blue), density (green), and temperature (red) in FLASH (top) and SNSPH (bottom) for the 2×0.64 case. At t=6.00 s (left), differences in the pre-ignition conditions in FLASH and SNSPH are evident. At 6.60 s (right) the FLASH collision has launched a detonation while the SNSPH collision has yet to detonate.