School of Physics and Astronomy

UNIVERSITY OF LEEDS

Stellar Wind Feedback in Massive Young Star Forming Regions

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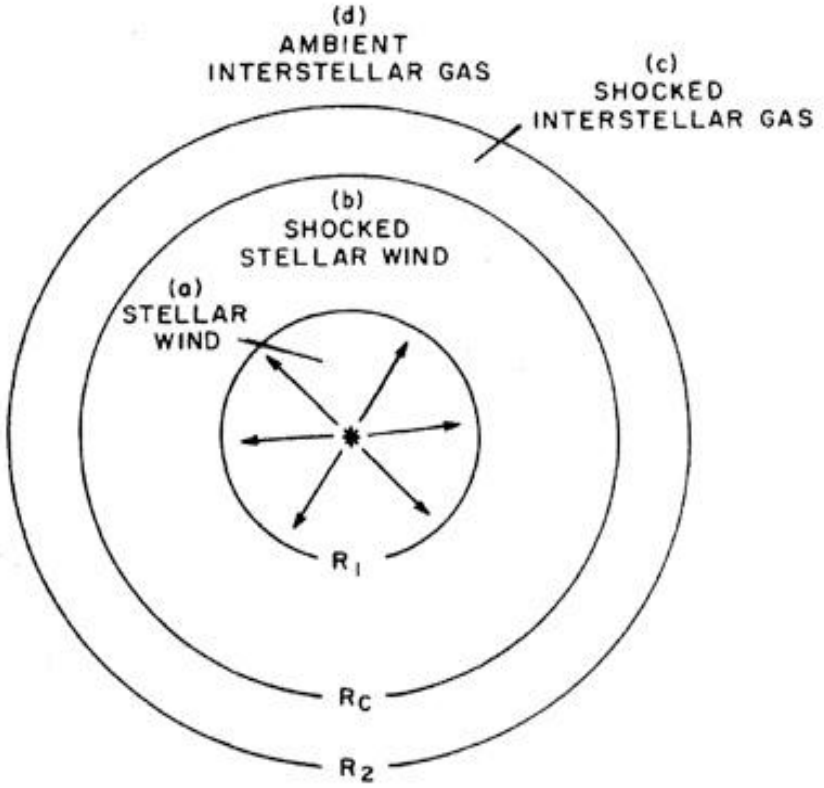
NGC 7635 – The Bubble Nebula

Structure of a bubble:

3 simplified models

- Castor et al. (1975)
- Chevalier & Clegg (1985)
- Harper-Clark & Murray (2009)



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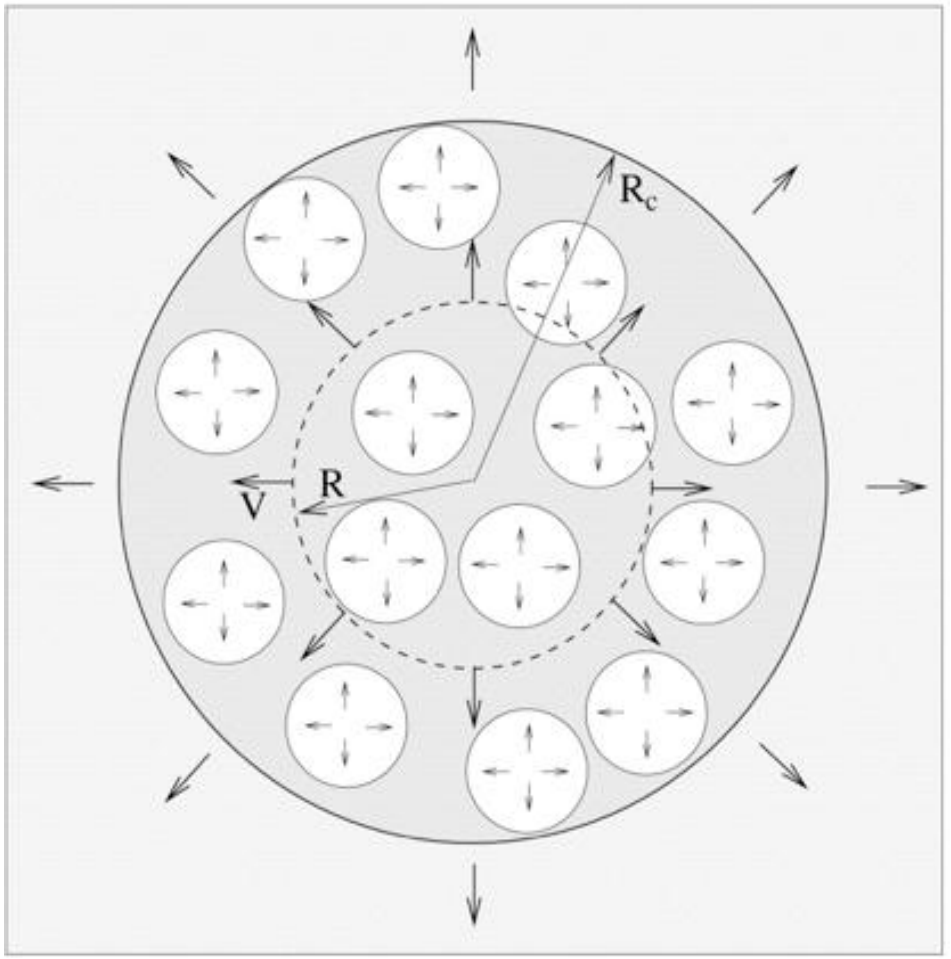

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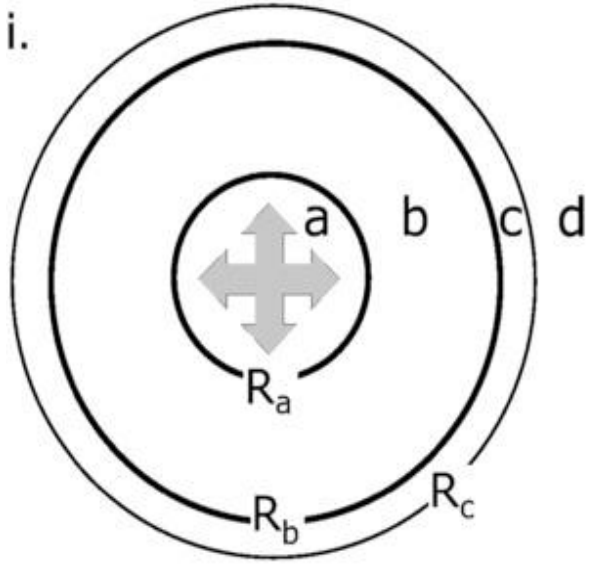
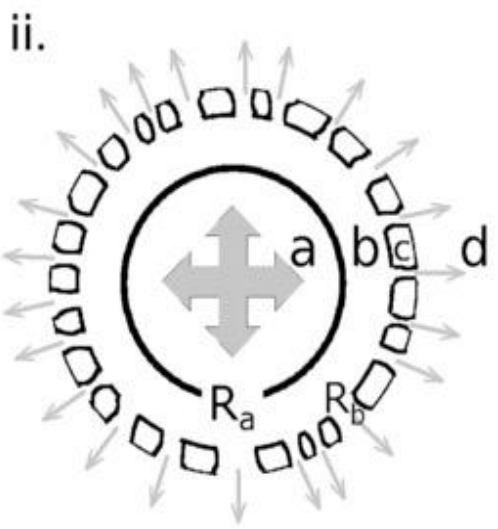
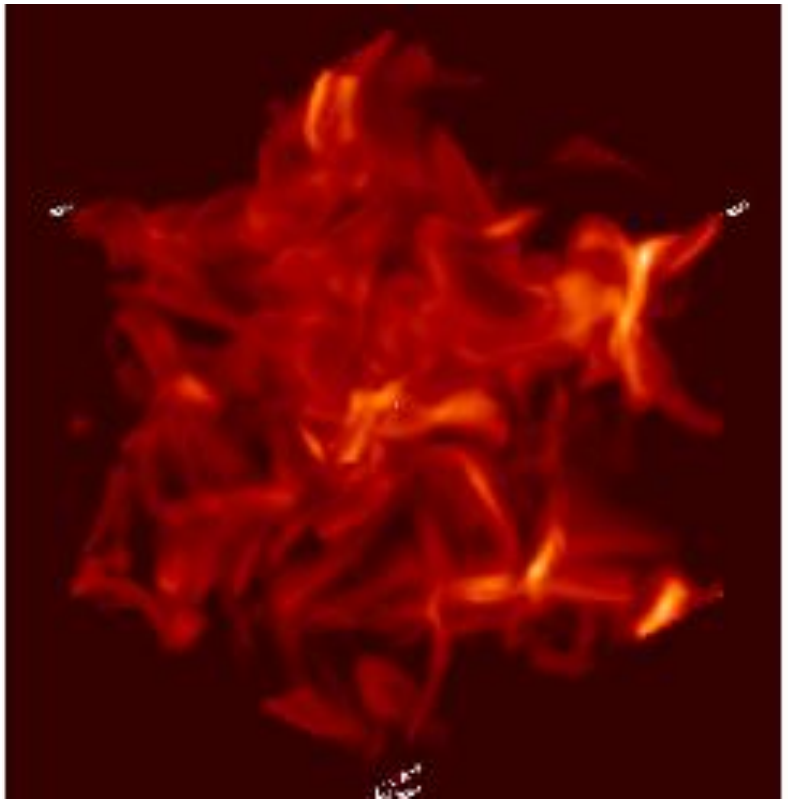
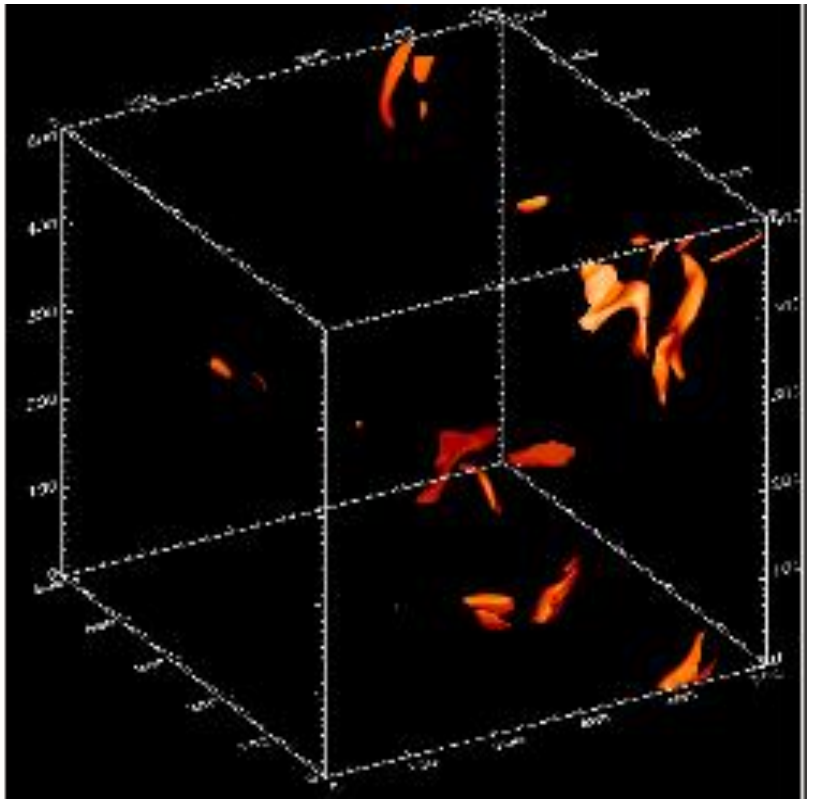




Simple modelling of stellar winds:

- Used UG code to simulate expanding winds from three massive young O stars
  - Stars located at (0,0,0)
- Winds expand into inhomogeneous environment
- GMC clump has 5 pc radius
- Total simulation size ±16 pc
- Heating prescription allows three stable phases





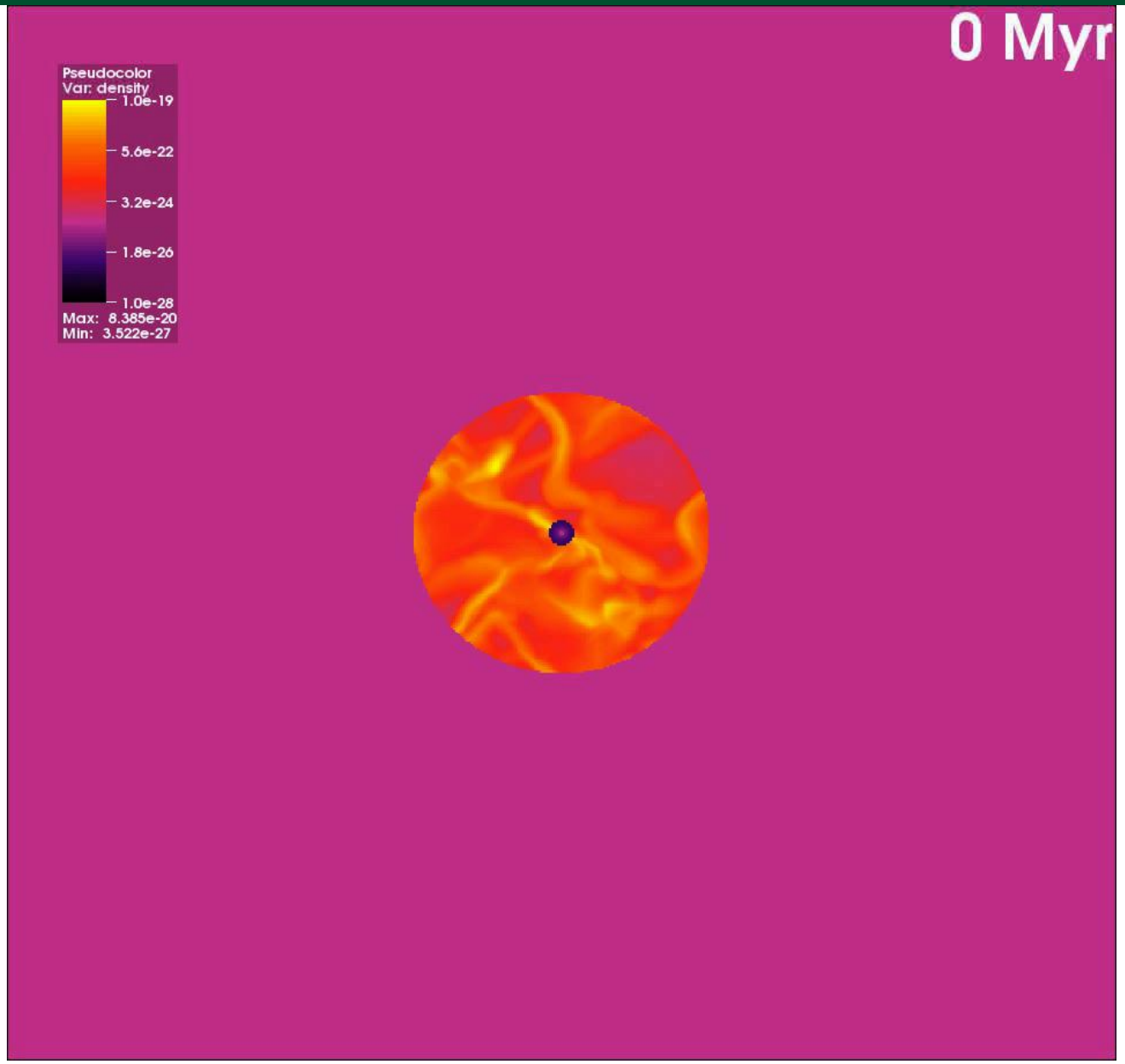
Initial conditions of the GMC based on turbulent ISM simulations of Vasquez-Semadeni et al. (2008)

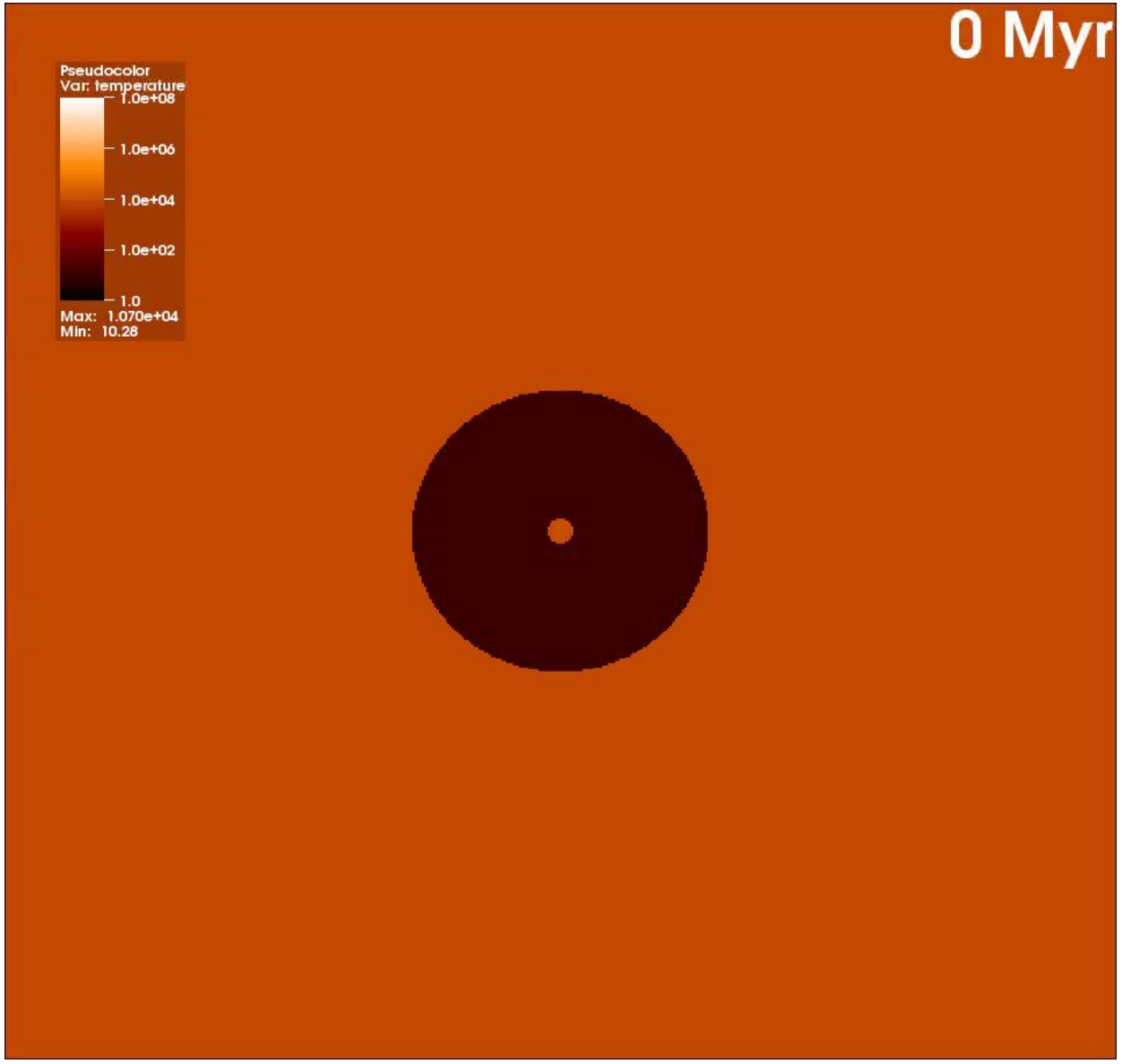
Evolution of the stars:

- The three stars evolve over the course of the simulation
  - 30 $M_{\odot}$, 25 $M_{\odot}$, 20 $M_{\odot}$

	Mass – loss ($M_{\odot}$/yr)	V_{inf} (km/s)	Duration (Myrs)
MS	5×10^{-7}	2,000	4
RSG	1×10^{-4}	50	0.1
WR	3×10^{-5}	2,000	0.3

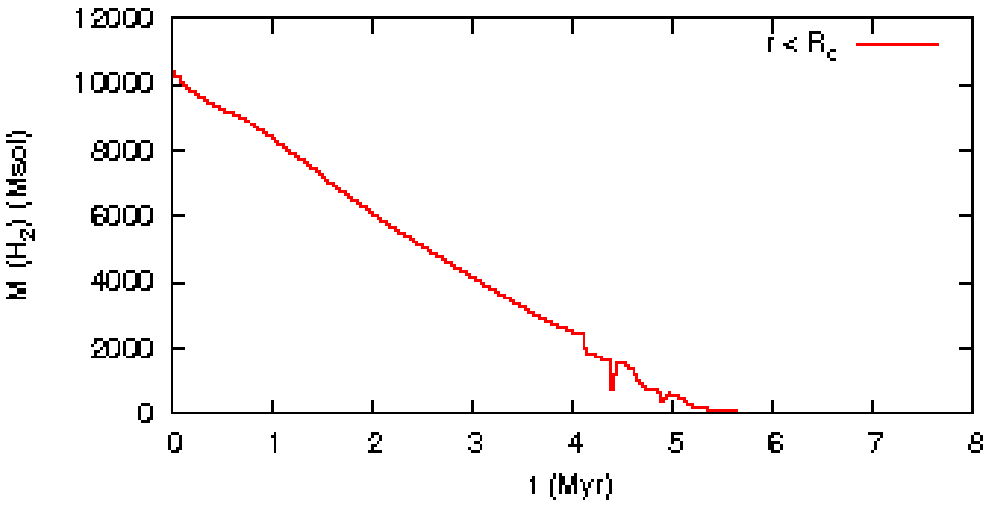
- The 25 $M_{\odot}$ star evolves to a RSG shortly after the first Sne
- The 20 $M_{\odot}$ star evolves to a RSG shortly after the second Sne


0 Myr
Pseudocolor
Var: density
1.0e-19
5.6e-22
3.2e-24
1.8e-26
1.0e-28
Max: 8.385e-20
Min: 3.522e-27


0 Myr
Pseudocolor
Var: temperature
1.0e+08
1.0e+06
1.0e+04
1.0e+02
1.0
Max: 1.070e+04
Min: 10.28

Evolution of H_2 mass of the cluster:

- Winds steadily evacuate clump gas from within the original clump radius
- Evolutionary stages of the stars can be seen
- By the end of the simulation almost all clump gas has been removed from the clump radius



Summary:

- Winds from stars form bubbles in the ISM
- Simulations show the expansion of winds from O stars into an inhomogeneous, turbulent GMC
- The structure of the gas has a large impact on the early expansion of the winds and destruction of the clump
- High density clumps can survive throughout the lifetime of the cluster, although highly ablated
- The supernovae, whilst impressive, do not have as big an effect as perhaps expected