

Numerical simulations of the interstellar medium

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April 6, 2011

Place in the galaxy

Hydrodynamical local box simulation

- ▶ $1.024 \times 1.024 \times 2.240 \text{ kpc}^3$
- ▶ $256 \times 256 \times 560$ mesh
- ▶ $\text{grav}(z) \sim \Sigma(M_{\odot} DM)$
(Kuijken & Gilmore 1989)
- ▶ SN Type I & Type II
- ▶ Differential rotation

Modelling supernova remnants

- ▶ (Ostriker & McKee 1988) \sim high resolution
- ▶ Sedov-Taylor \sim Snowplough \sim (Cioffi et al. 1998)
- ▶ Shocks \sim over-heating/cooling

Supernova growth rates

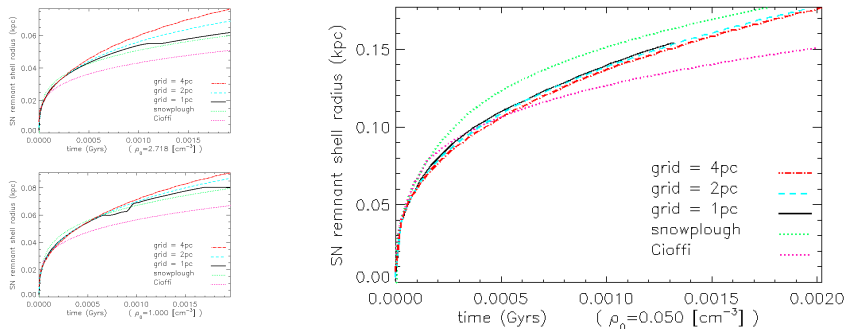


Figure: Plots of SN remnant shell radius over time. Panels for ambient density 2.71 , 1 and 0.05 cm^{-3} respectively. Each include grid resolution of 4 pc (red), 2 pc (light blue) and 1 pc (black). The snowplough (green) and Cioffi result (pink) are shown for comparison.

Supernova 1D slice profiles

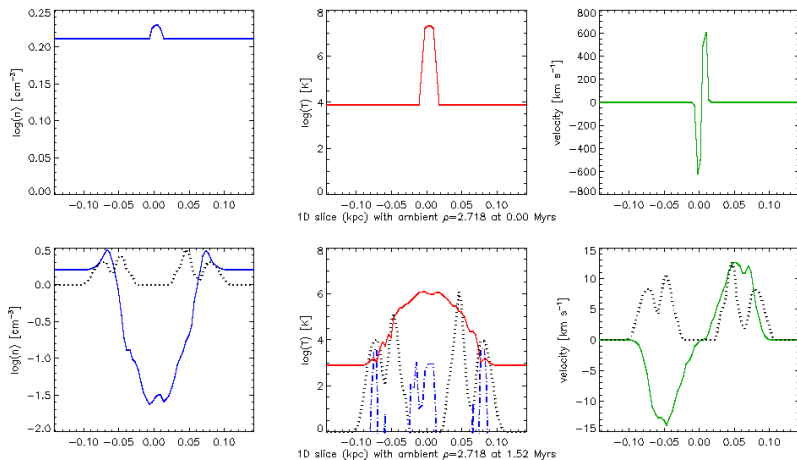


Figure: 1D slices through the SN remnant origin. Top: initial profiles, bottom: after 1.5 Myrs. Panels left to right: log density, log temperature and velocity along slice. Shock profile (dotted). Centre panel: log cooling (blue).

Scales and physics - comparing models

- ▶ Star formation (Balsara et al. 2001)
- ▶ Self gravity (Li et al. 2005)
- ▶ Galactic wind, fountain (de Avillez & Breitschwerdt 2005)
- ▶ Spiral arms

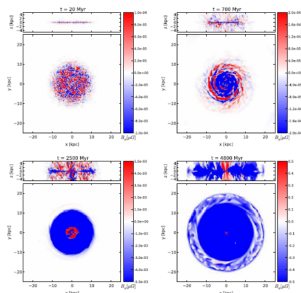


Figure: (Hanasz et al. 2004)

Cooling functions

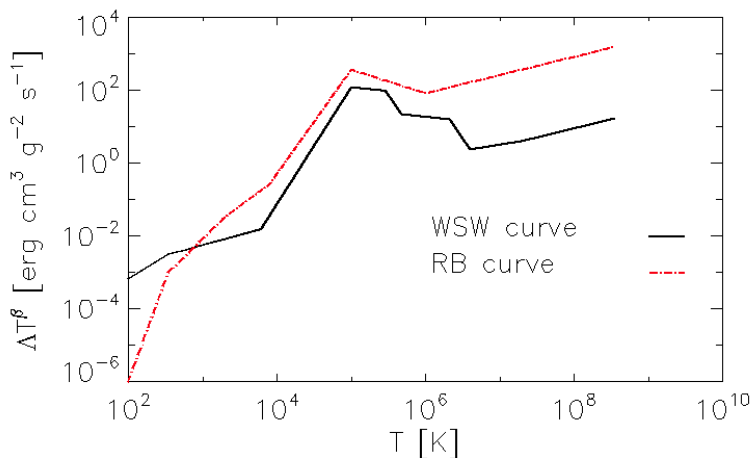


Figure: Cooling curves WSW derived from (Wolfire et al. 1995) up to $\simeq 10^5$ K and (Sarazin & White 1987) above $\simeq 10^5$ K; RB derived from (Rosen et al. 1993).

Volume filling factors

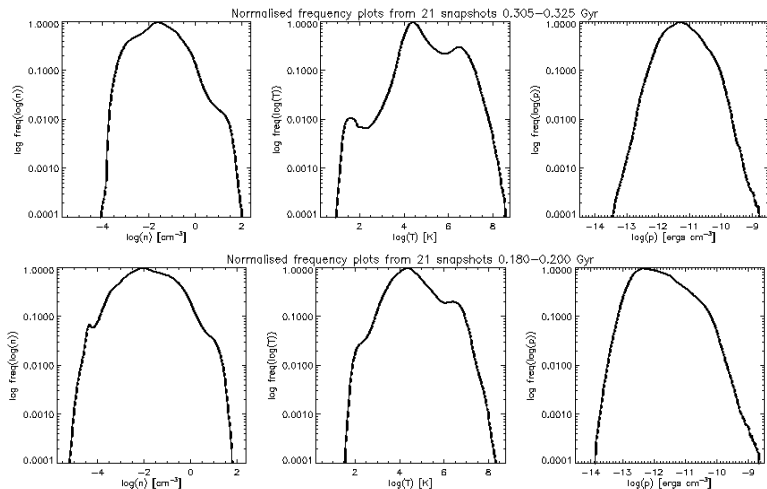


Figure: Normalized log freq distributions for $\log n \text{ cm}^{-3}$ (left panel), $\log T \text{ K}$ (mid panel) and $\log P \text{ erg cm}^{-2}$ (right panel). 21 snapshots spanning 20 Myr. Three phase ISM clearly reproduced top WSW cooling: peaks $\simeq 100$, 10^4 and 10^7 K. Lower panels: RB cooling.

Temperature fill (z)

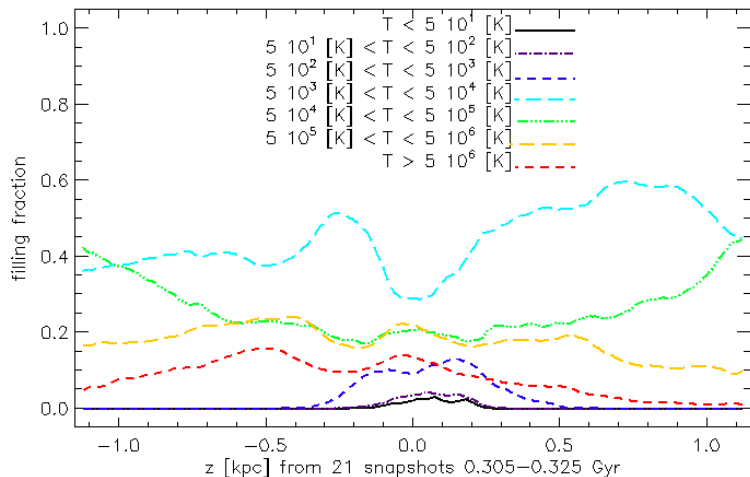


Figure: Temperature volume filling factors by height

Horizontal averages time series

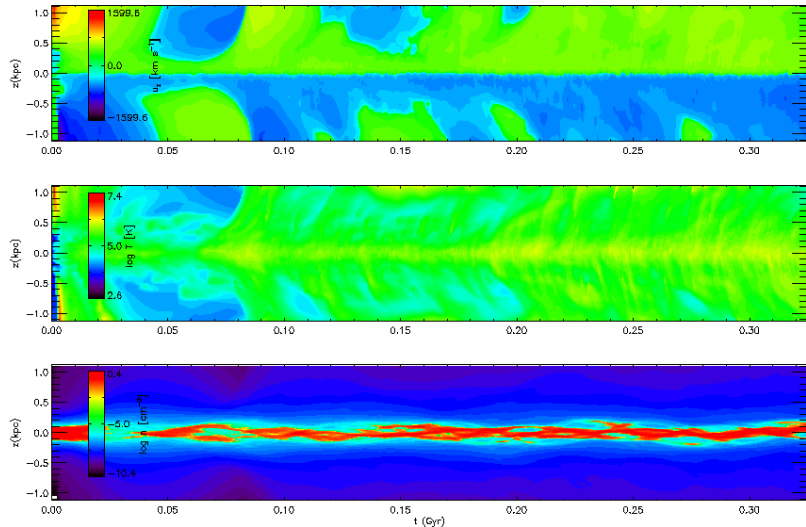













Figure: Horizontal volume averages U_z [km s^{-1}] (top), $\log T$ [K] (middle) $\log \rho$ [cm^{-3}] (bottom) against time [Gyrs].

MHD mini box simulation

Comparing MHD

- ▶ Ideal MHD -
magnetic reconnection
(Mac Low et al. 2005)
- ▶ Differential rotation
(Gressel et al. 2008)
- ▶ Mean \sim random field
dynamo
- ▶ Thermodynamic -
isothermal (Hanasz)

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