

HD simulations of super star cluster winds

R. Wünsch¹, J. Palouš¹, G. Tenorio-Tagle² and S. Silich²

¹ Astronomical Institute, Academy of Sciences of the Czech Republic, Boční II 1401, 141 31 Prague, Czech Republic

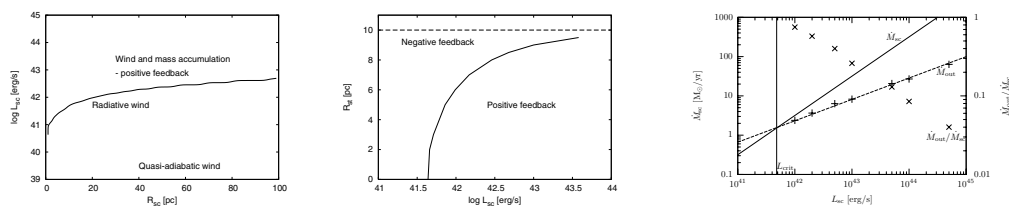
²Instituto Nacional de Astrofísica Óptica y Electrónica, AP 51, 72000 Puebla, Mexico

Abstract. We numerically model winds driven by super star clusters (SSC) using the hydrodynamic code ZEUS with the new radiative cooling procedure. The importance of cooling on the wind dynamics depends on the properties of the central cluster: the energy and mass deposition rates L_{sc} and \dot{M}_{sc} , and the cluster radius R_{sc} . Low mass clusters behave adiabatically, and their winds are well described by the solution of Chevalier & Clegg (1985). However, for larger L_{sc} and \dot{M}_{sc} and/or smaller R_{sc} , cooling becomes important, and the wind enters the radiative regime in which the wind temperature quickly drops to 10^4 K at a small distance away from the cluster (Silich *et al.*, 2004). There is no stationary wind solution for very energetic and compact clusters. This is expressed by the line of the critical luminosity L_{crit} shown by the left panel as a function of R_{sc} .

In the case of SSC above the threshold line, the stagnation point R_{st} appears inside the cluster. It splits the cluster volume into two parts: the outer one with $r > R_{st}$ where the wind velocity is always positive, and the inner one $r < R_{st}$ where it has a complicated time-dependent profile. The mass inserted into the outer region leaves the cluster in a form of quasi-stationary wind, while most of the mass from the inner region either accumulates there or passes the inner boundary and eventually feeds further star formation. The middle figure shows that the stagnation point R_{st} asymptotically approaches the cluster radius R_{sc} with the increasing L_{sc} .

The right figure summarises several of our calculations for a cluster with an $R_{sc} = 10$ pc. It shows the amount of the mass \dot{M}_{out} outflowing from the cluster depending on L_{sc} . It can be seen that \dot{M}_{out} grows with L_{sc} following the power-law fit of the simulations $\dot{M}_{out} \approx L_{sc}^{0.54}$. However, the fraction of the outflowing mass to the total mass deposited by the cluster \dot{M}_{sc} decreases with L_{sc} from 100% for $L_{sc} = L_{crit}$ to several percent for $L_{sc} = 5 \times 10^{44}$ erg s⁻¹.

Keywords. galaxies: star clusters, galaxies: starburst, ISM: jets and outflows



Acknowledgements

The authors gratefully acknowledge support by the Institutional Research Plan AV0Z10030501 of the Academy of Sciences of the Czech Republic, by the project LC06014 Center for Theoretical Astrophysics, and by CONACyT – México, research grant 47534-F.

References

- Chevalier, R. A. & Clegg, A. W. 1985, *Nature* 317, 44
 Silich, S., Tenorio-Tagle, G. & Rodríguez-González, A. 2004, *ApJ* 610, 226
 Tenorio-Tagle, G., Wünsch, R., Silich, S. & Palouš, J. 2006, *in preparation*