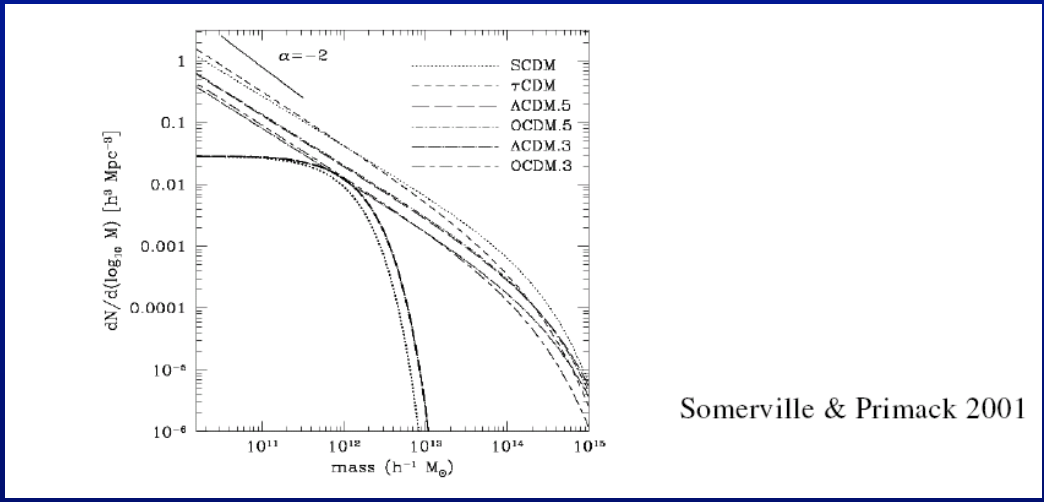
Project A2 – part2 :

The magnetized halos of spiral galaxies

Ralf-Jürgen Dettmar
Astronomical Institute
Ruhr-University Bochum

Why do we care about the (magnetized) ISM in galactic halos?

The role of feedback in structure formation (and magnetizing the IGM/ISM)



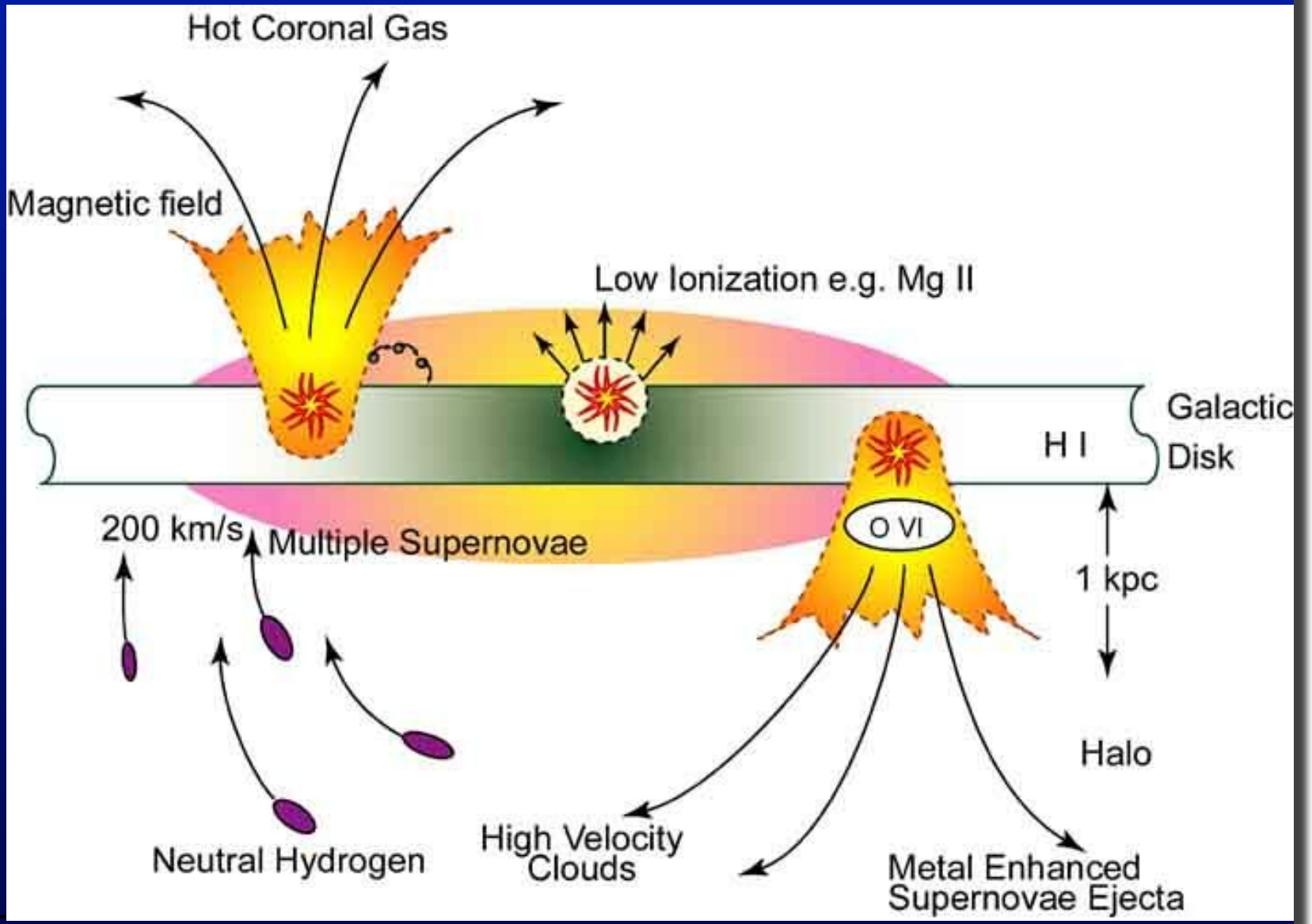
Somerville & Primack 2001

Chemical evolution of the ISM/IGM

Large scale structure of the magnetic field in galaxies

Dynamo theory, e.g. the helicity problem

SN driven ISM



view from top

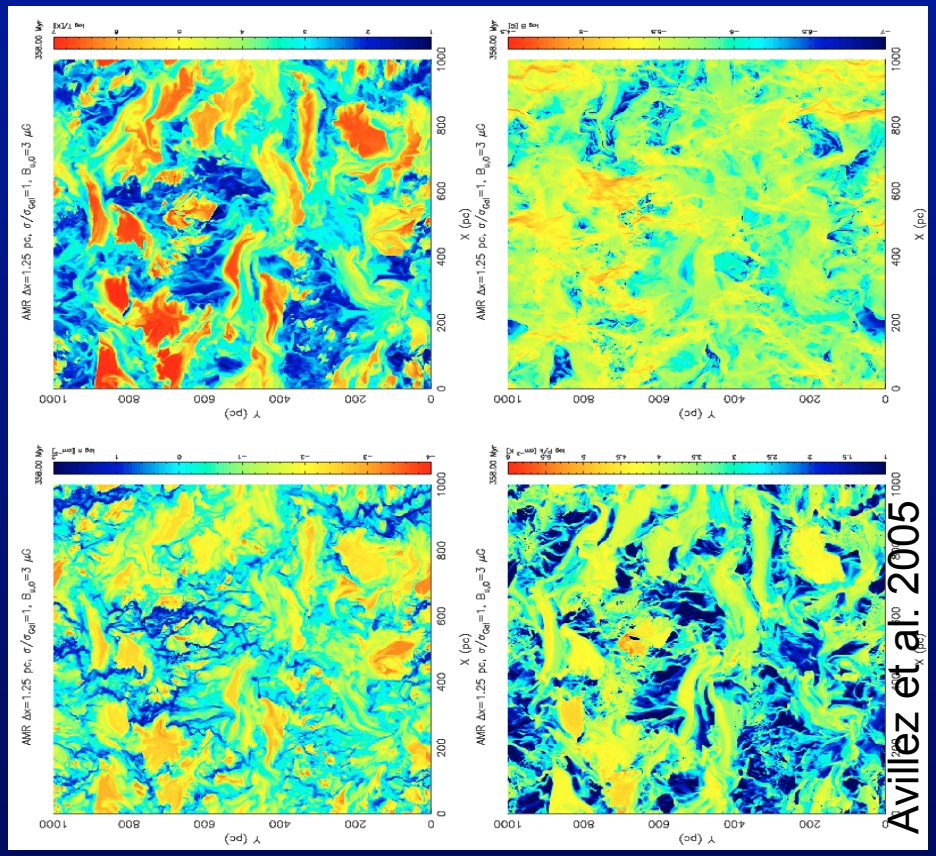
view from side

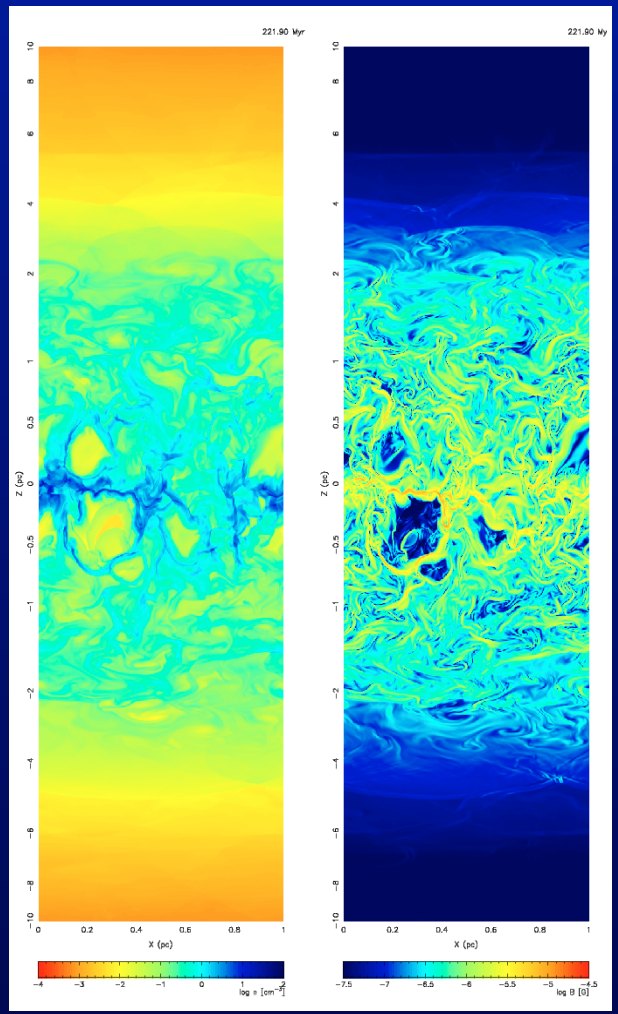
Density

Temperature

Density

Magnetic Field





Pressure

Magnetic Field

Magnetized halos of spiral galaxies

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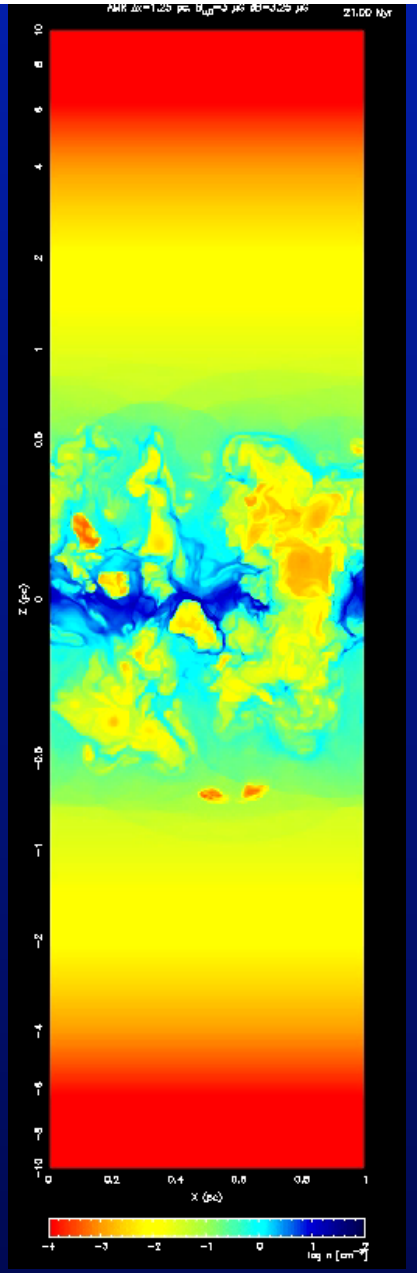
Oct. 4, 2010

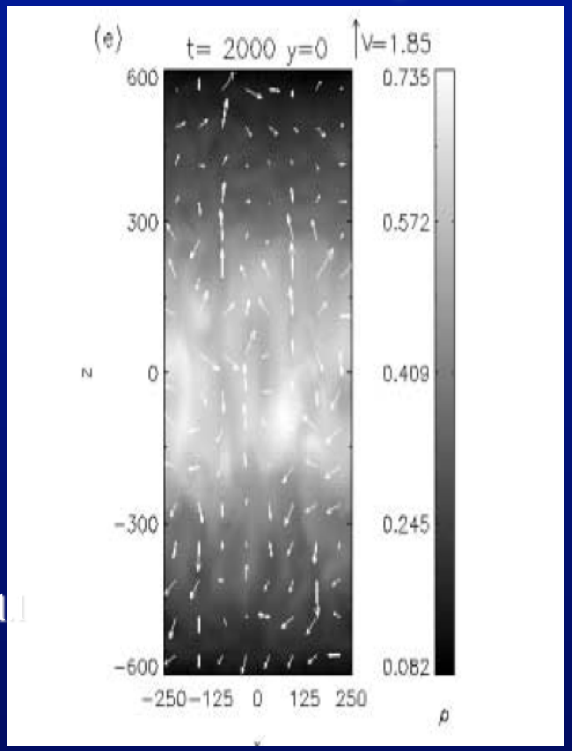
numerical models of the ISM:

Avillez & Breitschwerdt



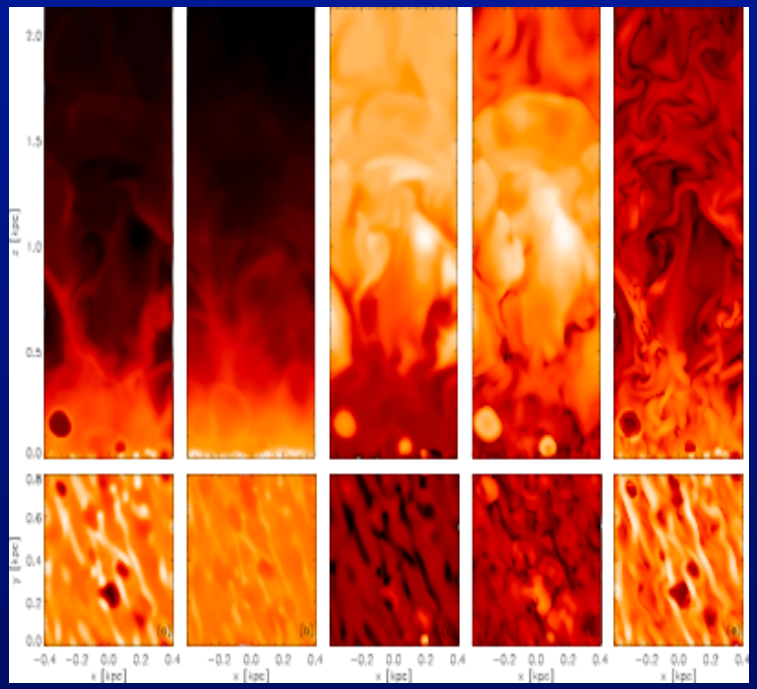
SN driven dynamos do work

cosmic rays



Hanasz et al

thermal (kinetic) energy



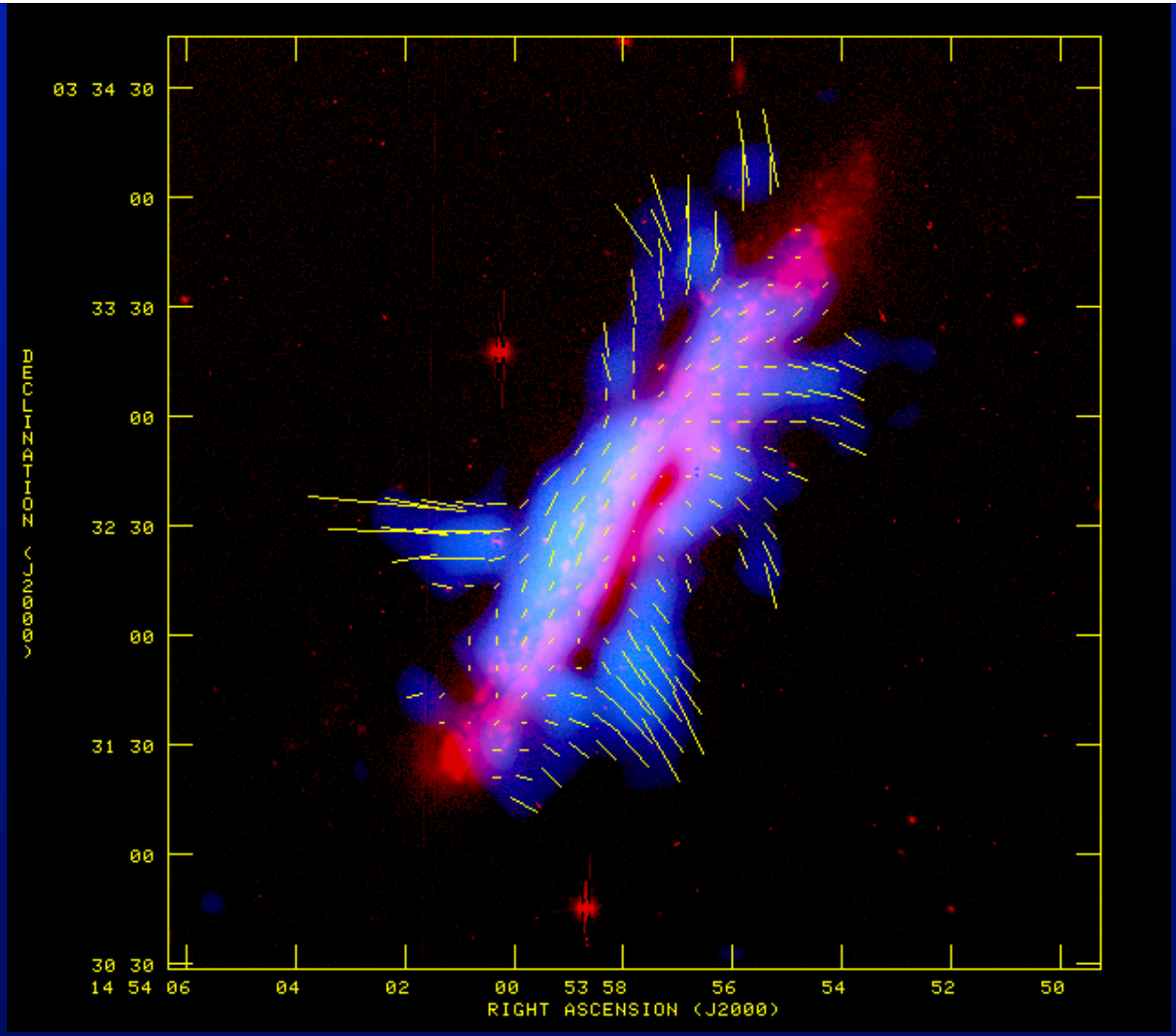
Gressel et al

ρ Σ T ν B

What happens in the combined model?
(when cosmic ray diffusion changes)

What is the role of magnetic instabilities ?
(MRI, Parker, Tayler)

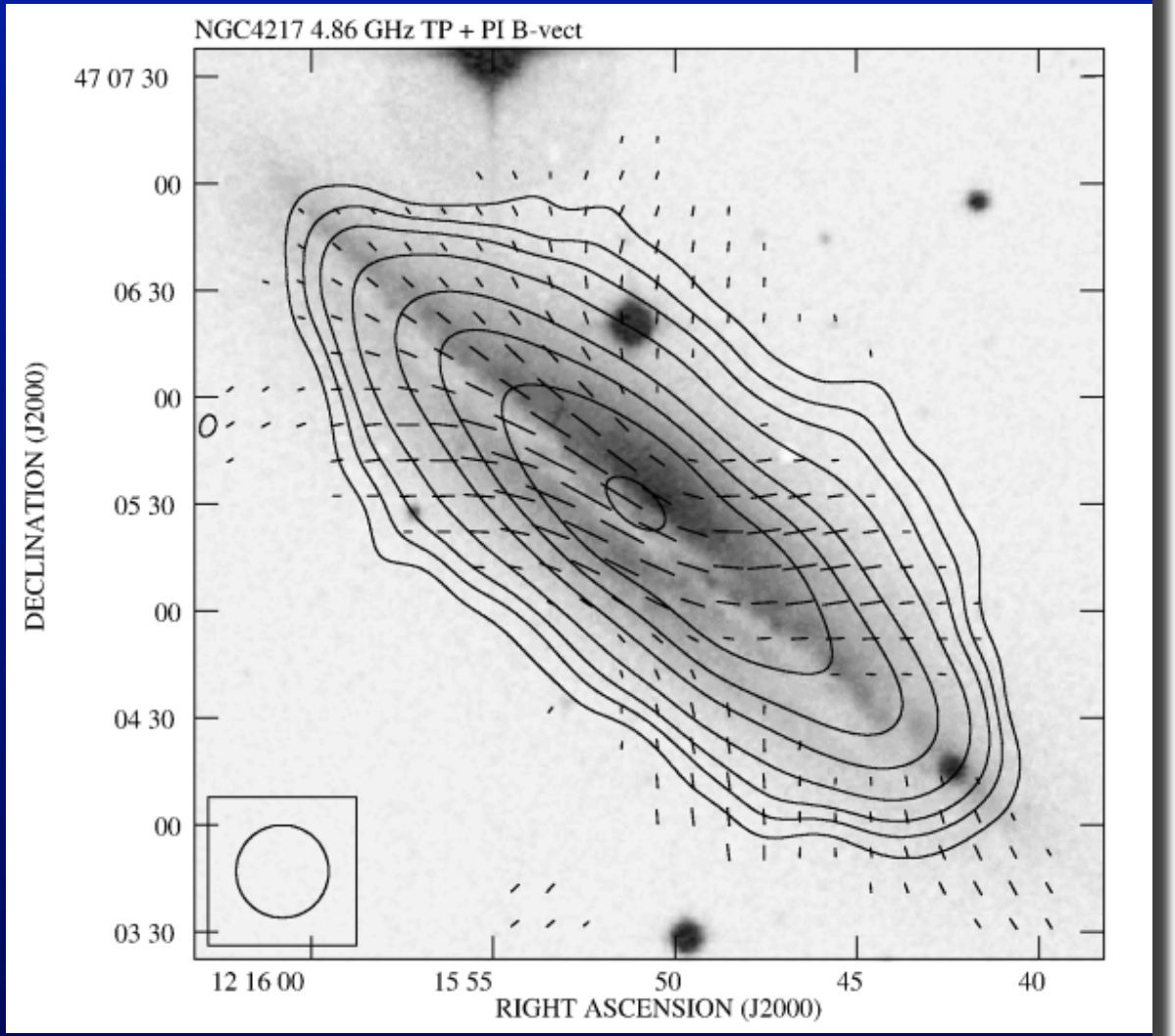
NGC5775



Tüllmann et al. 2000

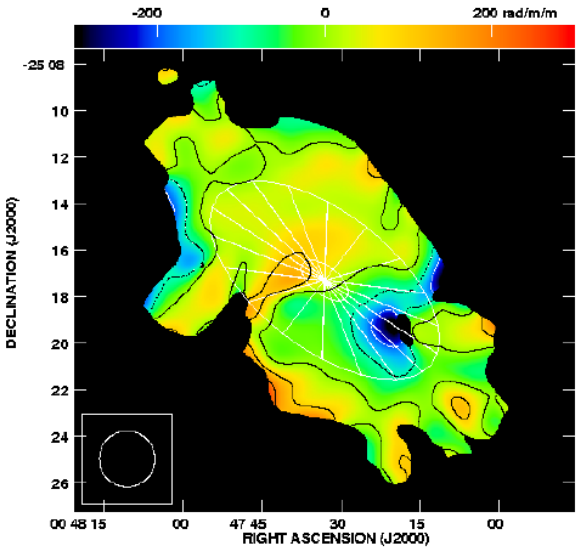
large scale magnetic field structure in halos

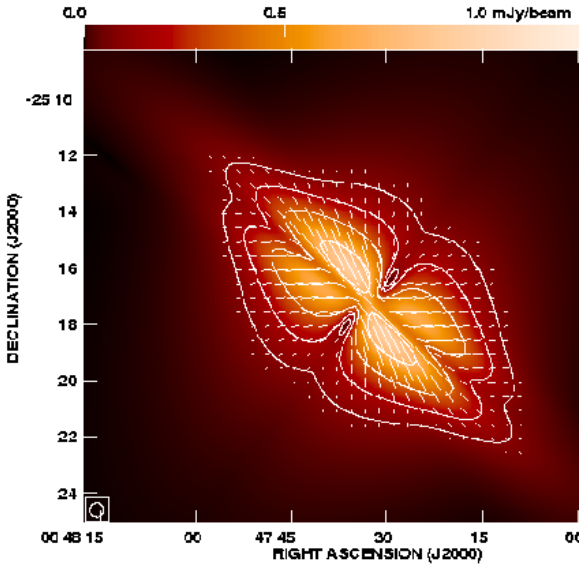
the global magnetic fields in disk galaxies typically have a significant poloidal component (based now on 6+ cases studied)

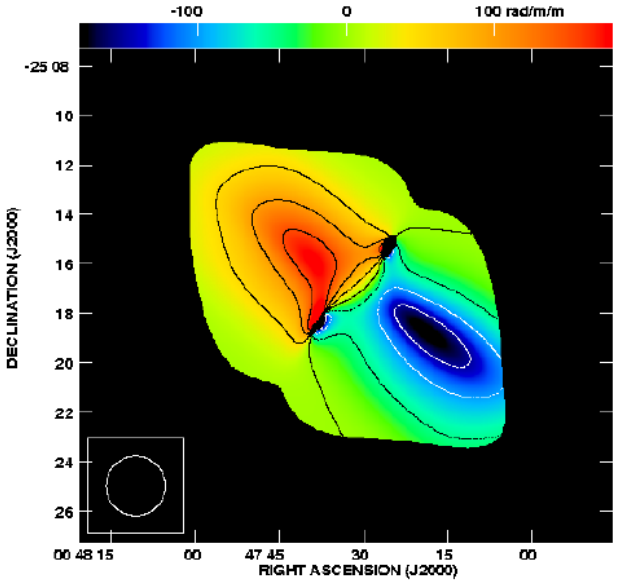


Soida & Dettmar AN 2006

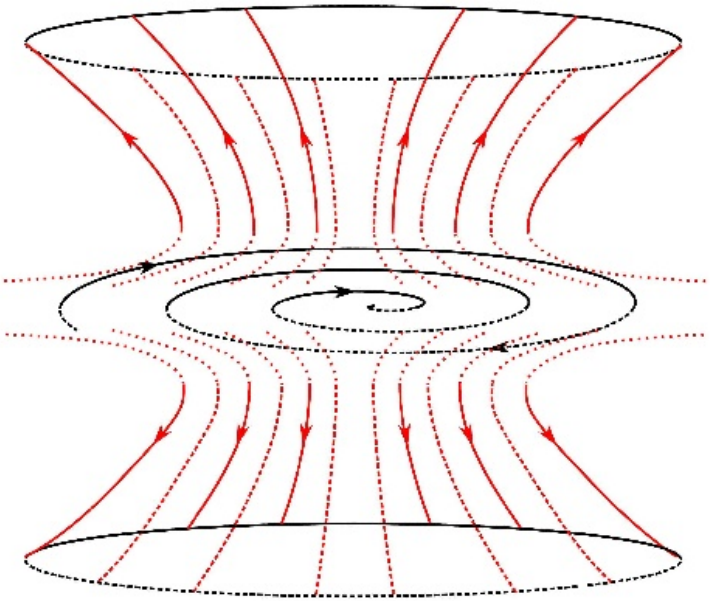
Magnetic field structure from rotation measure analysis







Magnetic field structure from rotation measure analysis



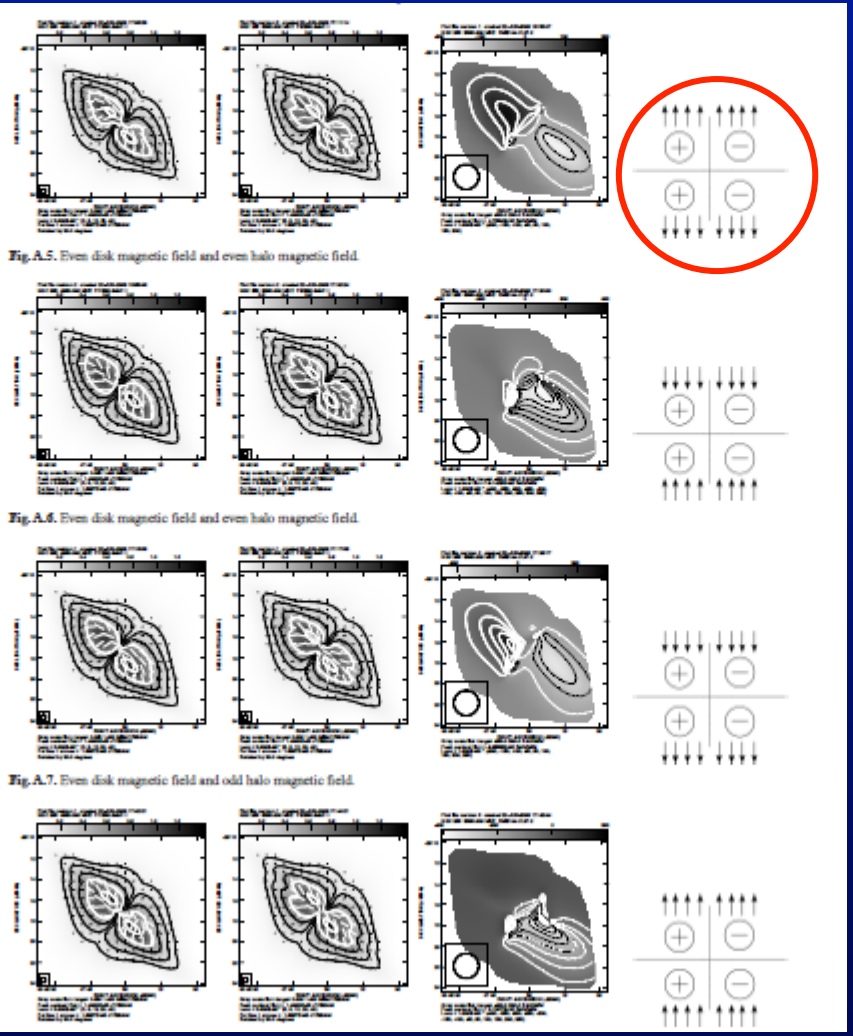


Fig. A.5. Even disk magnetic field and even halo magnetic field.

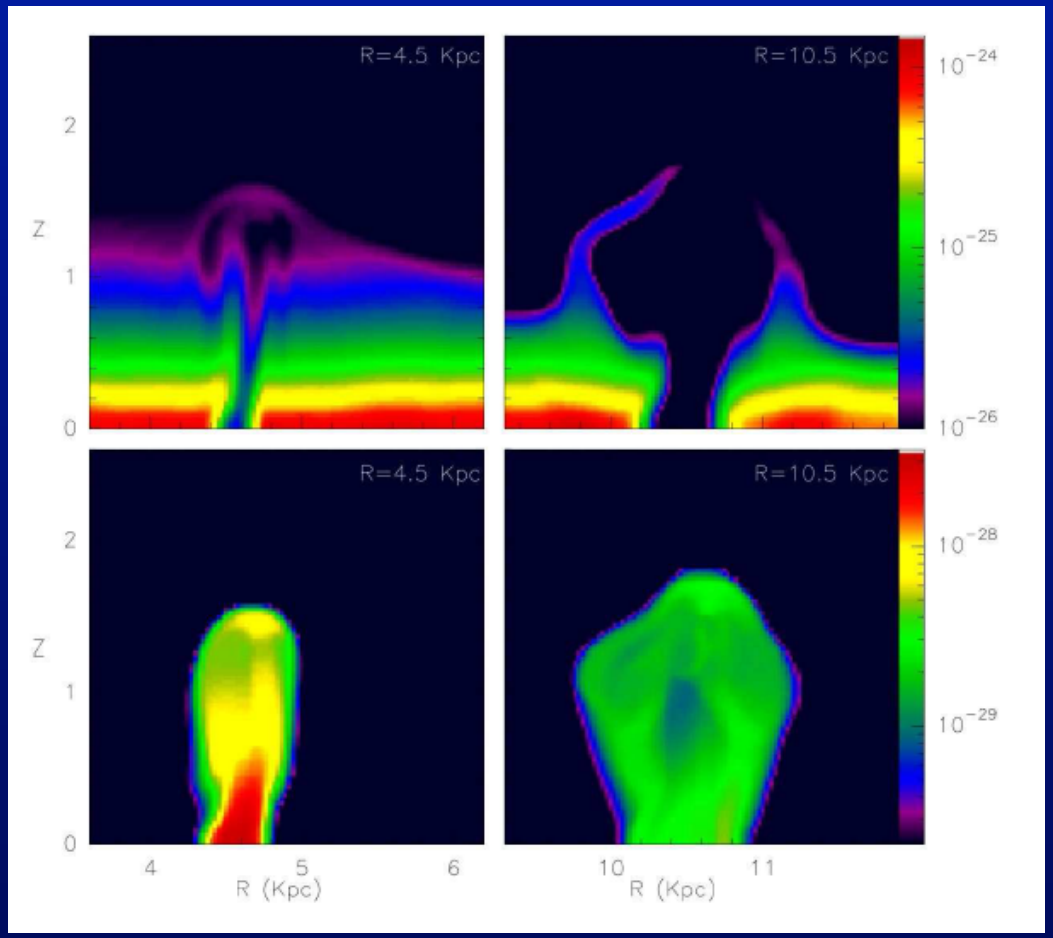
Fig. A.6. Even disk magnetic field and even halo magnetic field.

Fig. A.7. Even disk magnetic field and odd halo magnetic field.

two component model for B

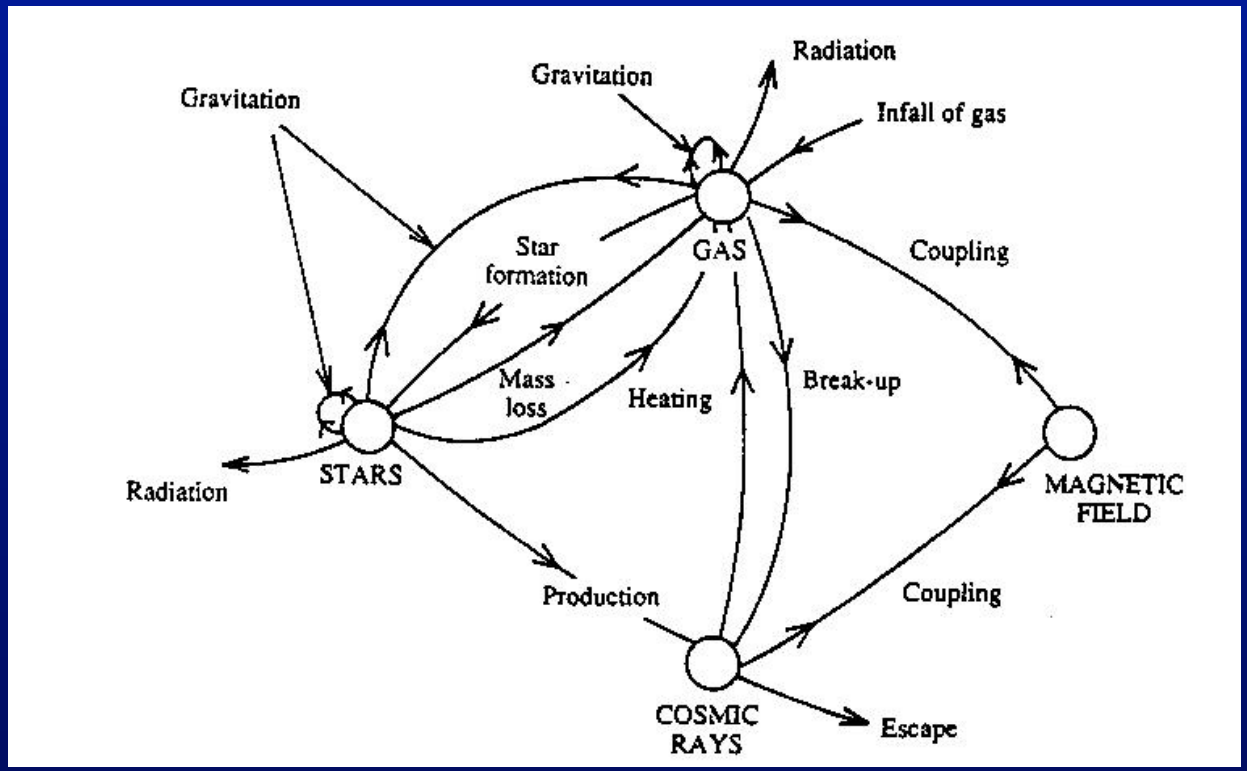
Heesen, Krause, Beck, Dettmar 2009 A&A

SN driven fountain not sufficient

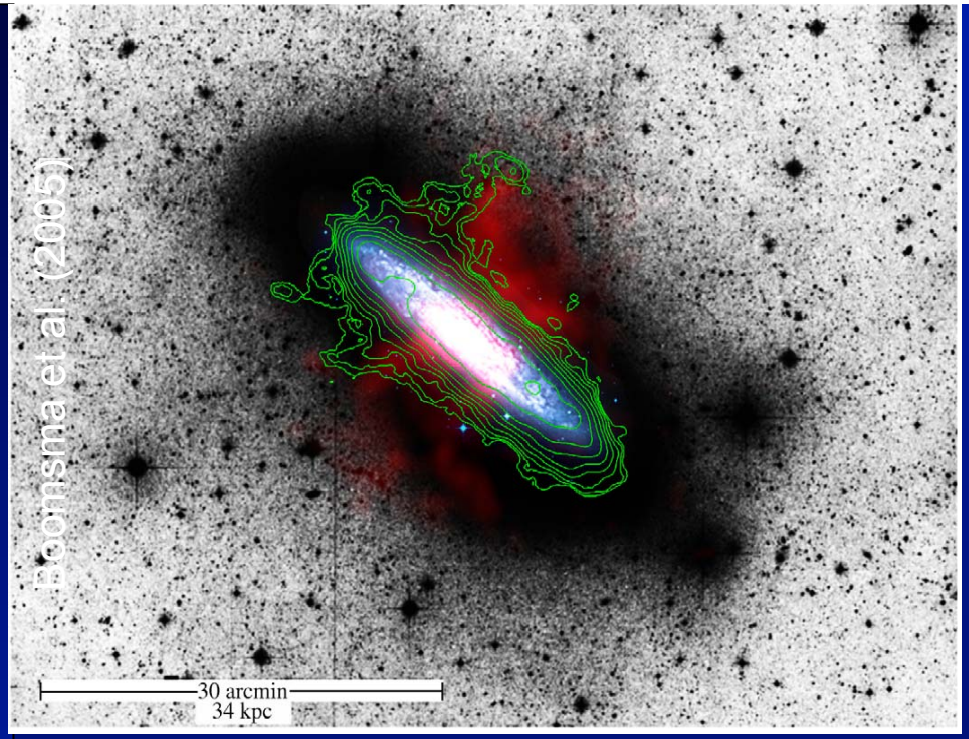


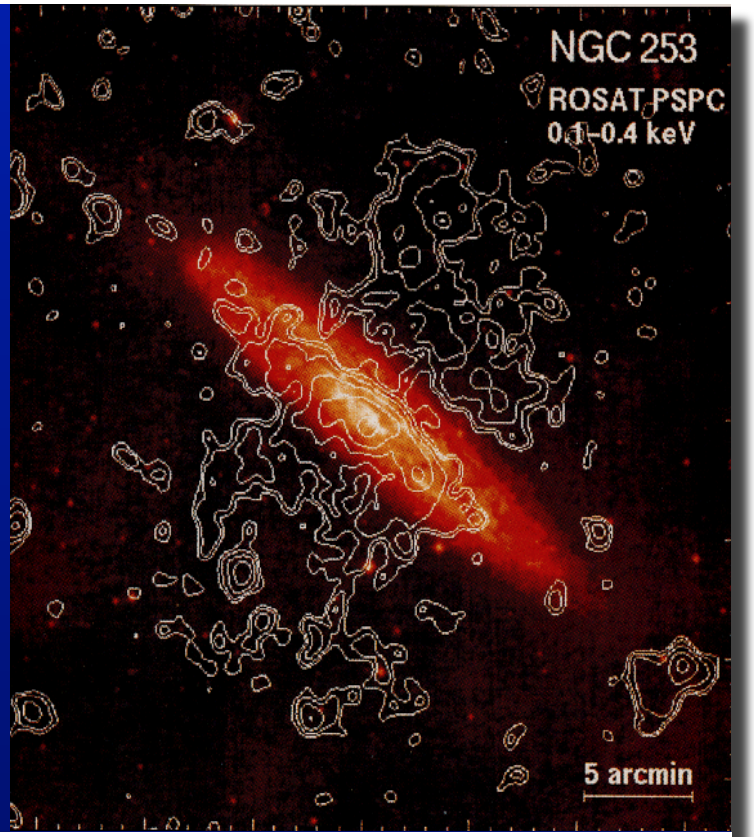
Melioli, …, Dal Pino et al. MN 2008

(from Taylor, Cambridge Univ. Press)



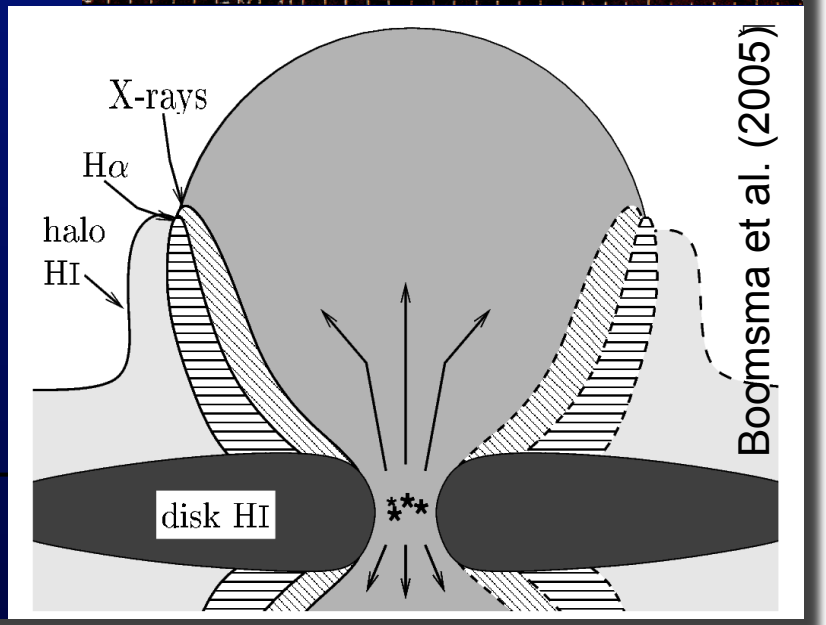
Magnetic Fields and Cosmic Rays contribute significantly to the energy density





Halo of NGC 253:

- X-ray emission
- Hα emission
- HI emission
- radio continuum emission



Magnetized halos of spiral galaxies

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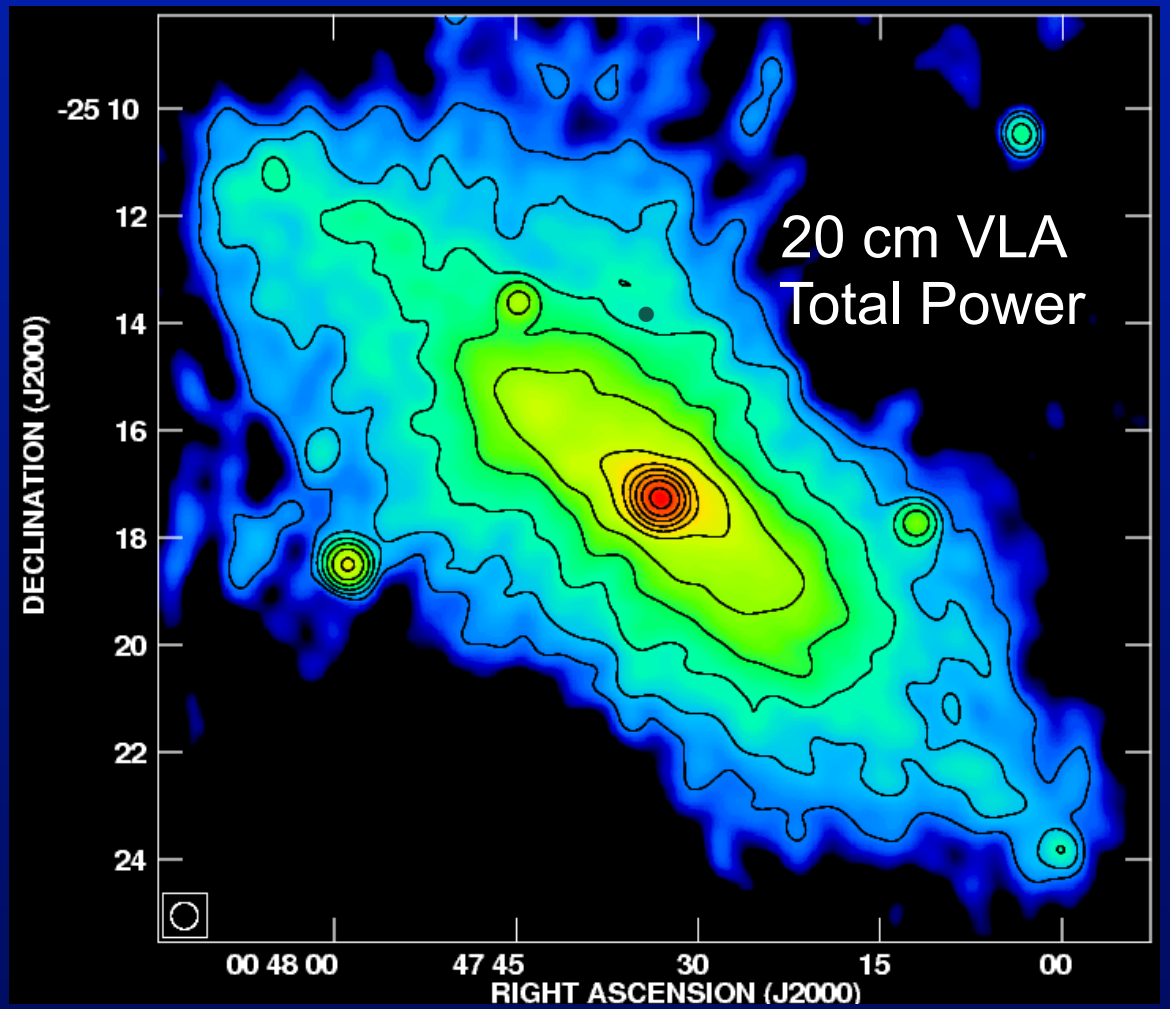
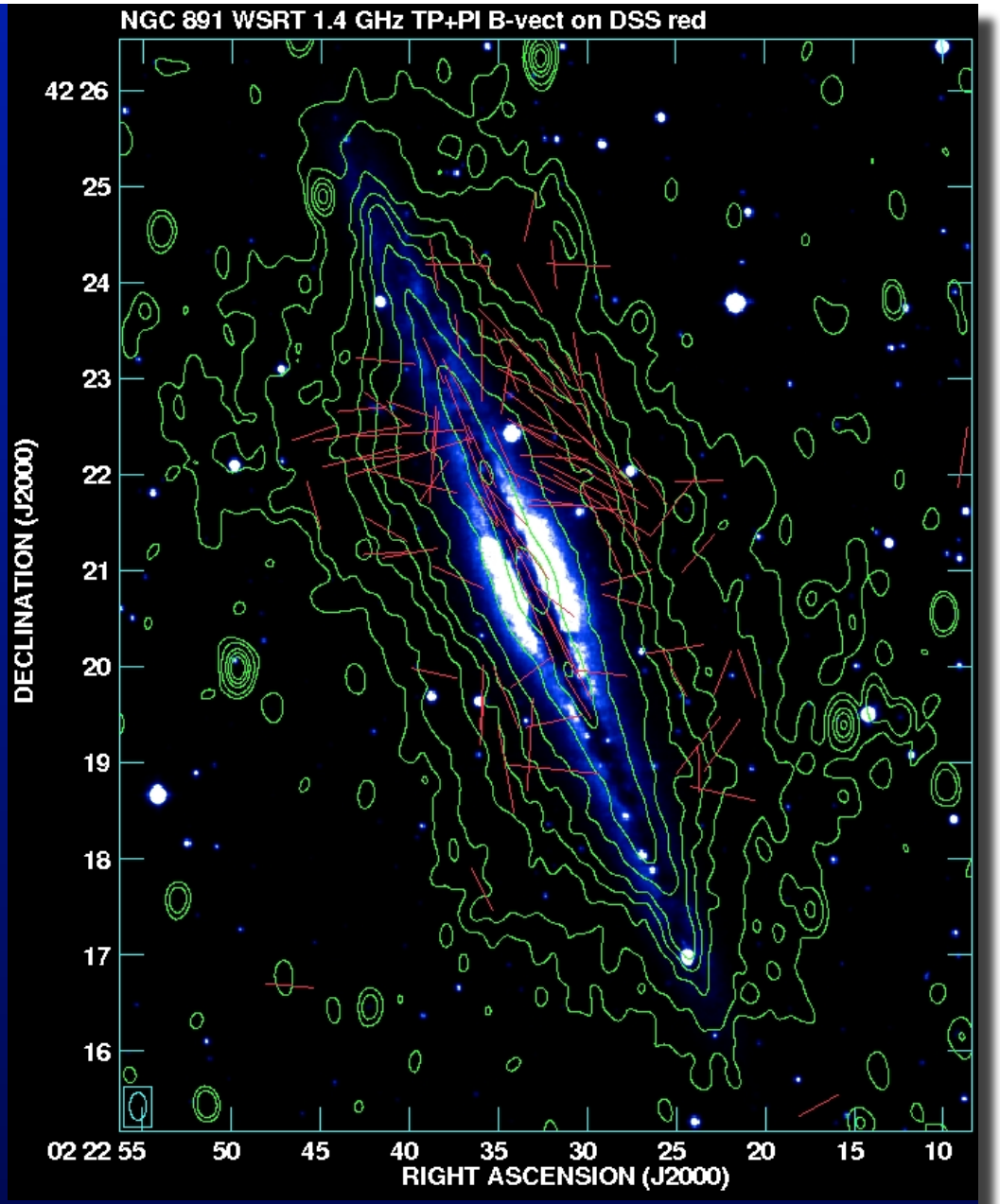
NGC253

Heesen et al. 2009

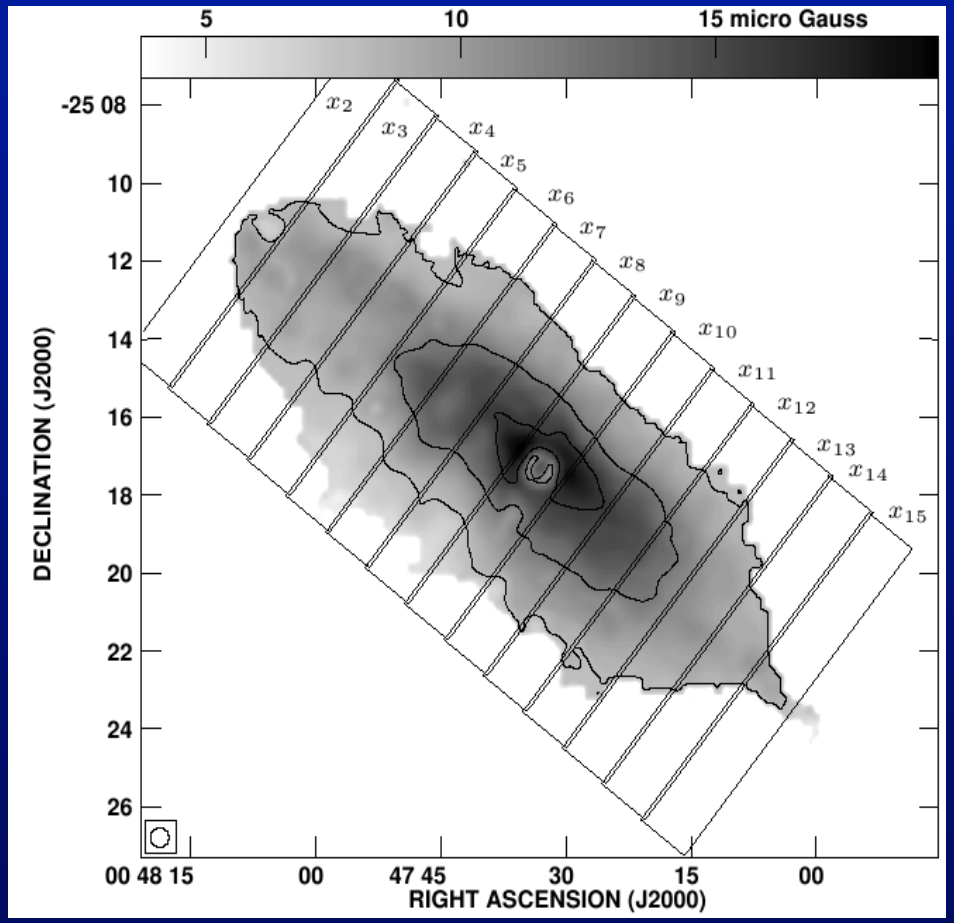


NGC891

Adebahr et al.



Total magnetic field strength

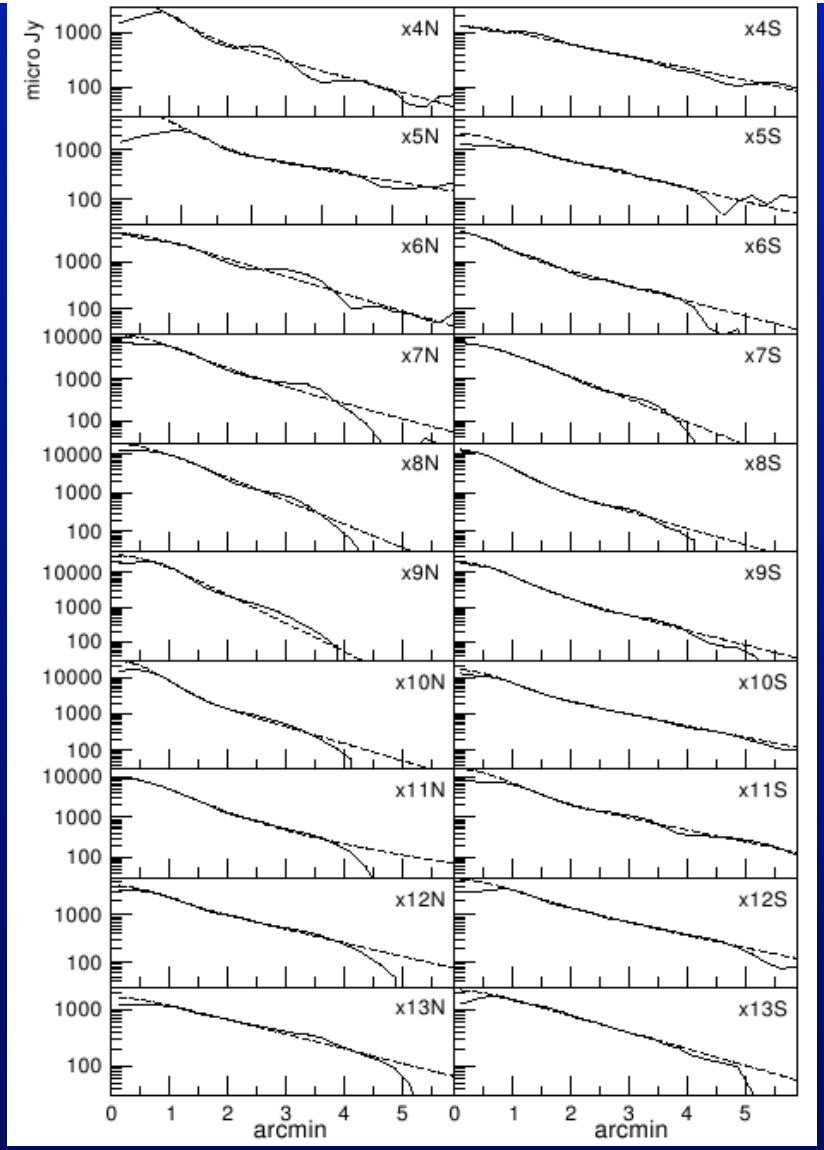


local magnetic field strength

local Synchrotron-lifetime

equipartition magnetic field strength:

$$B \propto L_\nu^{1/(3+\alpha_{\rm nt})}$$



total power emission

distance from the major axis: z

Exponential distribution with scaleheight: h perpendicular to disk: z

typical scaleheight ~ 1.7 kpc

VLA: 6.2 cm

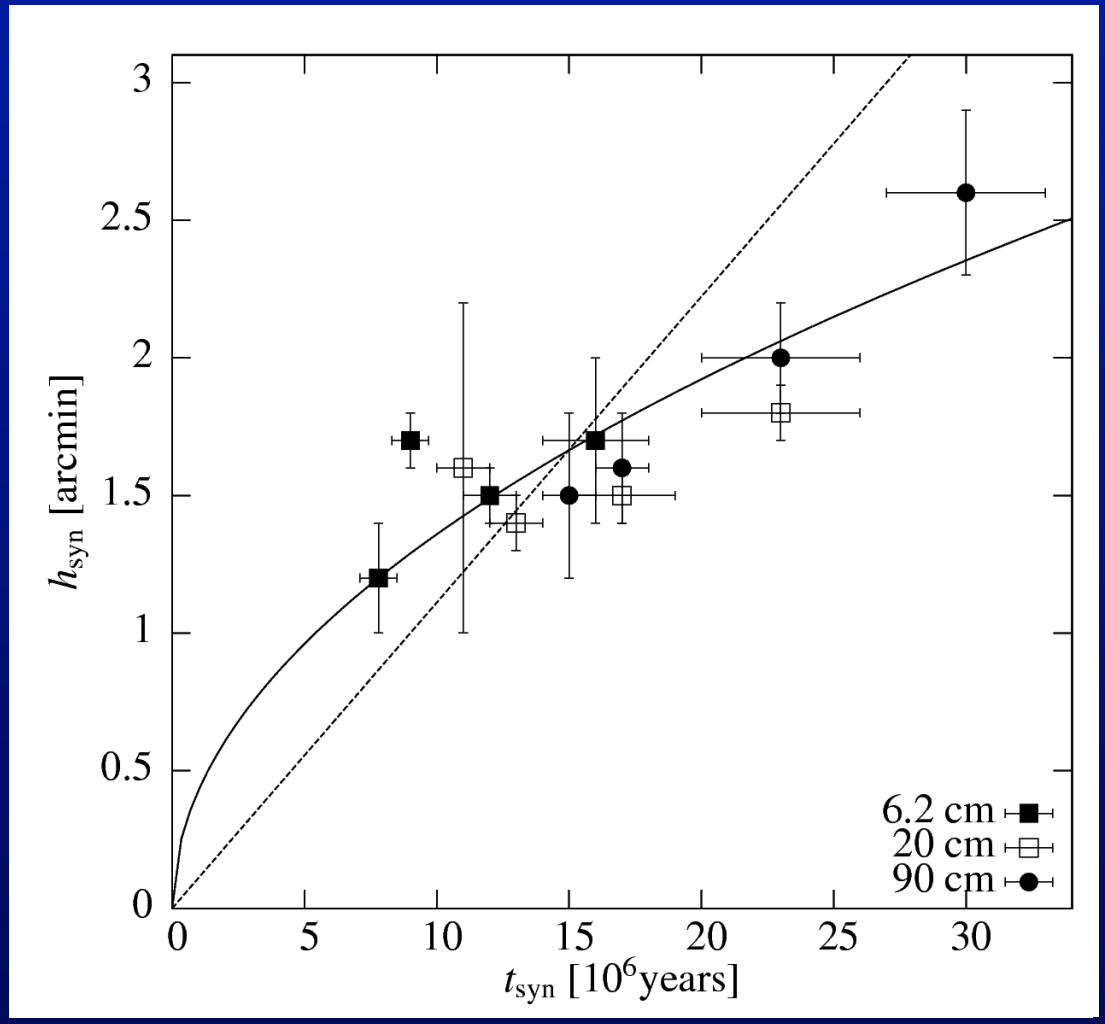
cosmic ray propagation speed (bulk speed):

$$v_e = \frac{3+\alpha_{nt}}{2}\frac{\Delta h_e}{\Delta t_{syn}}$$

$$v_e \cong (300 \pm 40)\,km \cdot s^{-1}$$

close to escape velocity!

Scaleheight vs. Synchrotron- lifetime



total power scaleheight

Synchrotron-lifetime

VLA + Effelsberg 6.2 cm

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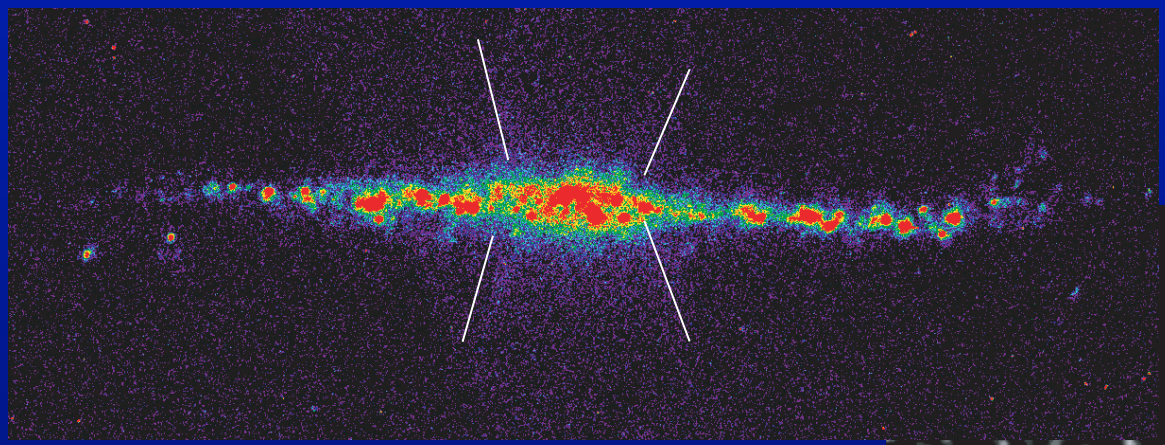
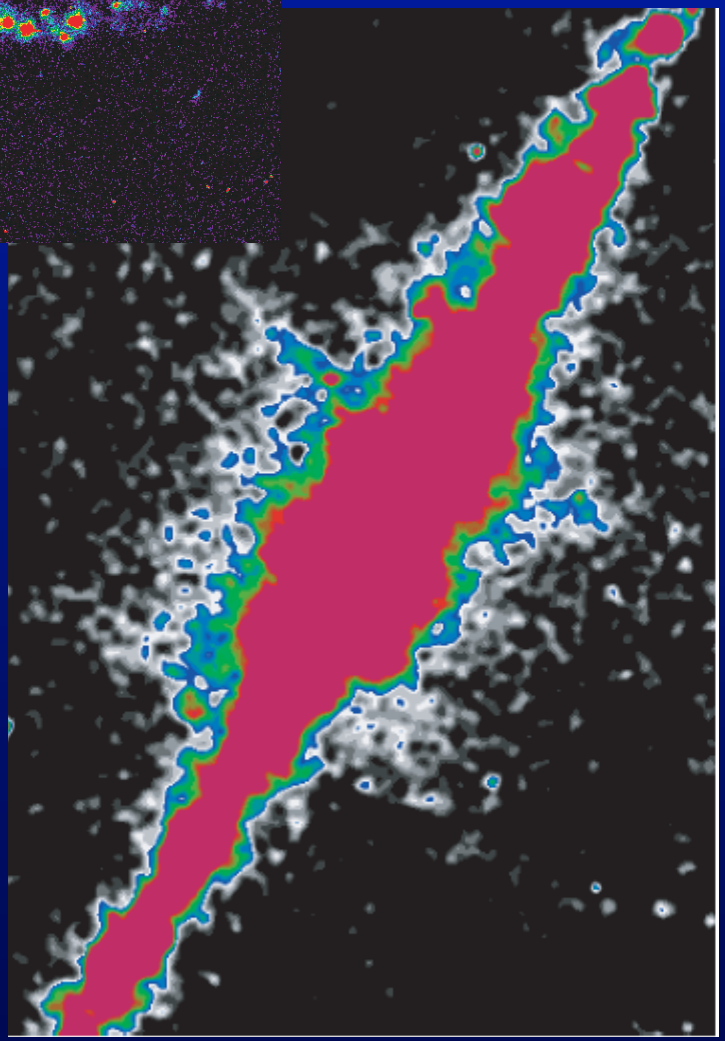
Oct. 4, 2010



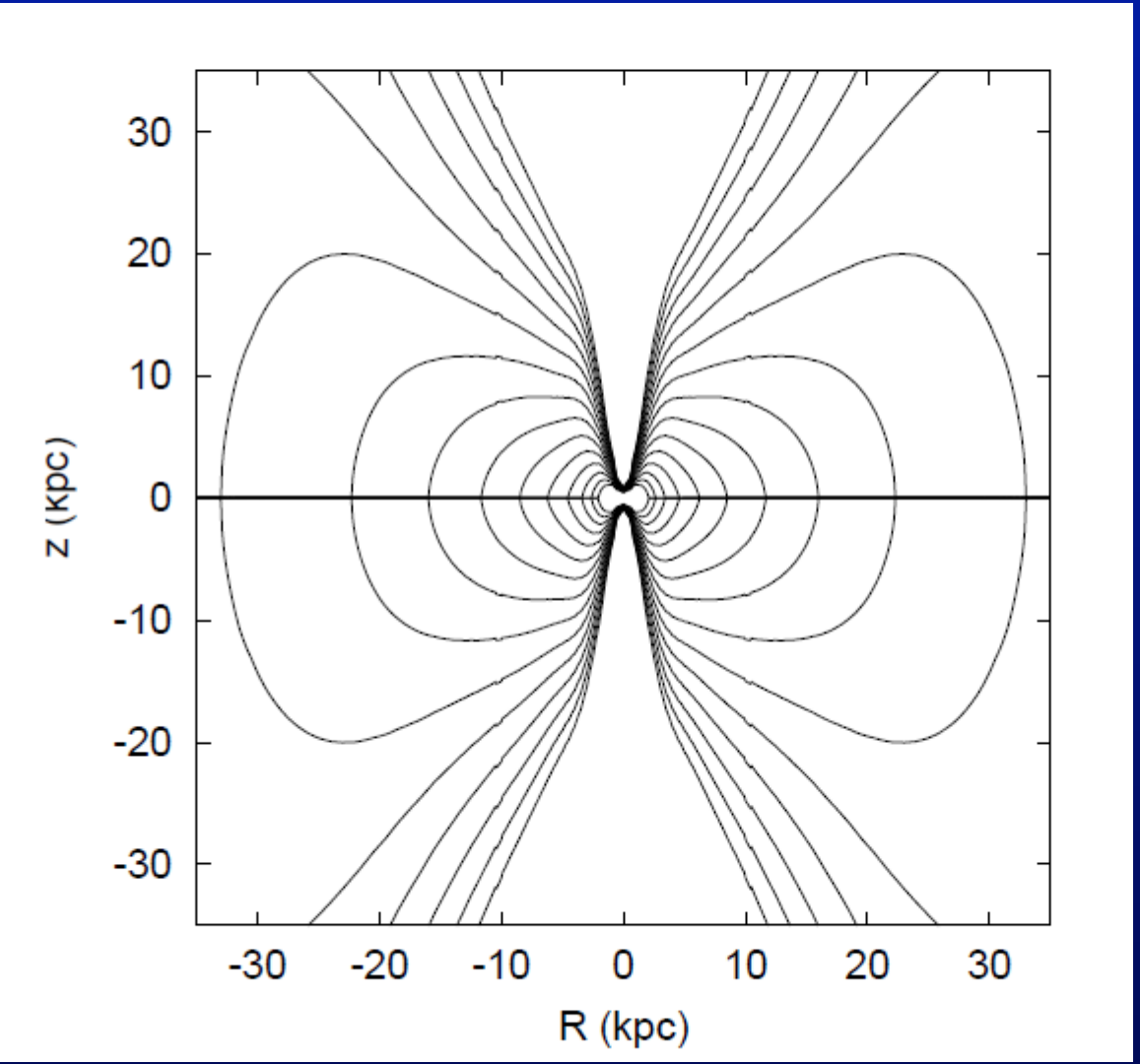


UGC 10043 in Hα

Matthews & de Grijs

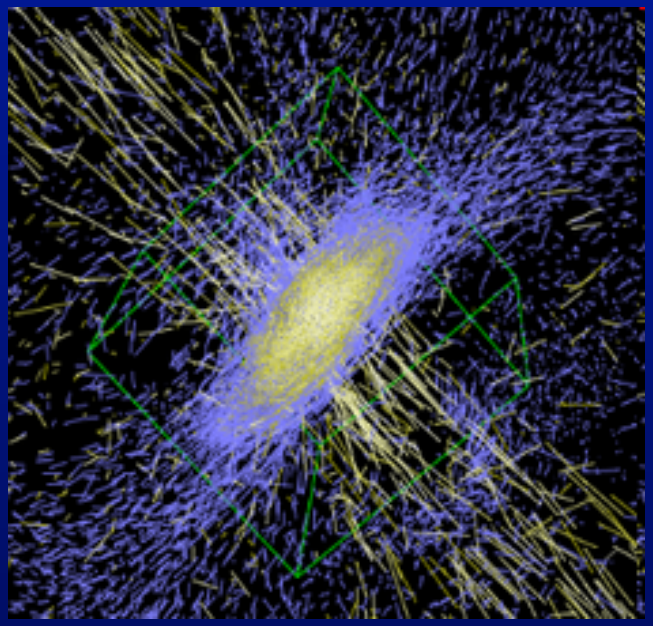
AJ 128, 137

Galactic gravitational potential

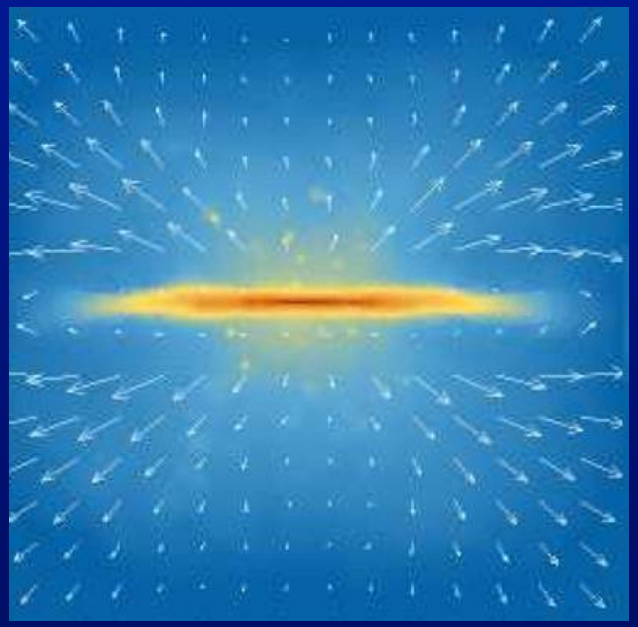


Kalberla ApJ 588 (2003)

Do galactic winds play a role?



Springel/MPA



Dalla Veccia & Schaye/Leiden

Two important questions:

- How does the magnetic field on galactic scale built up in the supernova-driven turbulent ISM
- How does the CR component contribute to the onset of galactic winds and thus to the global (chemical) evolution of galaxies and the intergalactic medium.

The End

The work at Ruhr-University Bochum in this area

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