^{56}Ni Production in Collisions of two White Dwarfs

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SNIa : Standard Paradigm

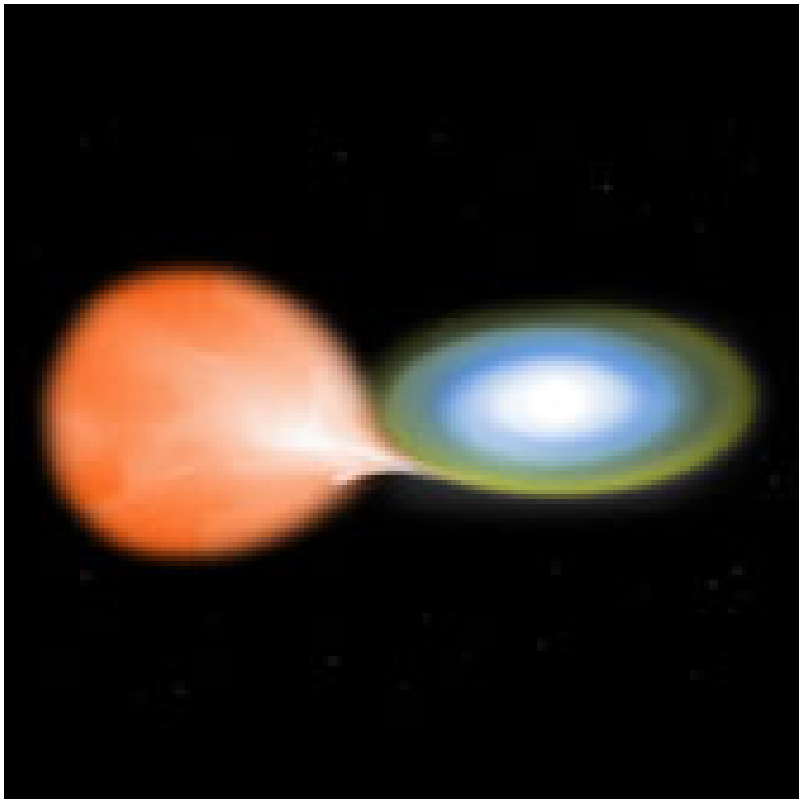

Illustration of Accreting White Dwarf

Credit: (Illustration) NASA/CXC/M.Weiss

- Chandrasekhar mass-limited WD accretes mass from binary companion
- SNIa powered by $^{56}\mathrm{Ni} \rightarrow {}^{56}\mathrm{Co} \rightarrow {}^{56}\mathrm{Fe}$
- Typical SNIa produce 0.5-0.9 $M_{\odot}$ of $^{56}\mathrm{Ni}$

Atypical SNIa

- **Overluminous SNIa:** **1.2-1.7** $M_\odot$ ^{56}**Ni** $\longrightarrow$ SN2003fg, SN2006gz, SN2007if, SN2009dc
- **Sub-luminous SNIa:** $\sim$ **0.1** $M_\odot$ ^{56}**Ni** $\longrightarrow$ SN1991bg, SN2005dm, SN2005bl

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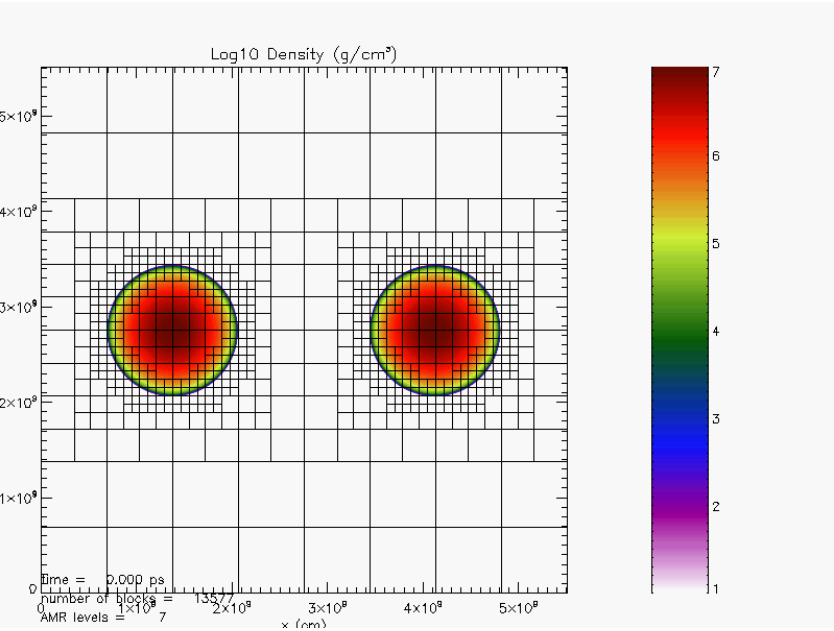
Proposal

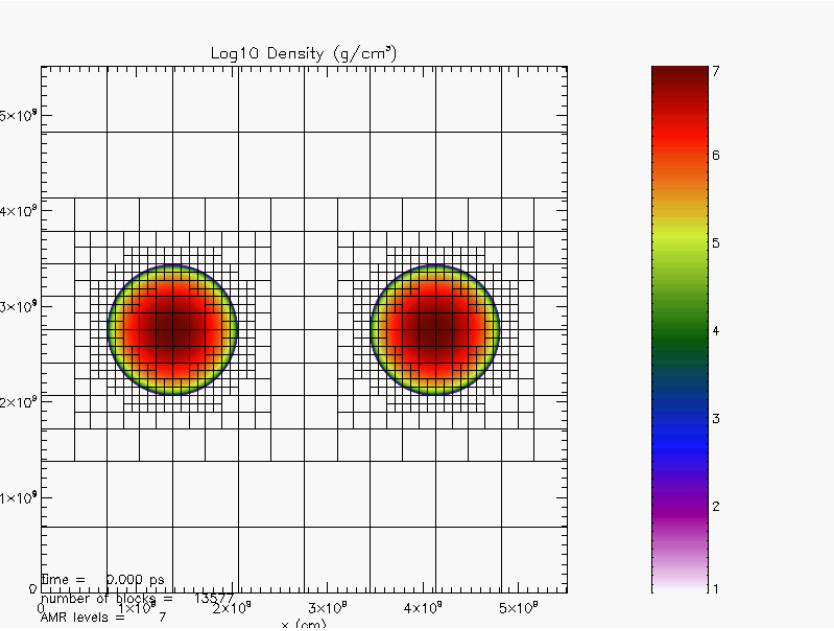
We investigate a double-degenerate (white dwarf collision) scenario as a possible progenitor system for these atypical SNIa

Simulations-Numerical Methods



- CODE: FLASH (Fryxell et al 2000)
- 3D Eulerian hydro
- Grid: Adaptive mesh refinement
- Gravity solver: Poisson multigrid
- Nuclear burner: 13-isotope alpha-chain network

Simulations-Setup and Initial Conditions



- 3D Cartesian box (L=8 WD radii)
- Composition:
  50 %Carbon - 50 % Oxygen
- Impact parameters:
  b = 0, 1, 2 WD radii
- Masses: 0.5 - 0.9 $M_{\odot}$

FLASH movie: 0.6+0.6 head on collision

0.6+0.9 head on collision

Results and Future Work

- Preliminary results indicate 0.0-0.9 $M_{\odot}$ ^{56}Ni.
- Ni yields are consistently lower than those obtained from SNSPH for same initial conditions
- Modify nuclear burner in FLASH to handle higher WD masses ($> 1\ M_{\odot}$)
- Investigate WD mergers
- Obtain theoretical lightcurves based on our simulations

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Take home message:

The double-degenerate scenario appears to be promising as a candidate of sub- and overluminous SNIa.
This scenario can also produce nickel in the same range as typical SNIa!

Detonation Structure: Comparison with SNSPH