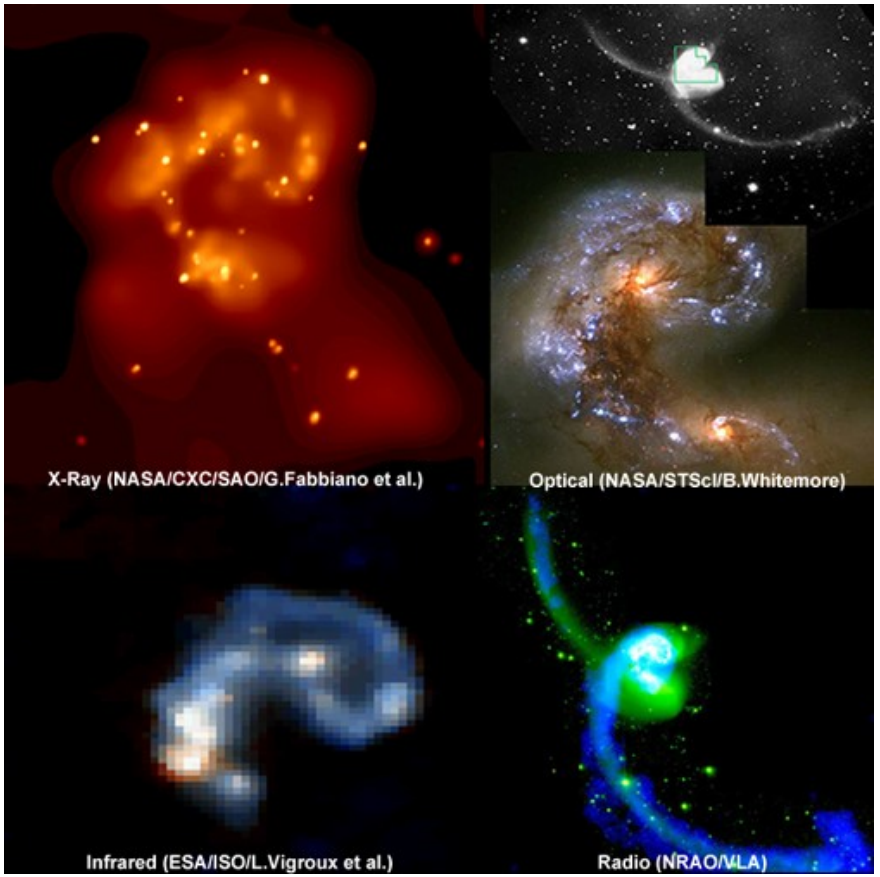
Dense Star Clusters

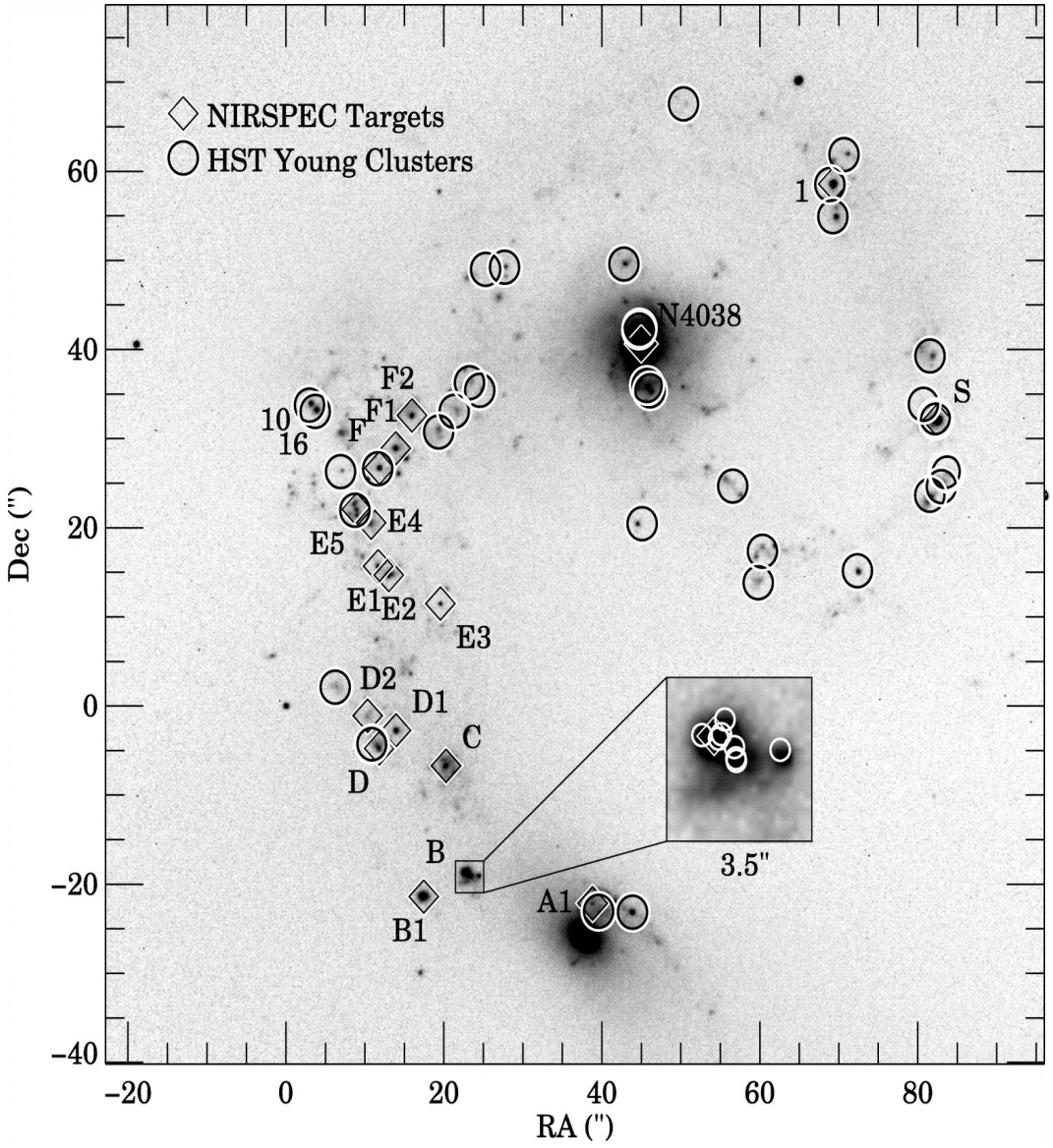
Jan Palouš
Richard Wünsch,Guillermo Tenorio-Tagle,
Sergyi Silich, Casiana Munoz-Tunon

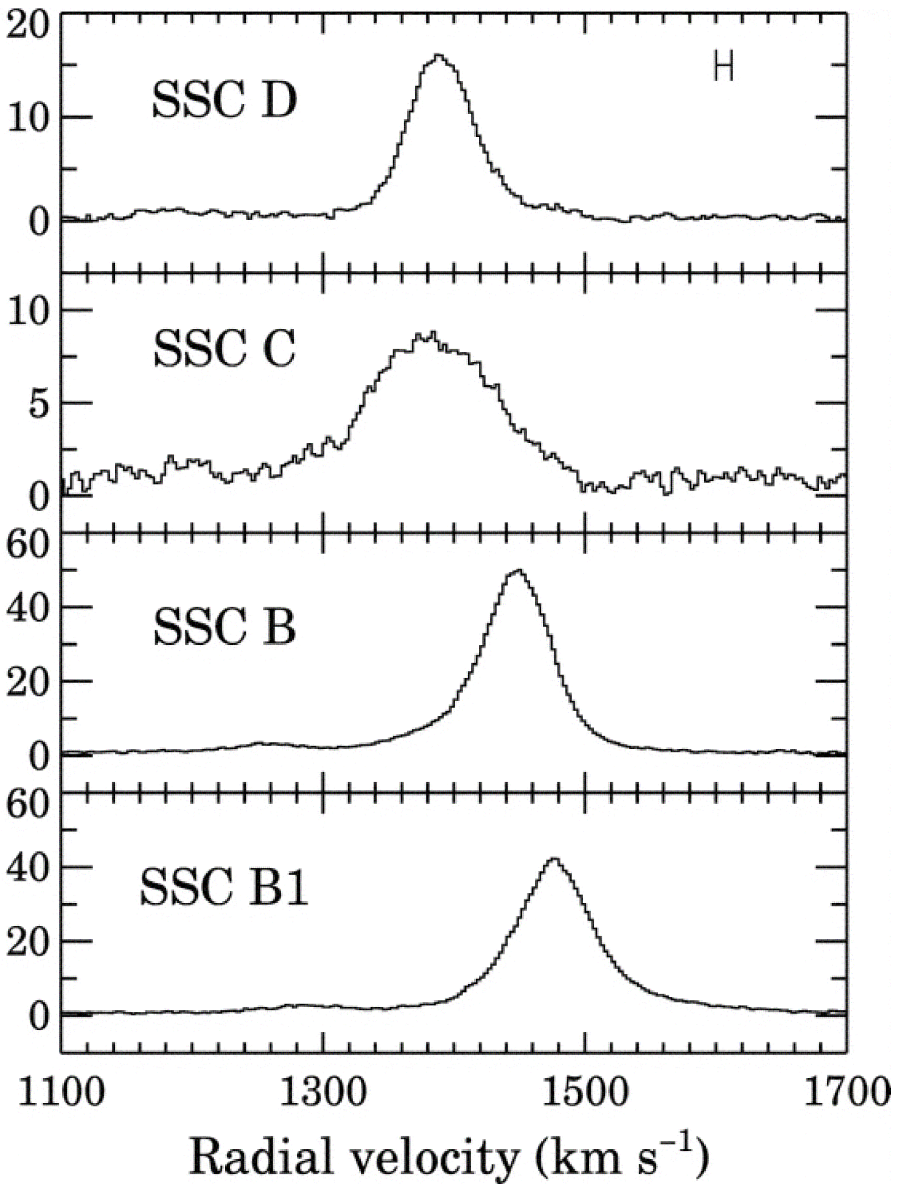
Astronomical Institute, ASCR, Czech Republic

Antenae


X-Ray (NASA/CXC/SAO/G.Fabbiano et al.)
Optical (NASA/STScI/B.Whitemore)
Infrared (ESA/ISO/L.Vigroux et al.)
Radio (NRAO/VLA)

Br_gamma emission line of SSC in Antennae (Gilbert & Graham, 2007)





Henry et al. 2007: Blue Compact Dwarf Galaxy He 2-10

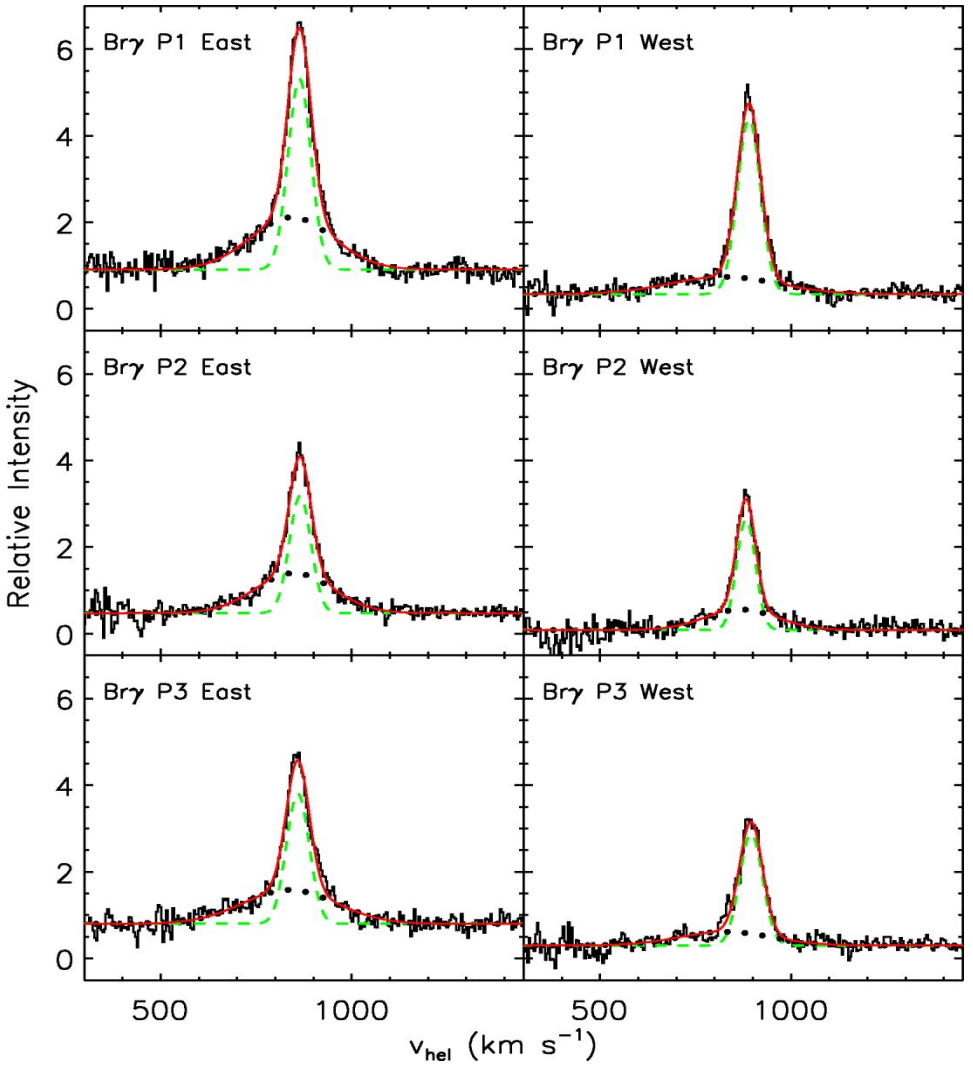


Table 2. Brackett Line Profiles

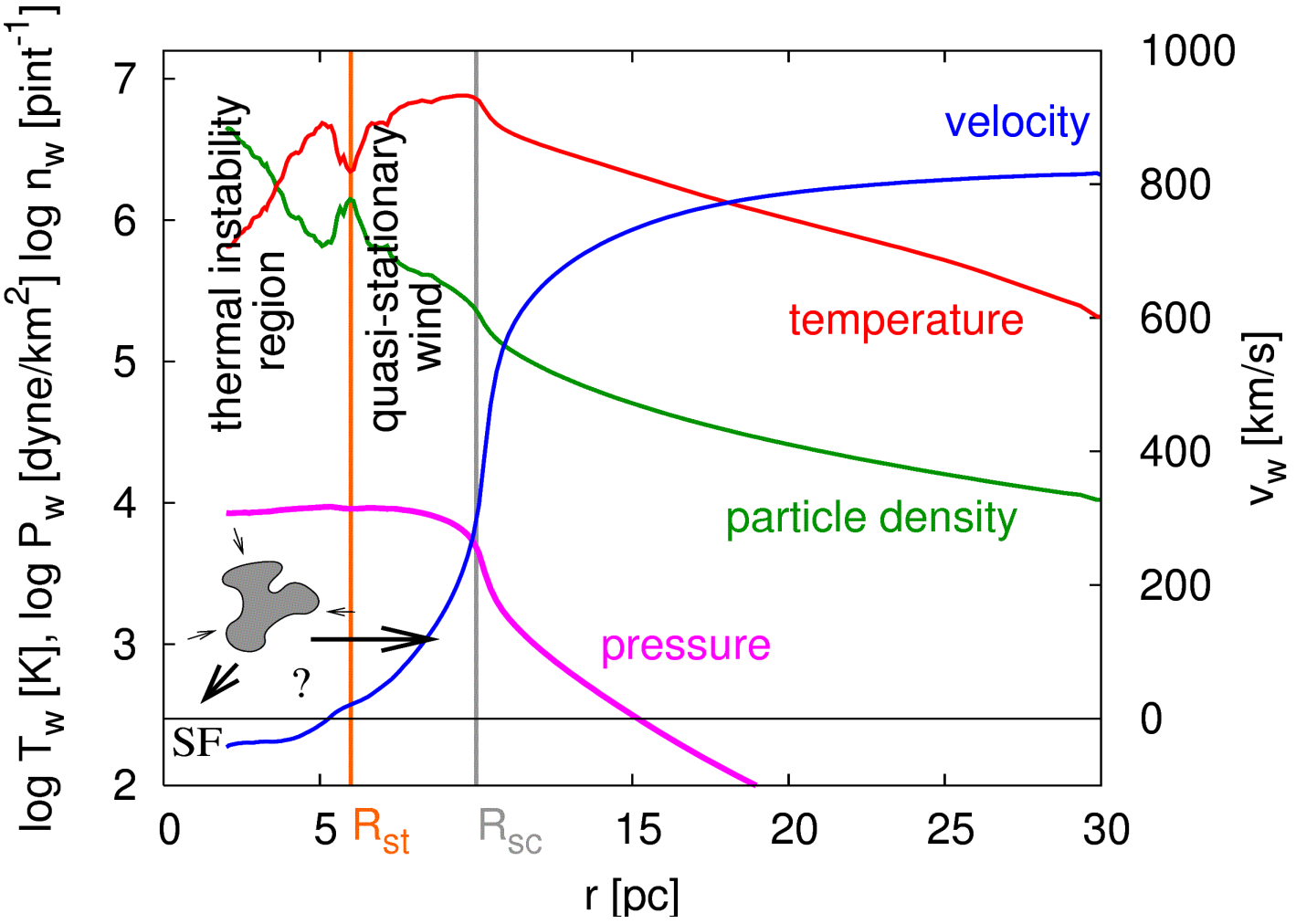
Spectrum	Eastern Region: Total v	Total FWHM	Narrow v	Narrow FWHM	Broad v	Broad FWHM	F_{narrow}/F_{broad}	Western Region: Total v	Total FWHM	Narrow v	Narrow FWHM	Broad v	Broad FWHM	F_{narrow}/F_{broad}
	(km s^{-1})							(km s^{-1})						
Brγ														
P1	861±1	66±2	863±1	70±3	843 ±3	254±10	1.0±0.1	887±1	61±2	890±1	71±1	824±11	331±24	2.2±0.2
P2	860±1	62±2	865±1	67±2	849±4	237±13	0.8±0.1	880±1	57±2	882±1	57±2	869±7	223±21	1.4±0.1
P3	857±1	58±2	859±1	71±2	837±5	287±14	0.9±0.1	891±1	59±2	895±1	71±2	829±14	284±28	2.0±0.2
Br α														
P1	867±1	85±4	869±1	85±2	847±11	37±39	1.5±0.2	872±1	64±10	...	...	...	...	...
P2	862±1	80±10	...	...	...	...	...	895±1	78±9	...	...	...	...	...
P3	859±1	59±8	...	...	...	...	...	899±1	72±8	...	...	...	...	...
P4	866±1	72±5	866±1	76±2	835±14	528±62	1.0±0.1	884±1	65±4	...	...	...	...	...
P5	863±1	74±10	...	...	...	...	...	901±1	69±6	...	...	...	...	...
P6	859±1	64±6	860±1	63±2	805±15	432±53	1.2±0.2	...	...	...	...	...	...	...
P8	...	...	...	...	...	...	...	890±1	74±7	...	...	...	...	...

Note. — Velocities are heliocentric. Values are given for the total emission line, as well as the narrow and broad Gaussian components.

Model: Winds in a Forming Cluster

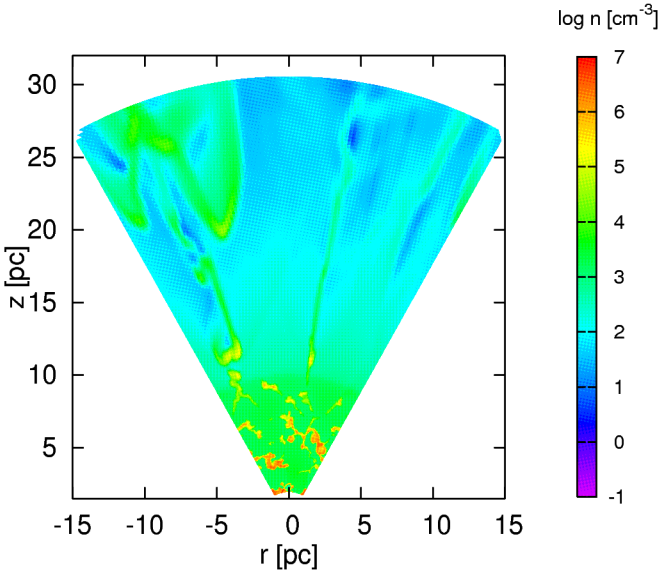
- Thermalization of the mechanical wind energy in wind x wind collisions;
- Efficiency of the thermalization process eta;
- Eta is a function of stellar density, Mach number of the winds, and their chemical composition;
- Heating of the stellar ejecta;
- Cluster superwinds: importance of the heating.

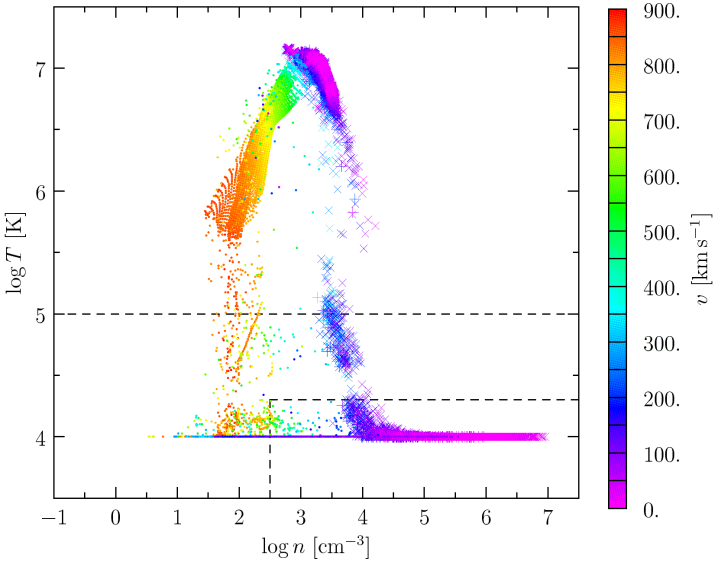
Stagnation of Cluster Winds Tenorio-Tagle et al. 2007, 2009; Wunsch et al. 2007, 2008

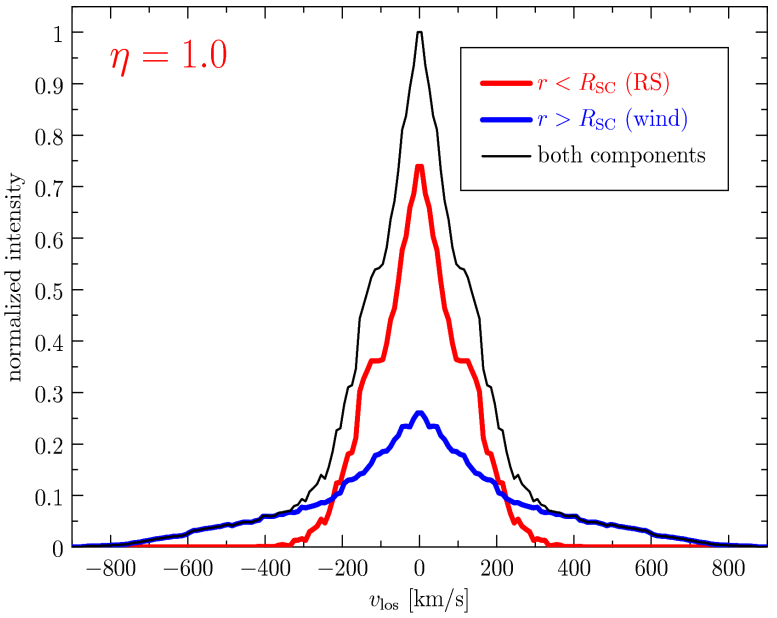


A cluster above the threshold line

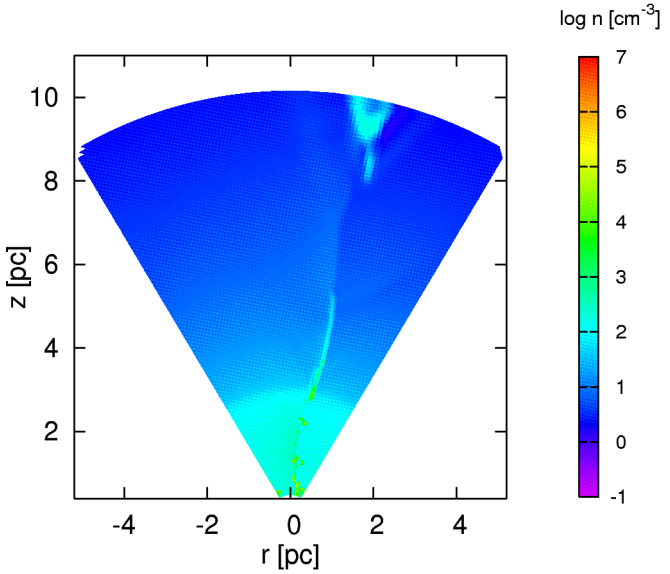
eta = 1.0

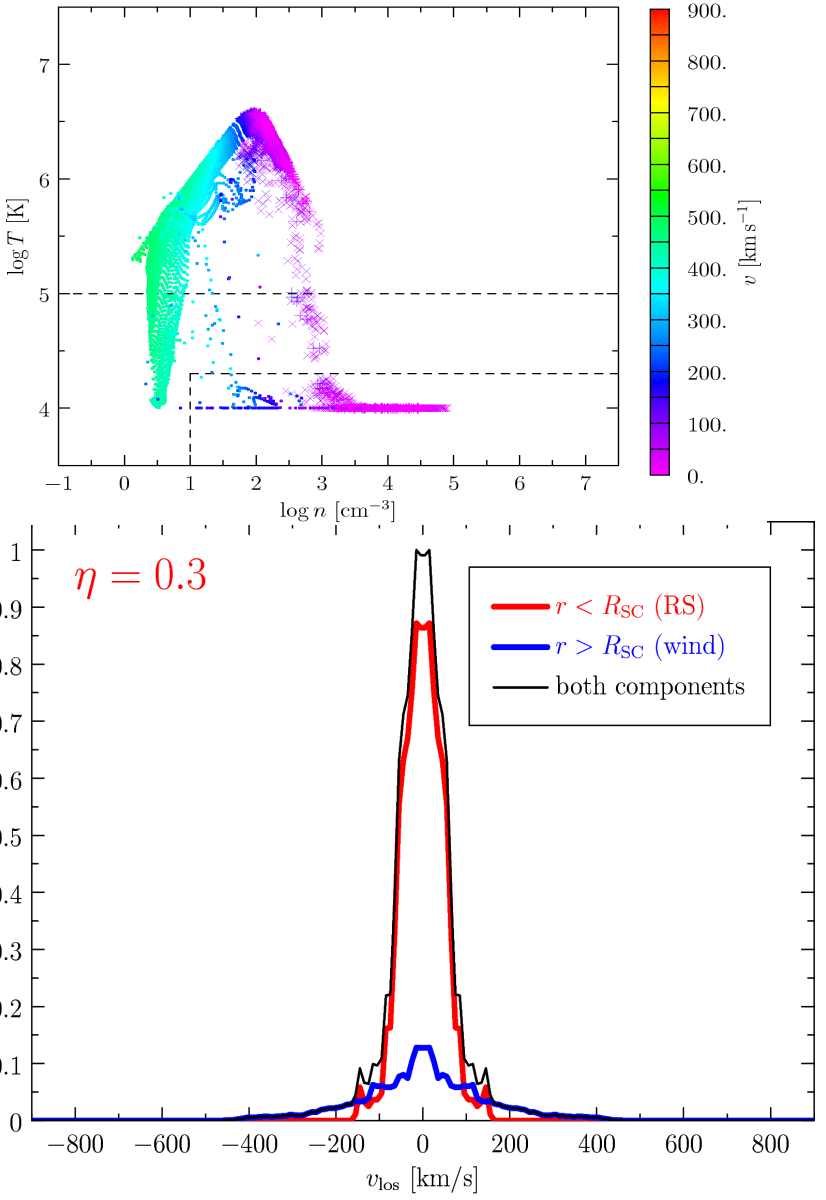




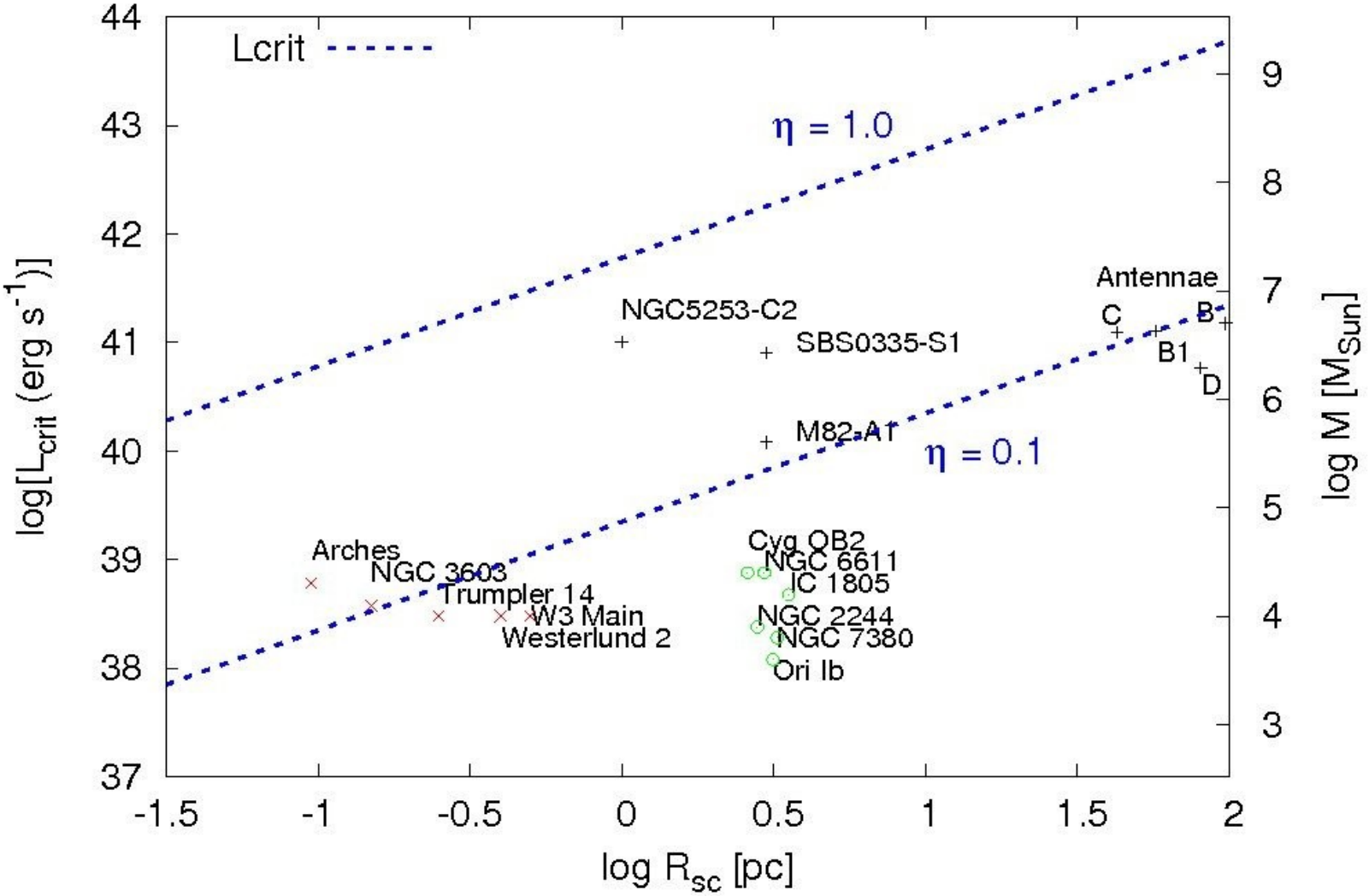


A cluster above the threshold line
eta = 0.3

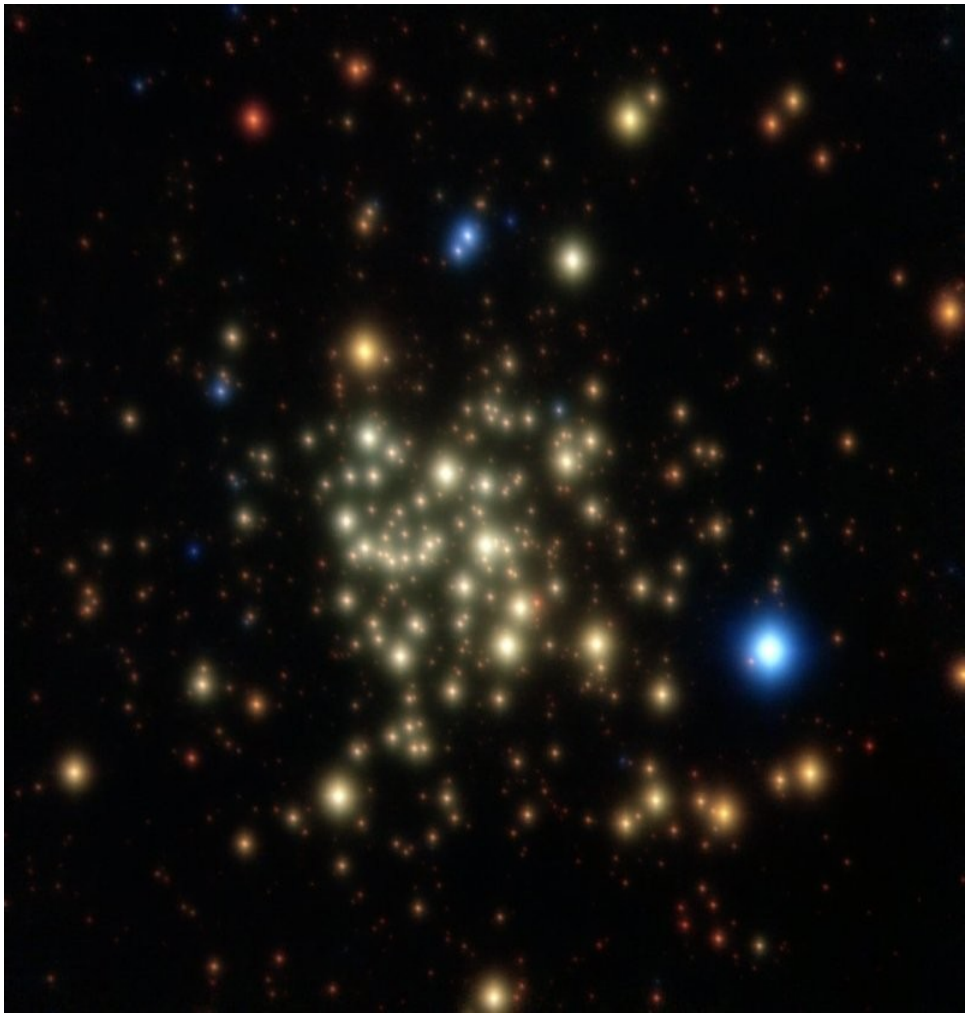


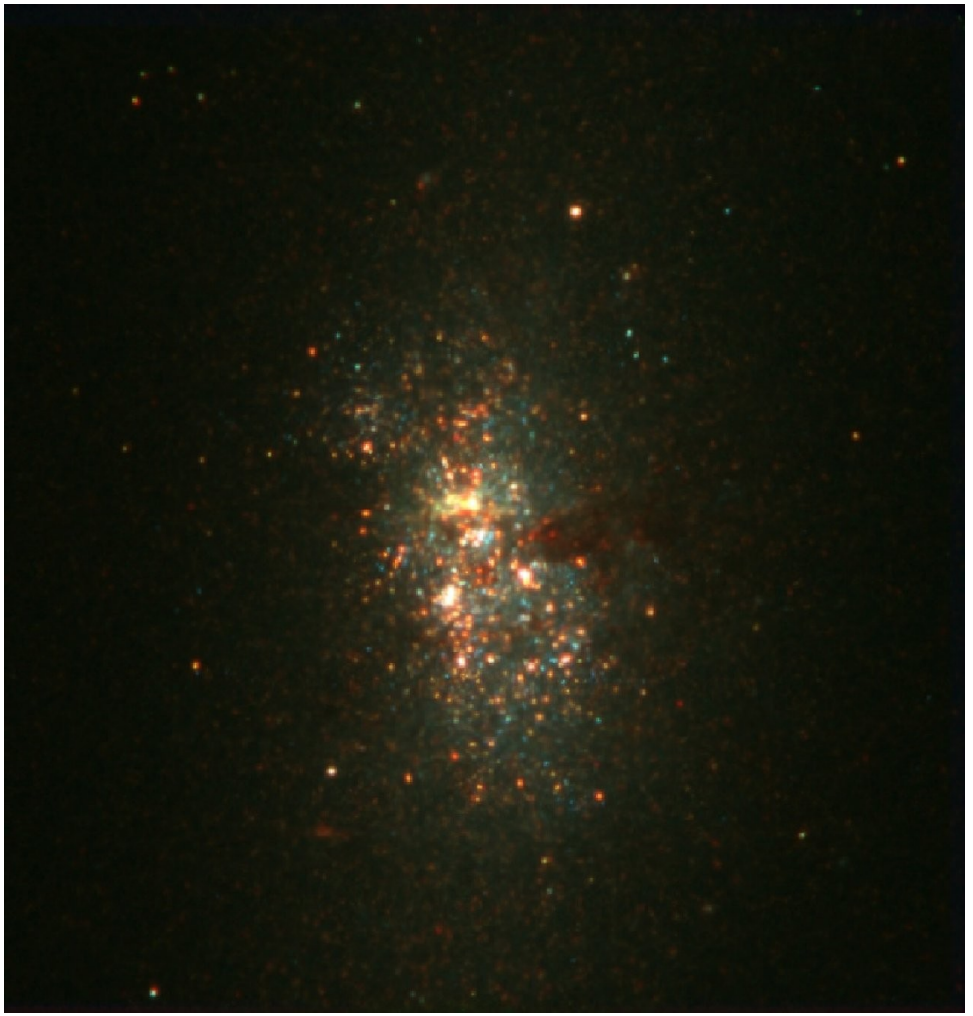


Luminosity versus Radius plane

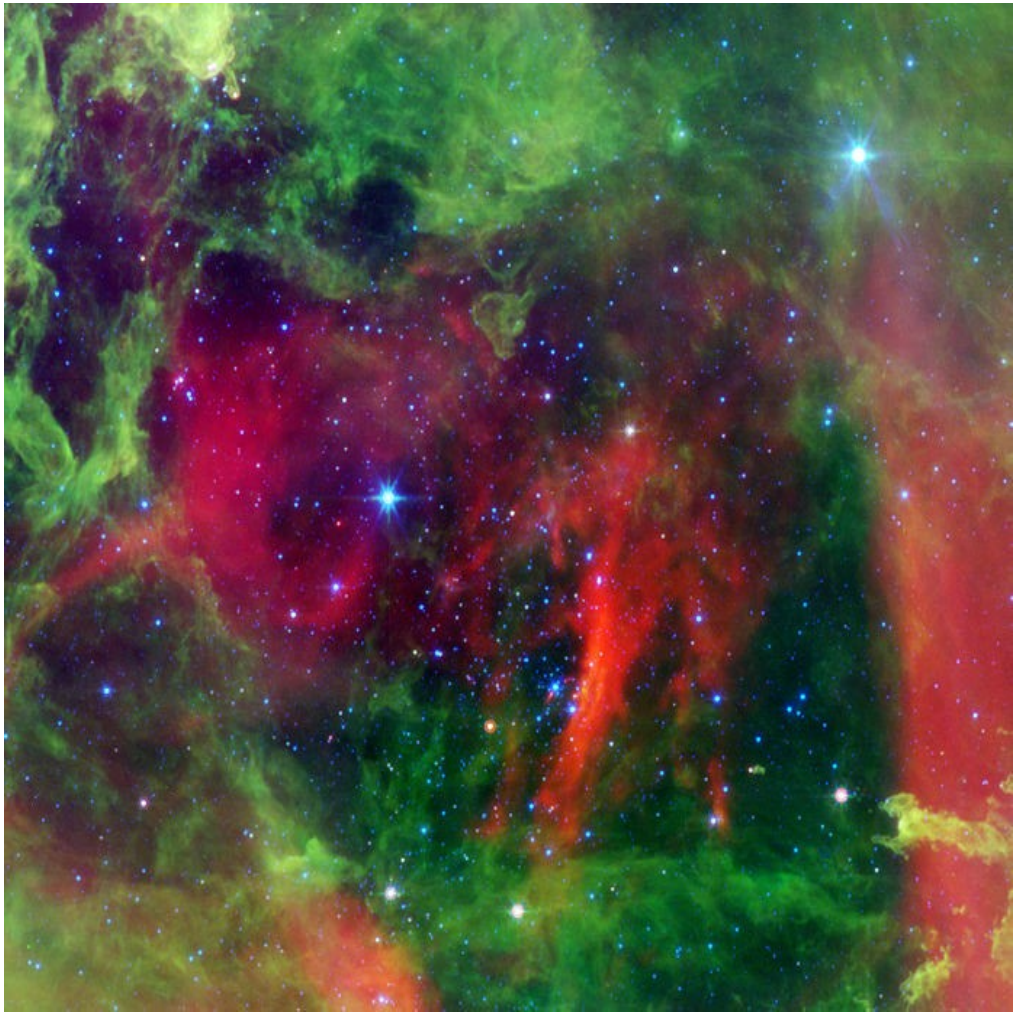


Star Burst Clusters: Arches & NGC 5253

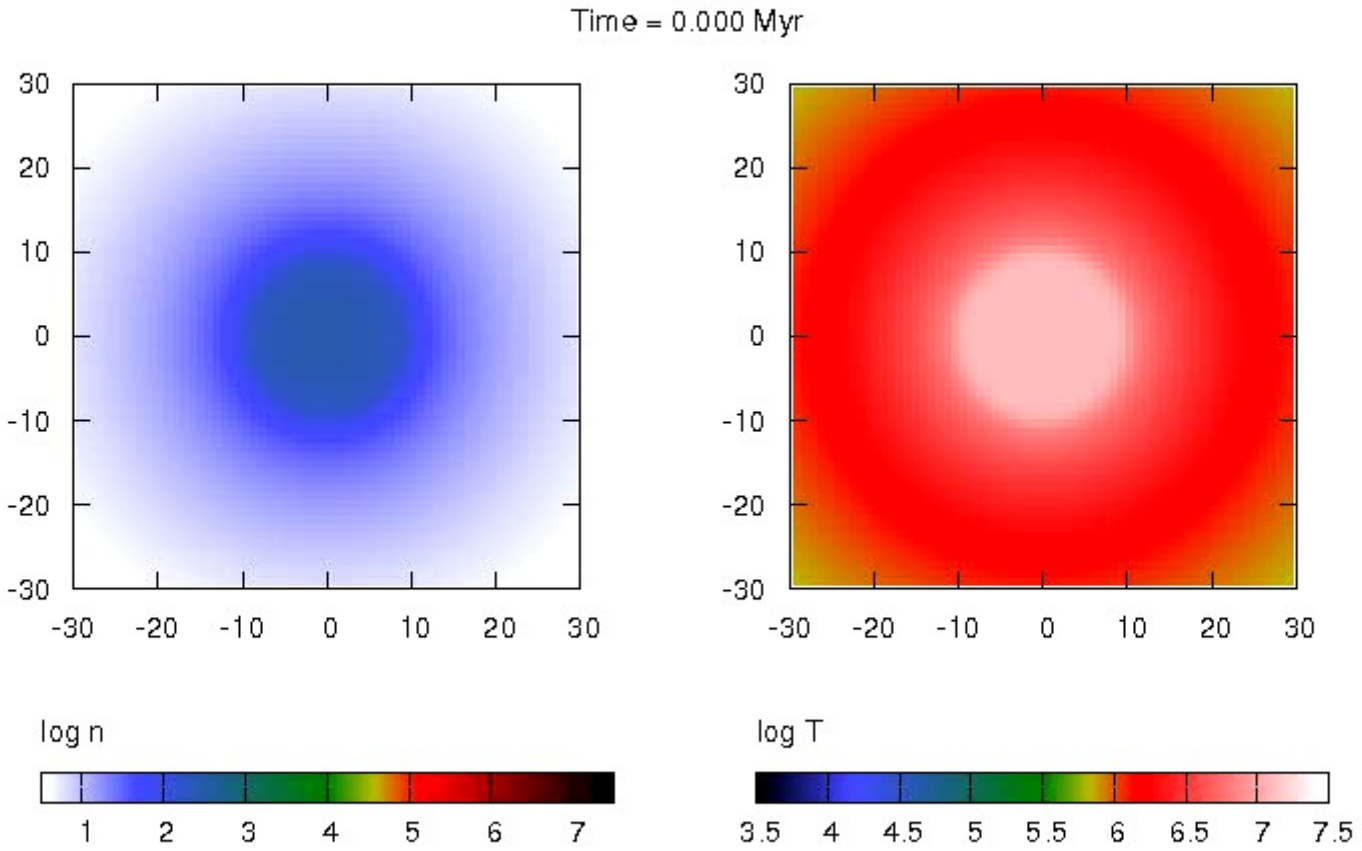




Leaky Clusters:
NGC 2244 & NGC 6611



3D simulation of a cluster early evolution



Conclusions

- Dense versus low-stellar density clusters: presence or absence of thermally unstable region: star burst or leaky clusters;
- Emission lines of the SSC have two components: one more intense from re-pressurising shocks and the second of low intensity from the wind. They show that the thermalization efficiency is low;
- Secondary star formation from metal enriched gas: multiple main sequences;
- Bumpy IMF;
- Cold mass concentration in the cluster central part may feed the central BH.