# Galactic winds and dynamos 

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## Some facts

- Outflows are common (R.J.Dettmar)
- Outflows are related to star formation in the disk (R.J.Dettmar, D.Bomans)
- Bulk velocity of cosmic rays in the halo of NGC253 is similar to the escape velocity of $\approx 300 \mathrm{~km} / \mathrm{s}$ (V.Heesen)
- Radio scaleheights do not depend on star-formation rate: bulk velocity of cosmic rays related to the star-formation rate (M.Krause)
- Outflows are needed for efficient large-scale dynamo (helicity flow)
- The required outflow velocities are only a few km/s faster outflows suppress the large-scale dynamo (D.Moss, S.Sur)


## Dynamos with winds

$$
R_{\alpha}=\alpha R^{2} / \eta
$$



+ : parity +/+
* : parity +/-
o : intermediate or oscillating
$x$ : decaying

Moss et al. 2010

## Tasks (theory)

- Which gas component carries the helicity flow? (hot gas)
- What is the outflow velocity required for efficient helicity transport? (a few $\mathrm{km} / \mathrm{s}$, effectively)
- How does the self-regulation work?
- Dependence of outflow velocity on star-formation rate?
- Effects of inflow?
- Understand magnetic reconnection
- Global MHD models with dynamo action and outflow:
(D.Breitschwerdt, Y.Dubois, M.Hanasz)

Small scales
Range of star-formation rates/total field strengths Barred galaxies

## Tasks (observations)

- Vertical distributions of edge-on galaxies in radio continuum, IR, Ha and X-rays
- Dependence on SF rate, field structure, ...
- Outflow (fountains or winds) velocities in Ha (and X-rays?)
- Variation of rotation velocity and velocity dispersion with height (HI,Ha)
Needed: spectral resolution (instrumentation is lacking!)
- Asymmetry of polarized emission in mildly inclined galaxies at several wavelengths: tomography
- Pattern of halo fields (PI and RM) of edge-on galaxies: coherent quadrupolar (dynamo), filaments, loops?
- Compare velocity fields with magnetic pattern

Higher resolution and sensitivity in radio polarization:

- LOFAR surveys of edge-on and dwarf galaxies (Key Project)
- EVLA surveys of edge-on galaxies (in prep) and dwarfs (LittleTHINGS)

