Complex galactic winds in low mass galaxies

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Language synchronisation

feedback: stellar (not AGN), interaction of stars with the interstellar medium

galactic wind: gas flow escapes the gravitational potential well of the host galaxy

outflow:

gas flow stays within the potential well of the host galaxy (and will eventually cool and fall back)





Feedback of massive stars on the ISM



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Mac Low & Ferrara (1998) Fujita et al. (2004,2009)

Feedback in moderate mass starburst galaxies



UNIVERSITÄT BOCHUM M82

galactic wind $V_{flow} > 400 \text{ km s}^{-1}$ r > 5 kpc

remember: M82 is not a dwarf galaxy!

Westmoquette et al. 2004

Feedback in dwarf starburst galaxies:

best preconditons, but difficult... often complex "onion" structure shells thick disks



NGC 1705 Hα-cont







Holes blown around starburst regions





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clearing out the dense birth clouds but different for clusters and loose associations! RUB

Anders et al. 2003

filled with hot, metal-enriched gas

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Martin et al. 2002

Feedback traced by cool gas Nal absorption lines of the flow

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Martin 2005, see also Rupke et al. 2005

We are in good shape, really?

* stellar input

- * details of gas in halo (and environment)
- * details of gas near the starburst core
- * magnetic fields
- * dynamical mass determinations
- * cooling and mixing issues





Stellar physics governs the energy input



FIG. 10.—Wind power of massive stars forming continuously with SFR = 1 M_{\odot} yr⁻¹ ($\alpha = 2.35$, $M_u = 120 M_{\odot}$, $M_l = 1 M_{\odot}$). Models for four different metallicities are plotted. The power released by SNs is included. The same line type has been used for winds and SNs of the same Z.

RUB tellar wind are important energy source UNIVERSITÄT

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Leitherer et al. 1992

New physics in stellar evolution models



Tracks: Meynet & Maeder 2005

RUHR STELLAR Stellar rotation is important!

Coherent filaments several kpc in halo







van Eymeren et al. 2007, 2009







Fabry-Perot

fast flow complex geometry or more than one shell

galactic wind ?

v[km/s]

van Eymeren et al. 2007, 2009

Infall of gas clouds or very little galaxies?



Galaxy-scale feedback



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IC 10: a dwarf starburst in the Local Group! (well hidden behind the galactic plane).

Bomans (2003)

Shells within shells







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Bomans, in prep

Starting outflow in dense clumpy medium two cases: depending on density

low density



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Tenorio-Tagle et al. 2006

Starting outflow in dense clumpy medium high density



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Tenorio-Tagle et al. 2006

Clumpy medium leads to complex shells



200

-200

0

200





Where is the diffuse X-ray emission?



IC 10: contiuum subtracted Ha with contours of X-ray emission overlayed



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HI holes, filaments, and streamers

IC10









Wilcots et al. 1998

Even in dwarfs there are ordered magnetic fields



Chyzy et al. (2004)

equipartition field strengh ~7 µG



Chyzy (2004) Chyzy et al., in prep.



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Conclusions

What determines properties of a wind?

- mode of starformation (cluster vs association)
- IMF, upper mass cut-off, stellar evolution
- density, pressure, clumpyness
- cooling, external pressure
- infall and interaction
- magnetic fields

all play important roles, often on small scales!

It is not only total energy deposition, DM mass and gas distribution on kpc scales...



