DISENTANGLING THE ROLE OF SUPERNOVAE, STELLAR WINDS AND IONISING RADIATION ON THE STRUCTURE OF GALACTIC DISCS

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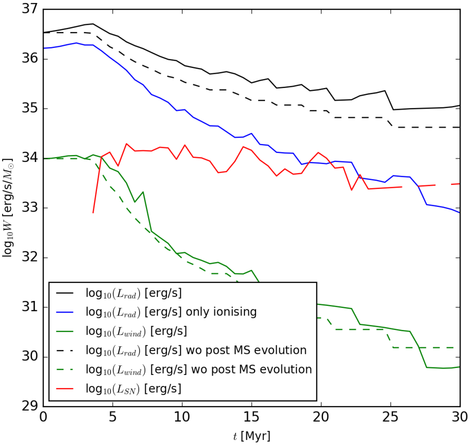
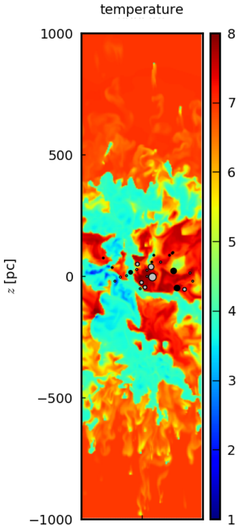
The energy budget



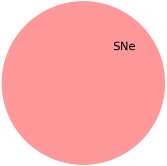
- ionising radiation and winds (early feedback), sharp drop after $t \sim 5 - 10\,\mathrm{Myr}$
- SNe starting after $\simeq 3\,\mathrm{Myr}$; they have approximately constant rate
- ionising radiation has smaller coupling efficiency (by factor of $\sim 0.1 - 0.01$ than winds or SNe)

The initial conditions

- box of side lengths 500 $\mathrm{pc} \times 500\,\mathrm{pc} \times 10000\,\mathrm{pc}$ centered at the galactic disc
- resolution 4 pc
- surface density of gas $\Sigma = 10\,\mathrm{M}_\odot\,\mathrm{pc}^{-2}$
- self-consistent modelling of sink particle formation (star clusters) and their feedback
- star clusters populated by a realistic IMF, one SN per $120\,\mathrm{M}_\odot$ of the stellar population
- gravitational acceleration due to gas, sink particles, background stellar potential coupled to mixed BCs
- chemistry H, H^+, H_2, CO, C^+
- no magnetic field for now; spatially constant G_0; no galactic shear



Modelling stellar feedback



- SNe for $\rho > 10^{-24}\,\mathrm{g.cm^{-3}} \rightarrow$ momentum injection

- SNe for $\rho < 10^{-24}\,\mathrm{g.cm^{-3}} \rightarrow$ thermal energy injection
- SNe have always fixed radius
- Wind feedback by momentum injection
- Ionising radiation traced by TreeRay
- three thresholds for sink particle formation (implicit parameter; nonuniform SFR):
  $\rho = 2.0 \times 10^{-22}\,\mathrm{g.cm^{-3}}$,
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  $\rho = 2.0 \times 10^{-20}\,\mathrm{g.cm^{-3}} \rightarrow$ 24 simulations

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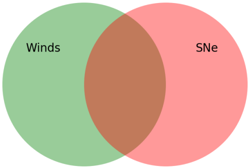

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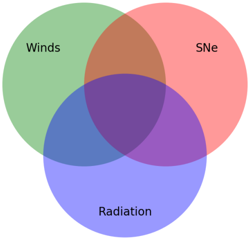

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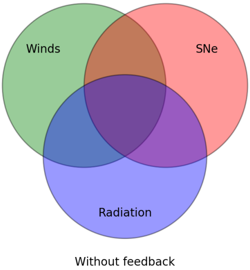

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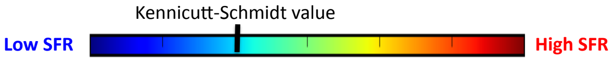
Overview of the SFR

- For 30 $M_\odot/\mathrm{kpc}^2/\mathrm{Myr}$ (Tammann+ 1994) $\rightarrow \sim$ 750 SNe per 100 Myr in the box



Dinnbier et al., in prep.

n_{sink} [cm^{-3}]	No FB	S	W	R	WR	SW	SR	SWR
10^3	10664 6	2263 8	7205 8	473 15	606 12	644 6	372 11	334 9
10^2	17141 24	2737 29	4965 49	398 50	610 45	1901 25	408 50	666 37
10^1	18316 45	5893 38	5691 71	2125 36	2467 39	3494 36	1423 23	1271 26

Mass in massive stars at t=100 Myr (upper number) — **Number of Sinks at t=100 Myr** (lower number)

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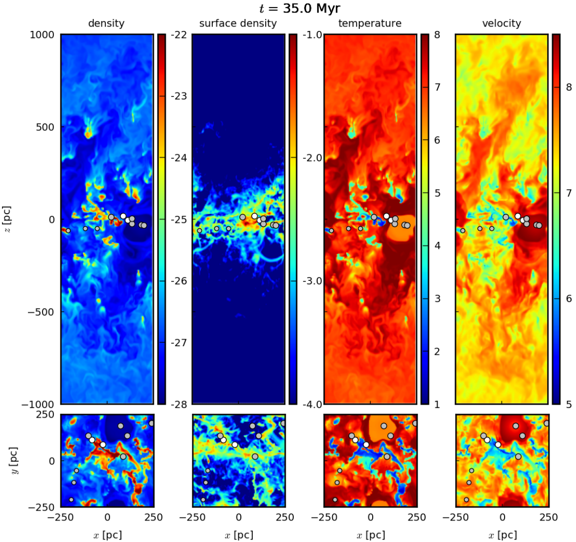
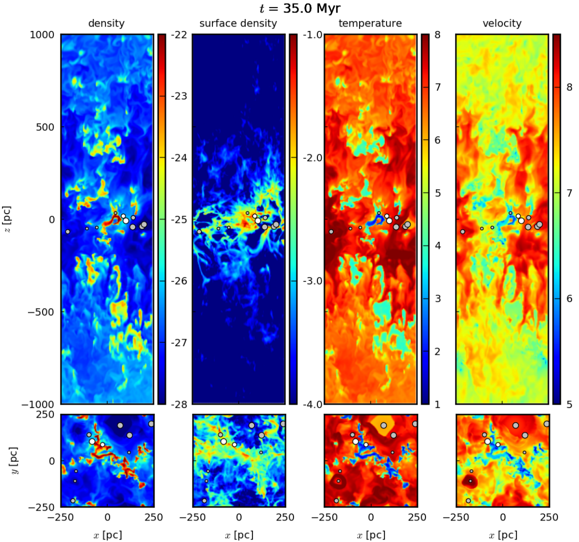
Mass in massive stars at t=100 Myr (upper number in each cell)

Number of Sinks at t=100 Myr (lower number in each cell)

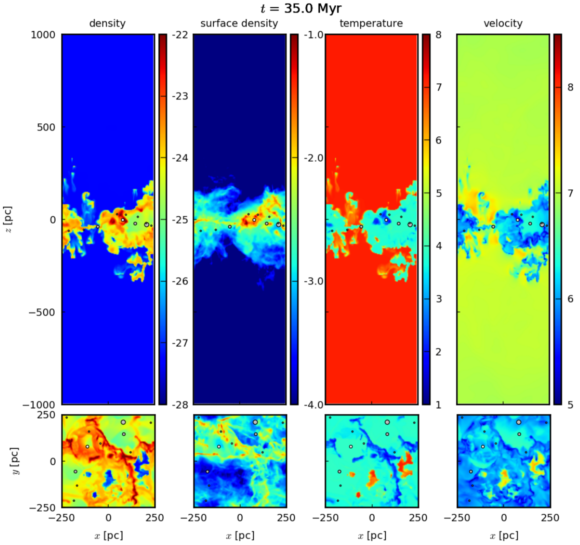
SNe feedback only



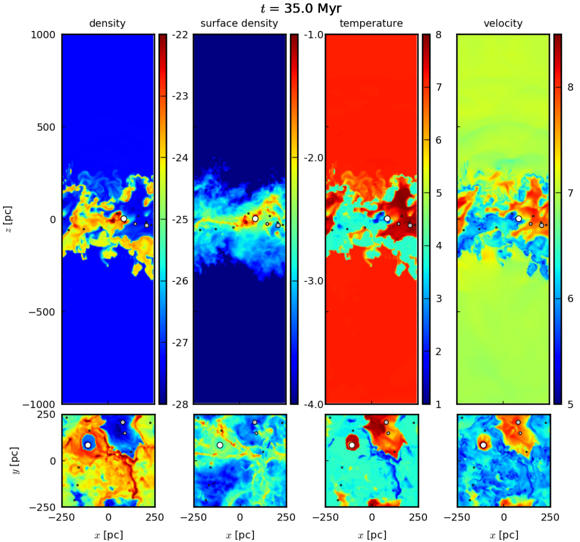
SNe and wind feedback



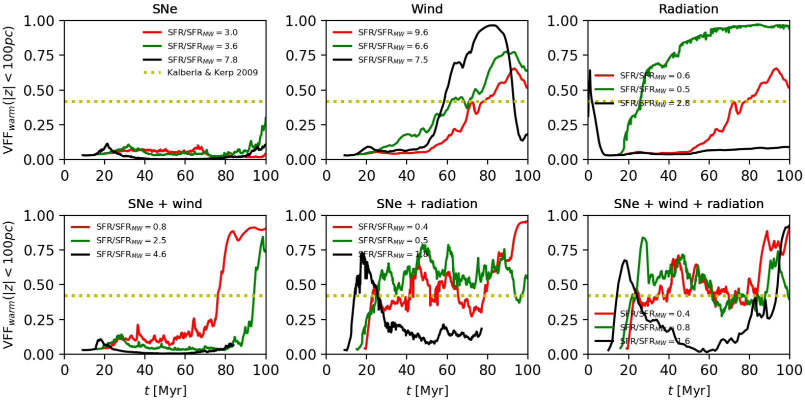
Ionising radiation only



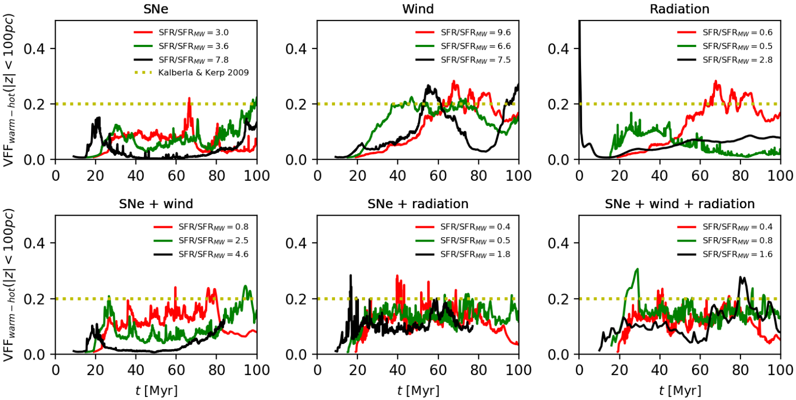
SNe, wind and ionising radiation



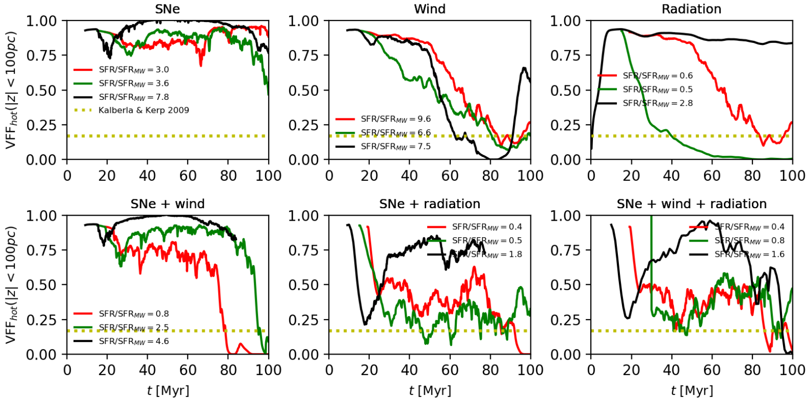
Volume filling fraction of the warm medium $(300\,\mathrm{K} < T < 1.0 \times 10^4\,\mathrm{K})$



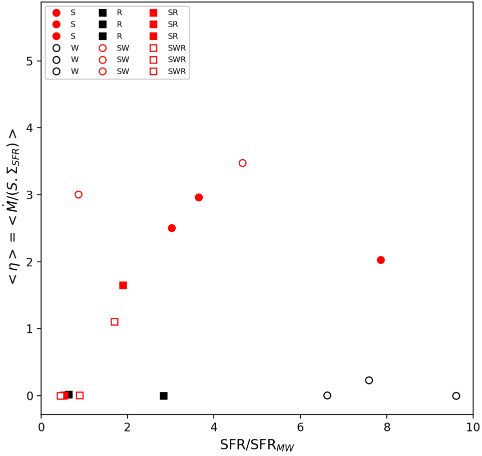
Volume filling fraction of the warm-hot medium $(1.0 \times 10^4\,\mathrm{K} < T < 3.0 \times 10^5\,\mathrm{K})$



Volume filling fraction of the hot medium $(3.0 \times 10^5\,\mathrm{K} < T)$



The mass loading factor



- SNe drive outflows
- winds are unable to drive strong outflows
- when acting together with SNe, ionising radiation tends to decrease mass loading

Conclusions

- Ionising radiation increases the volume filling factor of the warm phase and decreases the volume filling factor of the hot phase.
- When the ionising radiation is included, the values for the VFF are closer to the observed values than with SNe only $\rightarrow$ ionising radiation is likely to be important to properly model galactic discs.
- When included in self-consistent model of star formation, ionising radiation decreases the SFR substantially more than stellar winds.
- The role of stellar winds is subordinate to ionising radiation in setting the phases of the ISM, and regulating star formation.

Thank you for your attention