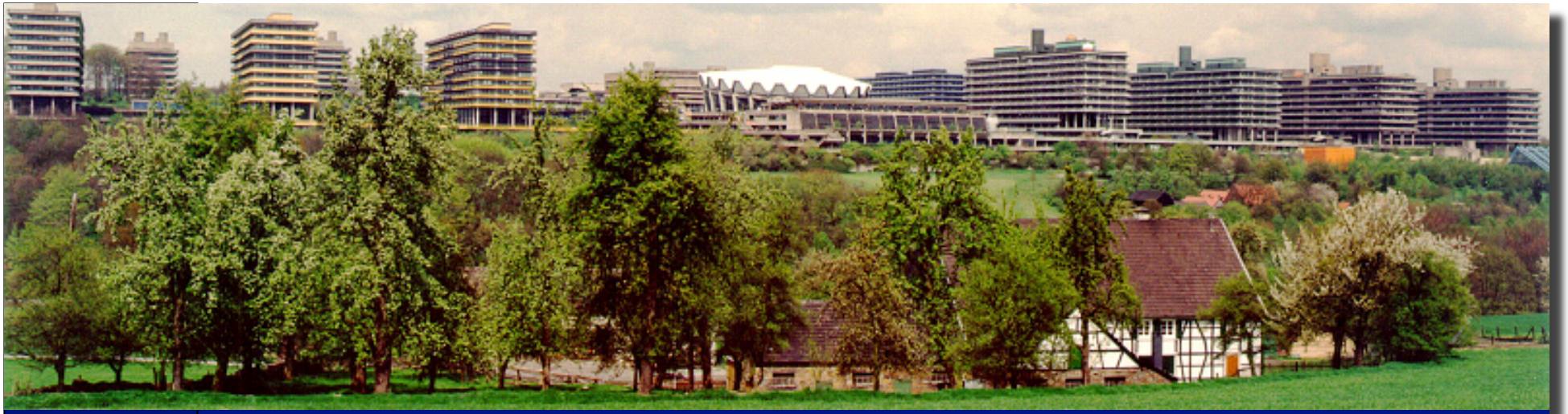

Cosmic ray driven galactic winds and magnetized galactic halos

Ralf-Jürgen Dettmar
Astronomical Institute
Ruhr-University Bochum

Strong magnetic fields in normal galaxies at high redshift

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Letter

Nature **454**, 302-304 (17 July 2008) | doi:10.1038/nature07105; Received 23 November 2007; Accepted 13 May 2008

Strong magnetic fields in normal galaxies at high redshift

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The origin and growth of magnetic fields in galaxies is still something of an enigma[1]. It is generally assumed that seed fields are amplified over time through the dynamo effect[2, 3, 4, 5], but there are few constraints on the timescale. It was recently demonstrated that field strengths as traced by rotation measures of distant (and hence ancient) quasars are comparable to those seen today[6], but it was unclear whether the high fields were in the unusual environments of the quasars themselves or distributed along the lines of sight. Here we report high-resolution spectra that demonstrate that the quasars with strong Mg II

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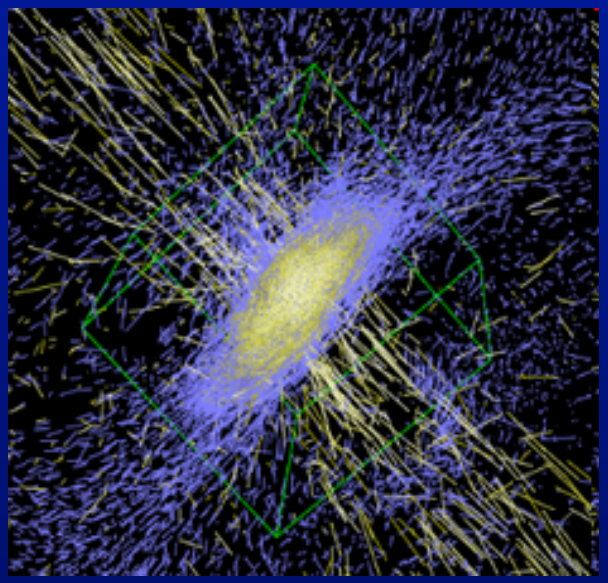
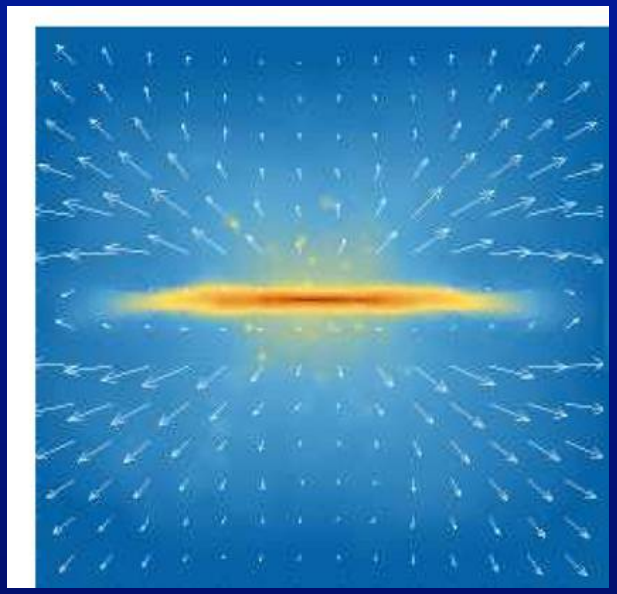
Do galactic winds play a role?

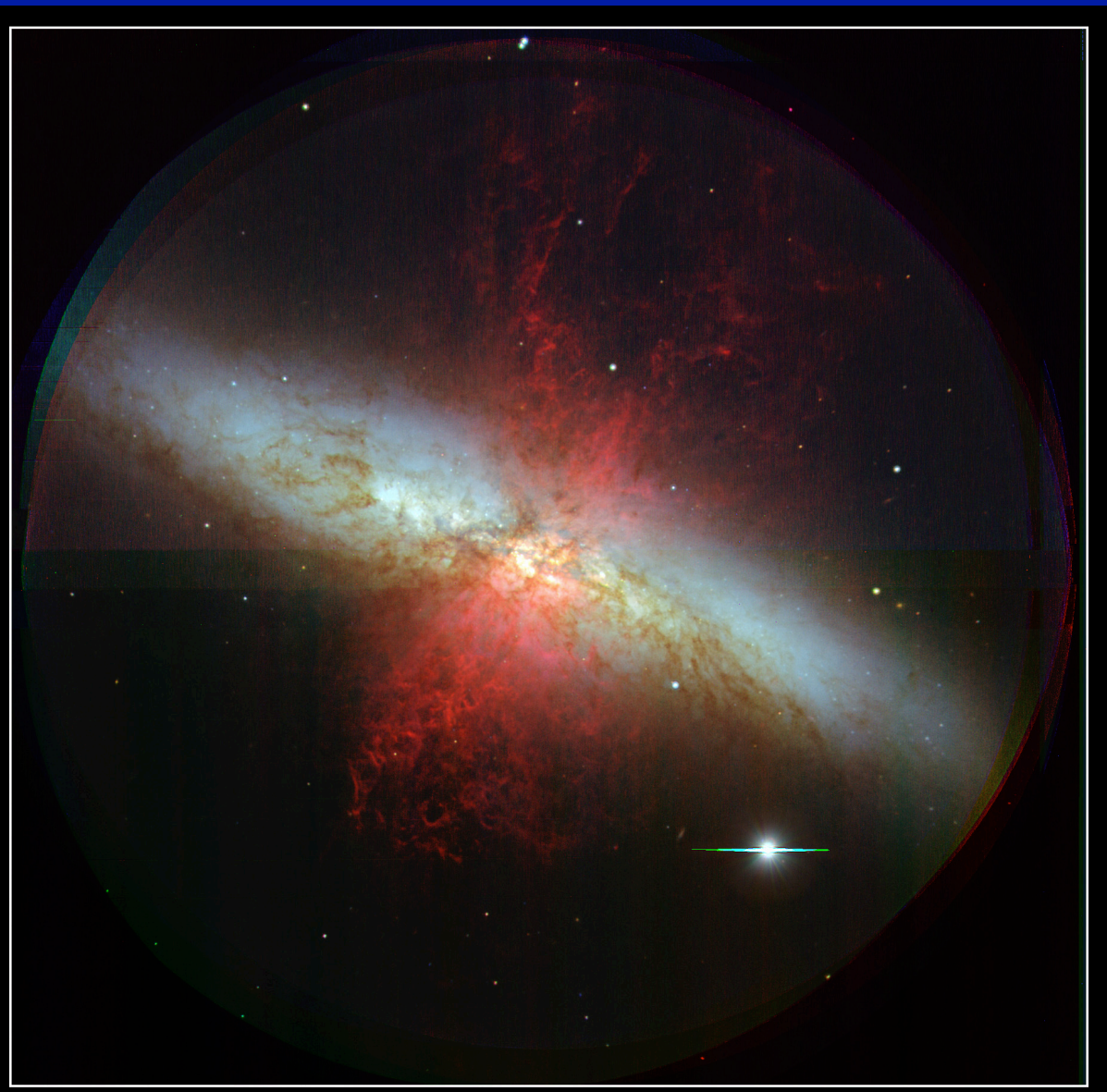


Springel/MPA



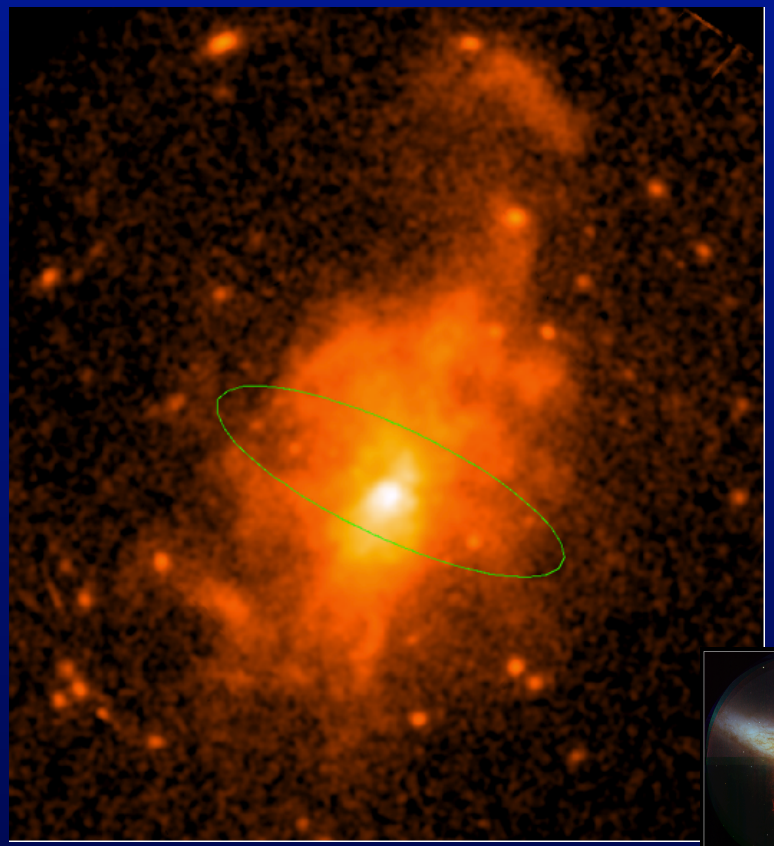
Dalla Veccia & Schaye/Leiden

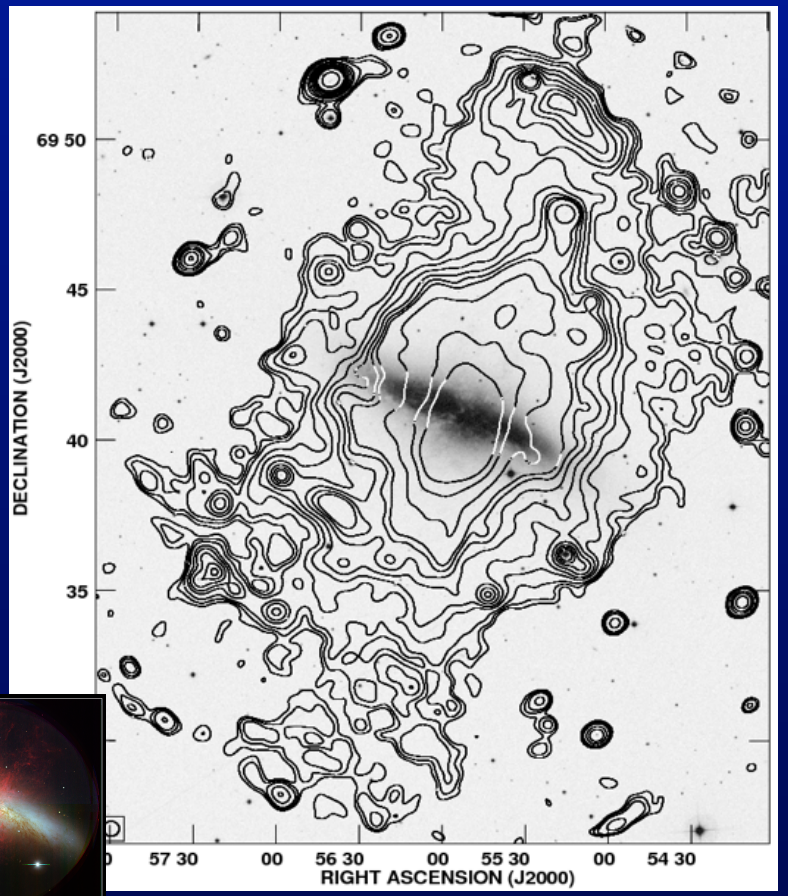
Starburst M82 (Subaru Teleskop)

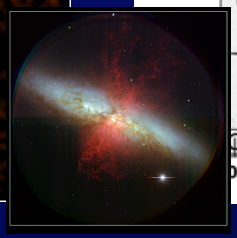


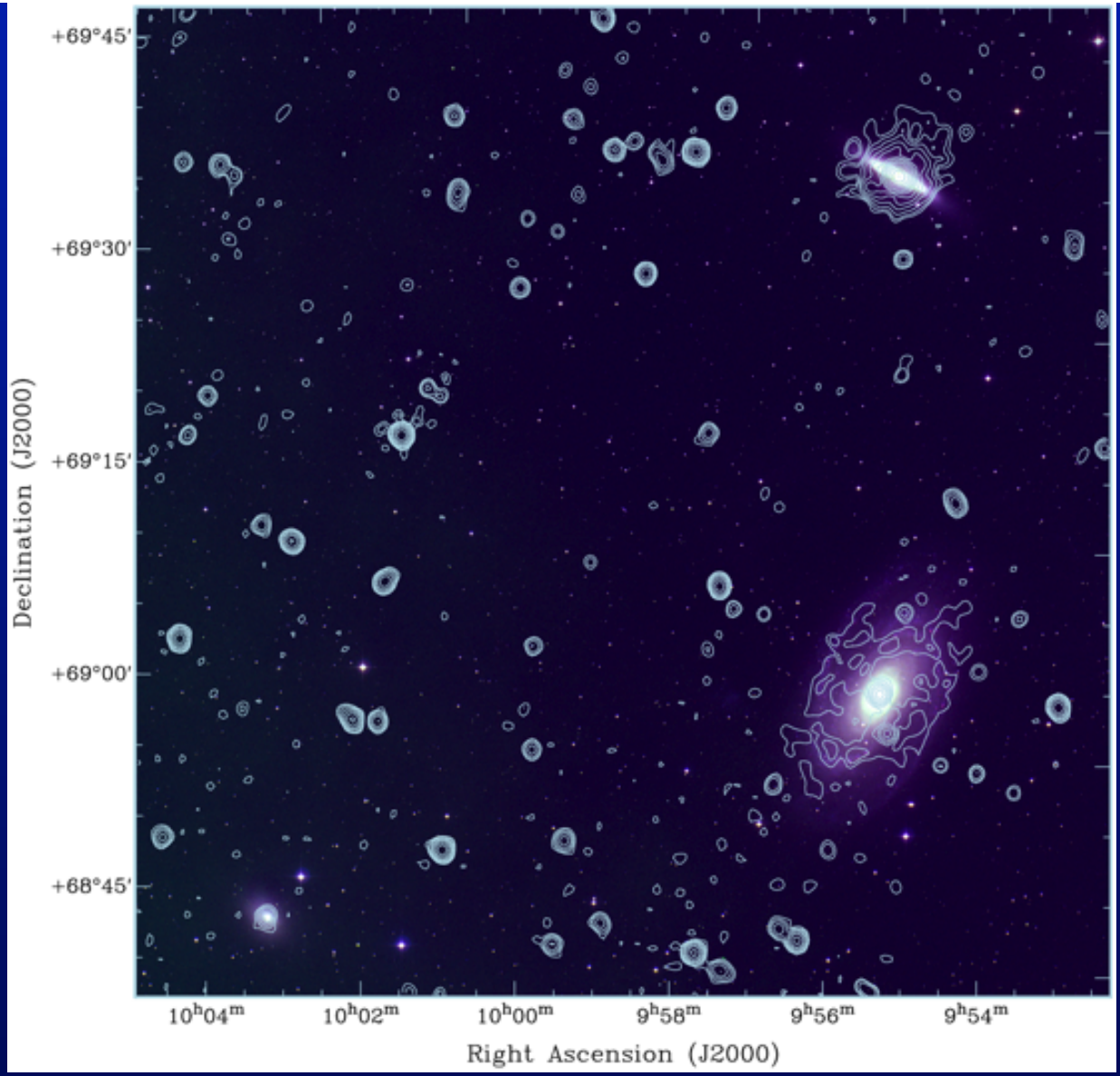
M82 in X-rays (Wezgowiec, Dettmar, et al. in prep.)

XMM/Newton



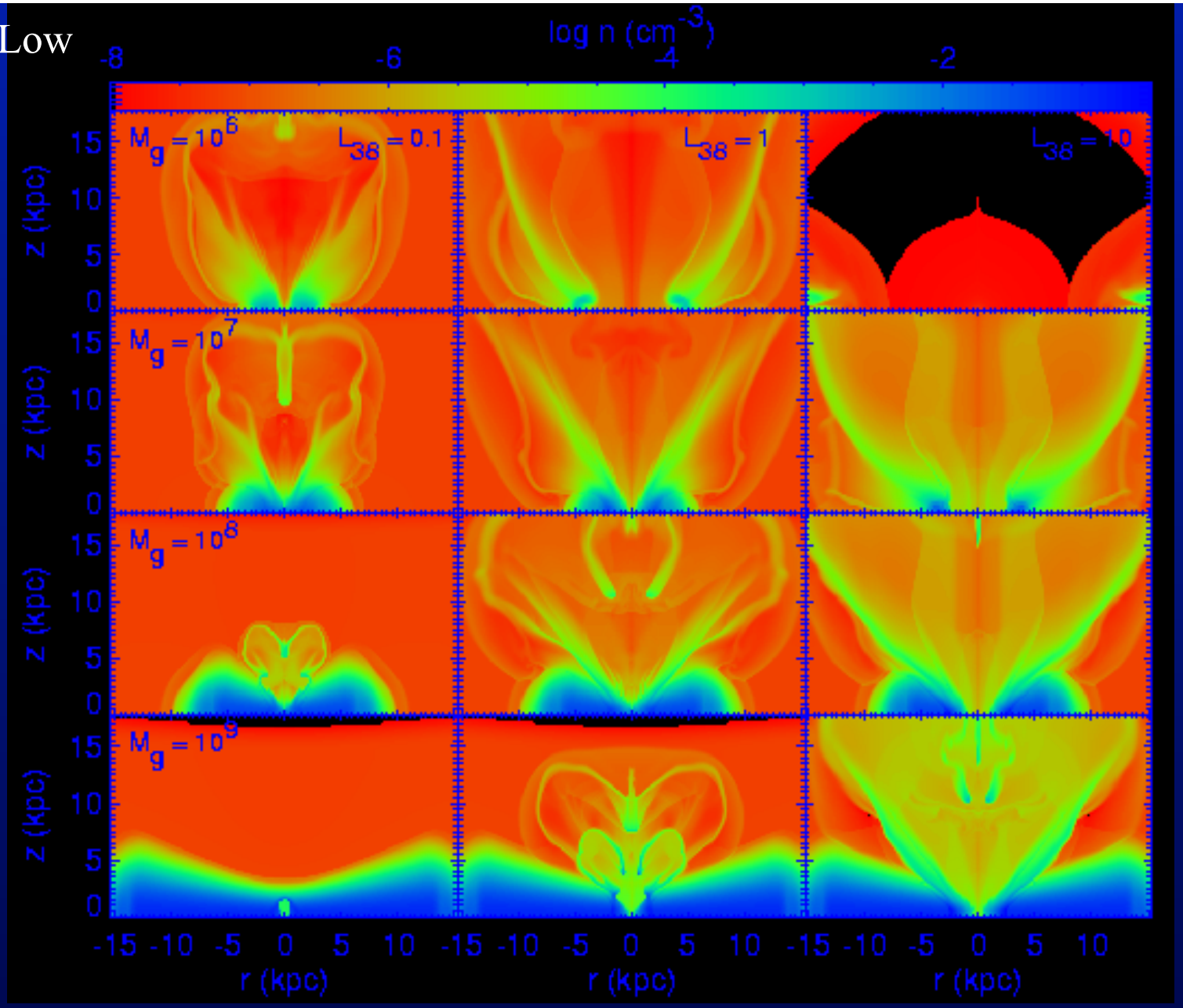




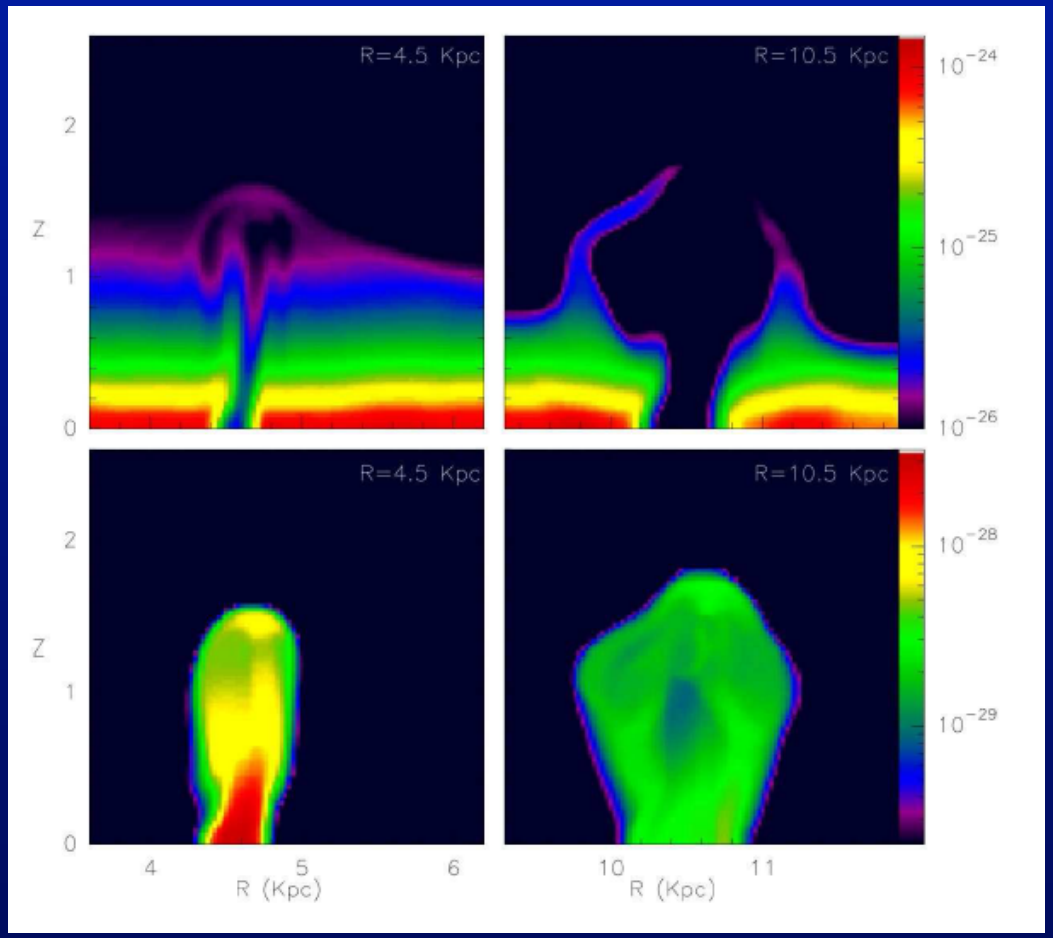


WSRT 90cm (Adebahr, Dettmar et al.)

*F*errara & McLow

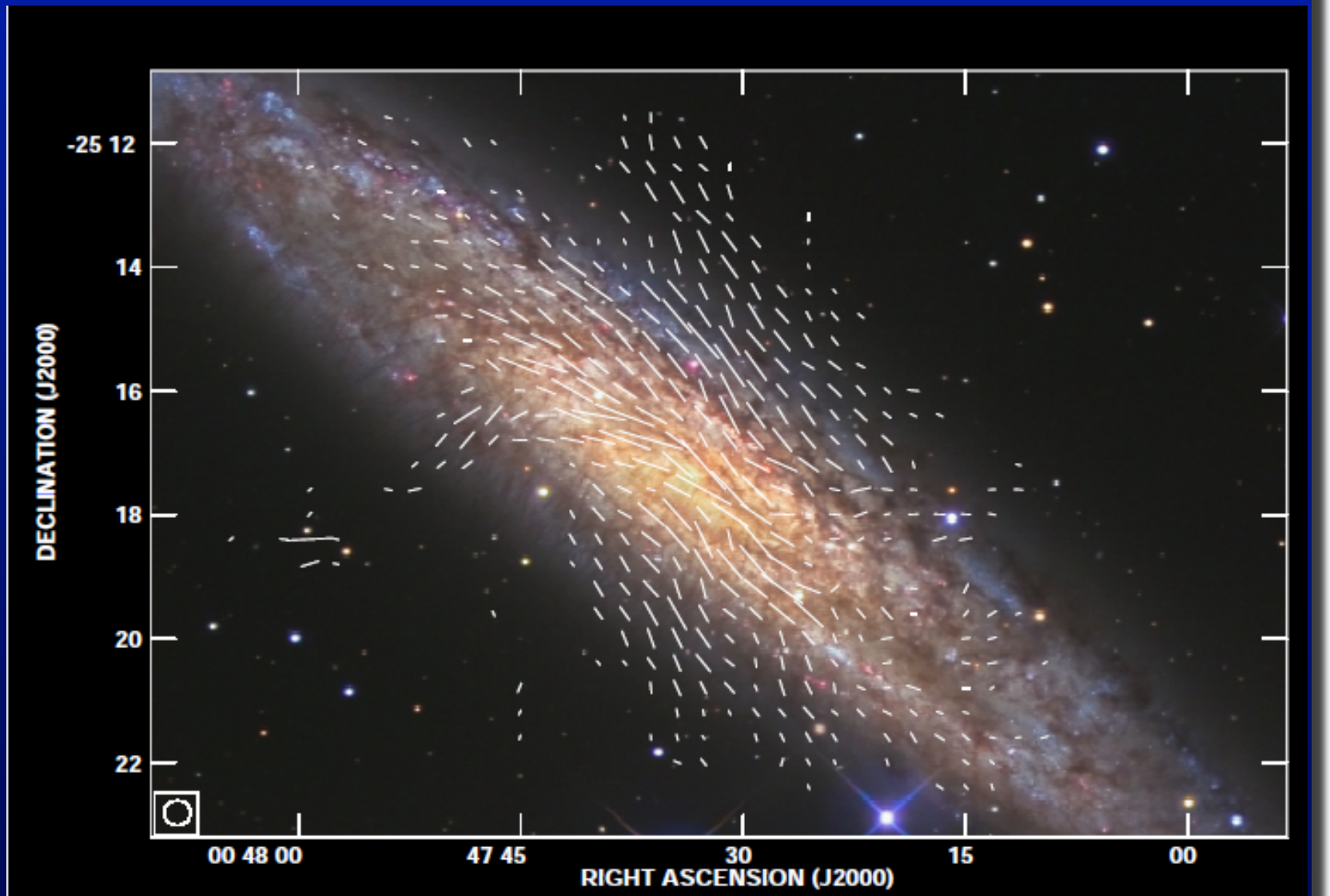


SN driven fountain not sufficient to drive wind



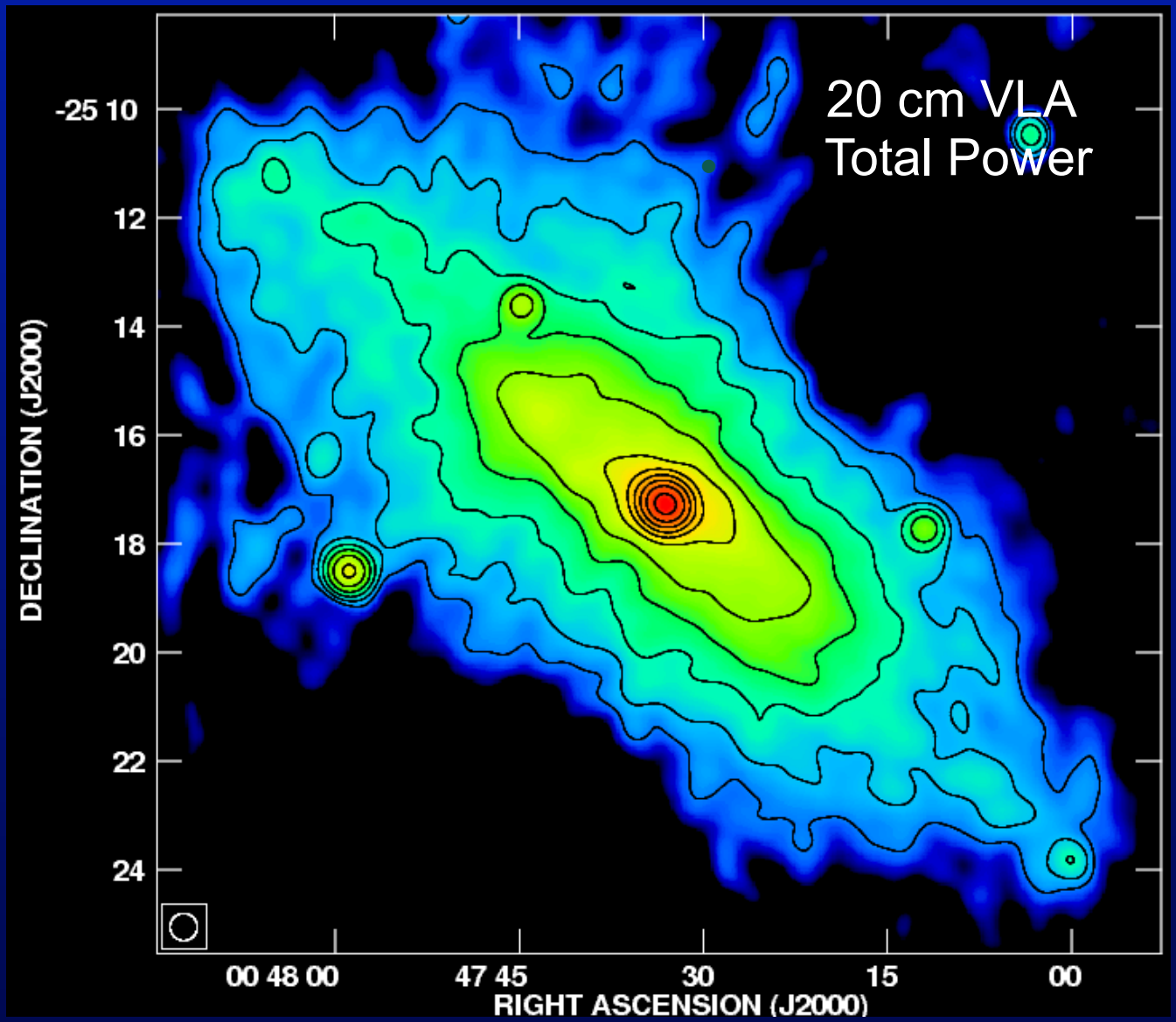
Melioli, …, Dal Pino et al. MN 2008

NGC 253 radiocontinuum study at 3, 6, 20, 90 cm

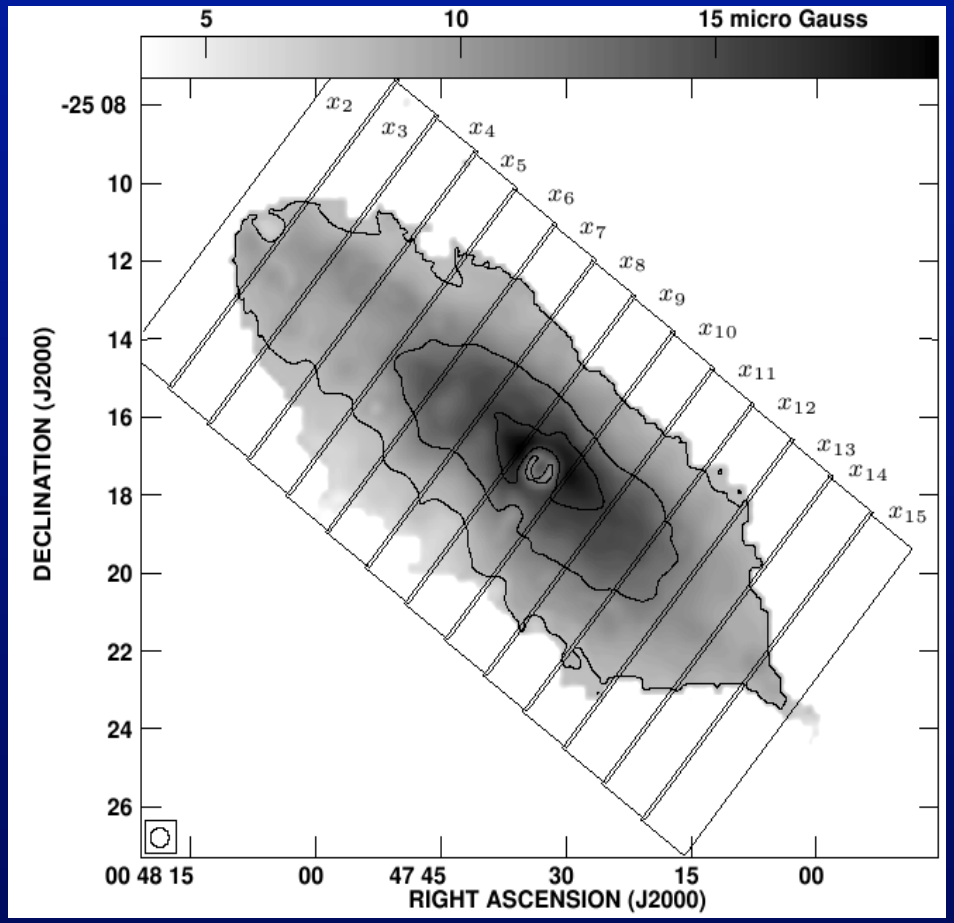


Heesen, Krause, Beck, Dettmar 2009 A&A 494, 563 & 506, 1013

VLA 6cm mosaic (15 pointings)



Total magnetic field strength

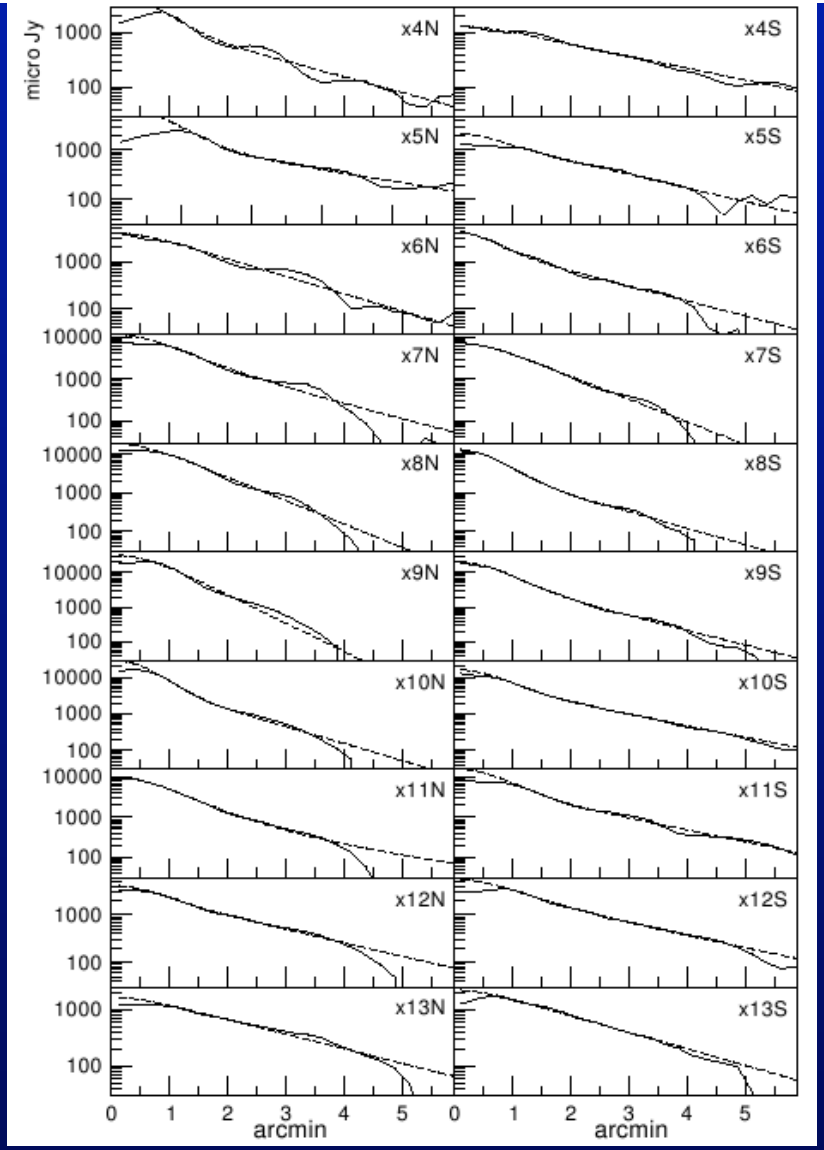


local magnetic field strength

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

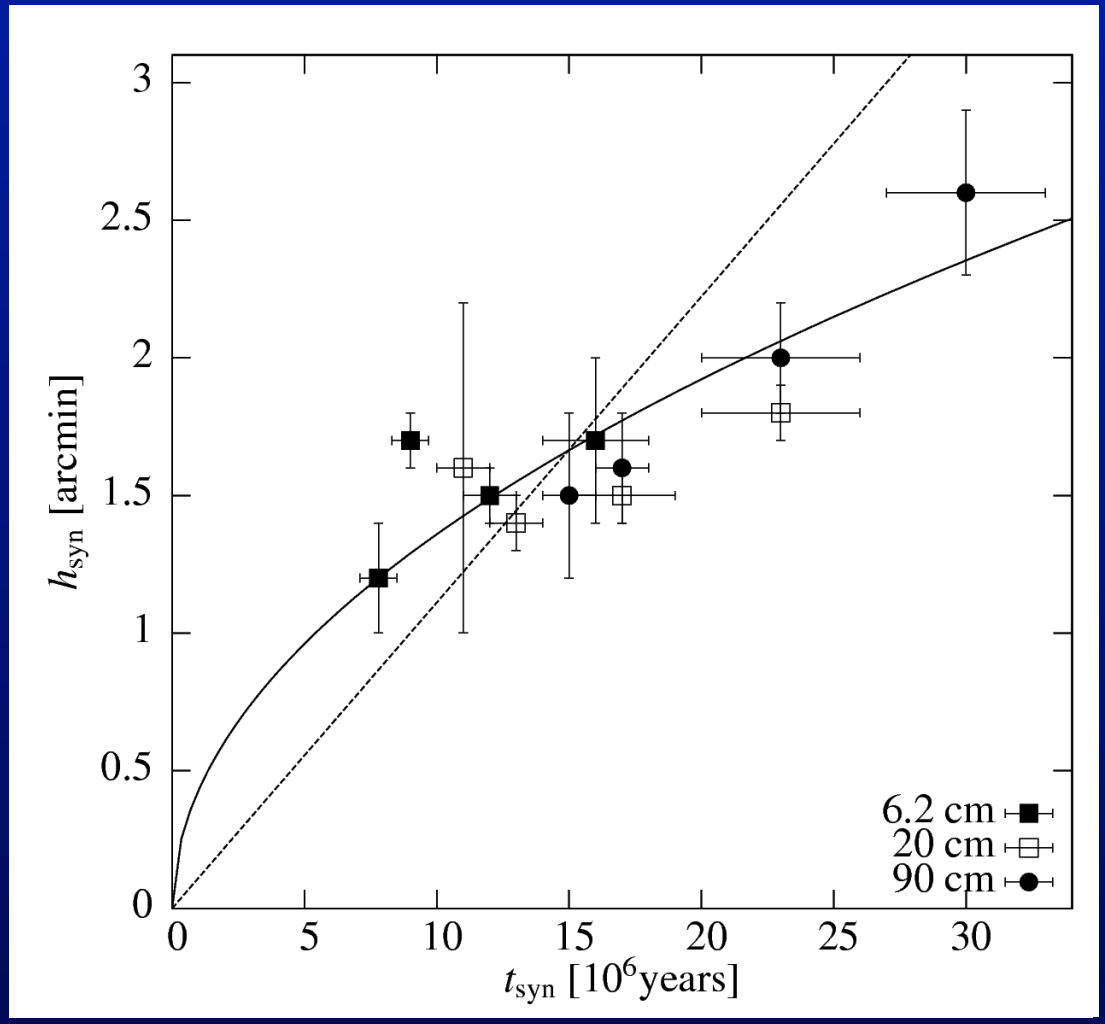
cosmic ray propagation speed (bulk speed):

$$v_{\rm e} = \frac{3+\alpha_{\rm nt}}{2}\frac{\Delta h_{\rm e}}{\Delta t_{\rm Syn}}$$

λ6.2 cm: $\bar{v}_{\lambda 6.2} = (280 \pm 40)\ \mathrm{km\,s^{-1}}$

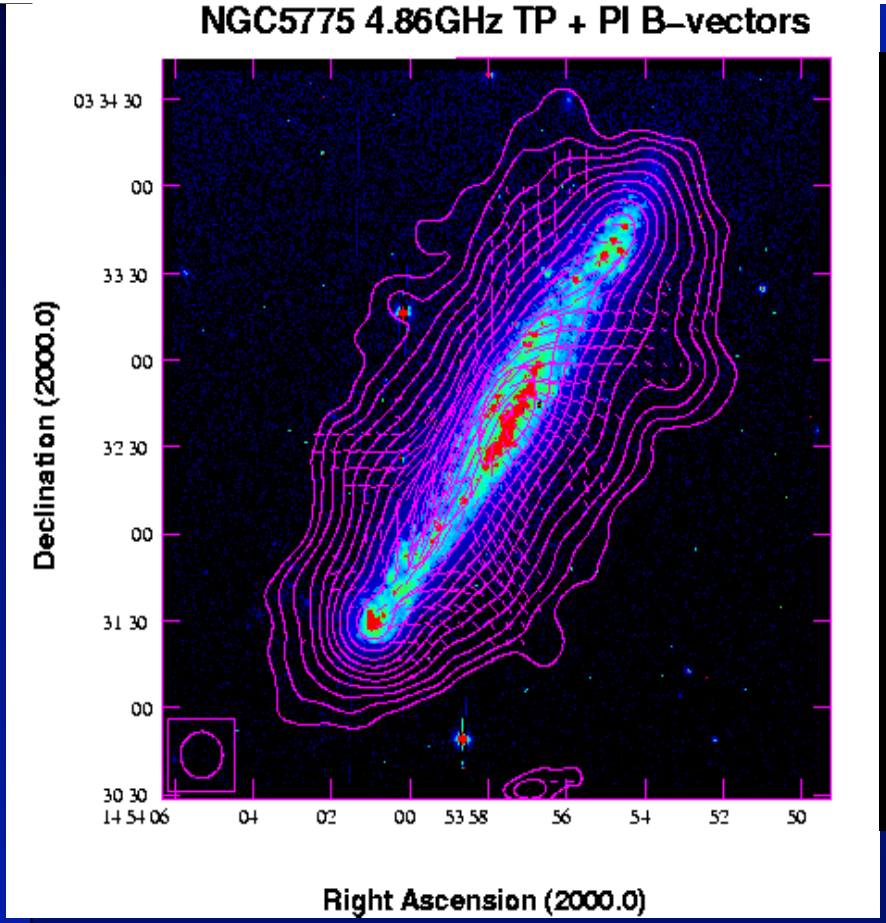
close to escape velocity!

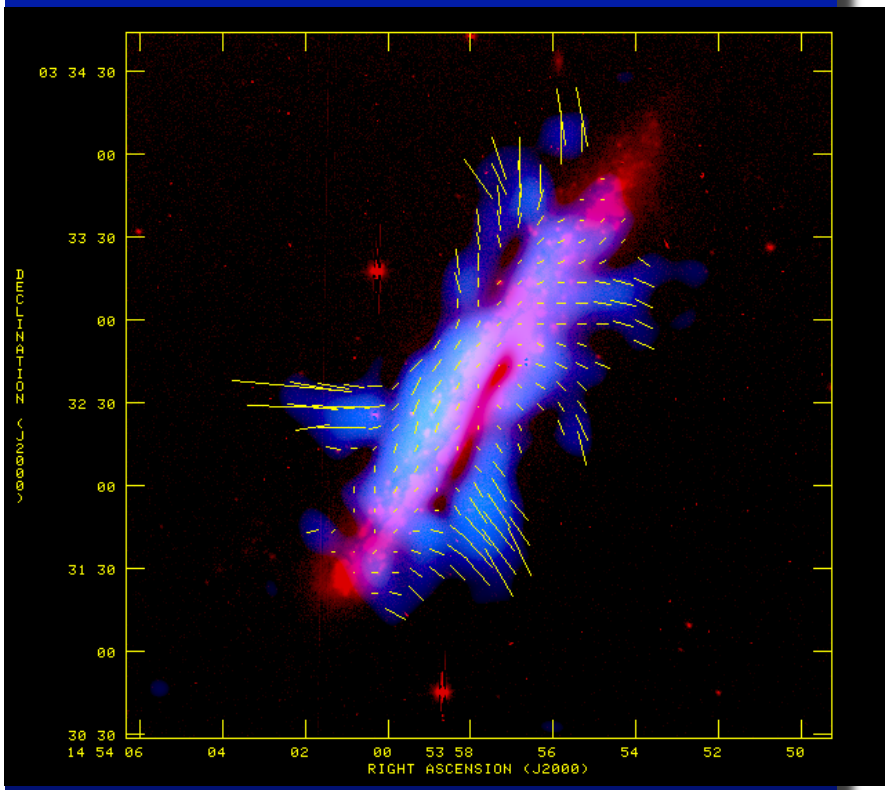
Scaleheight vs. Synchrotron- lifetime



total power scaleheight

Synchrotron-lifetime

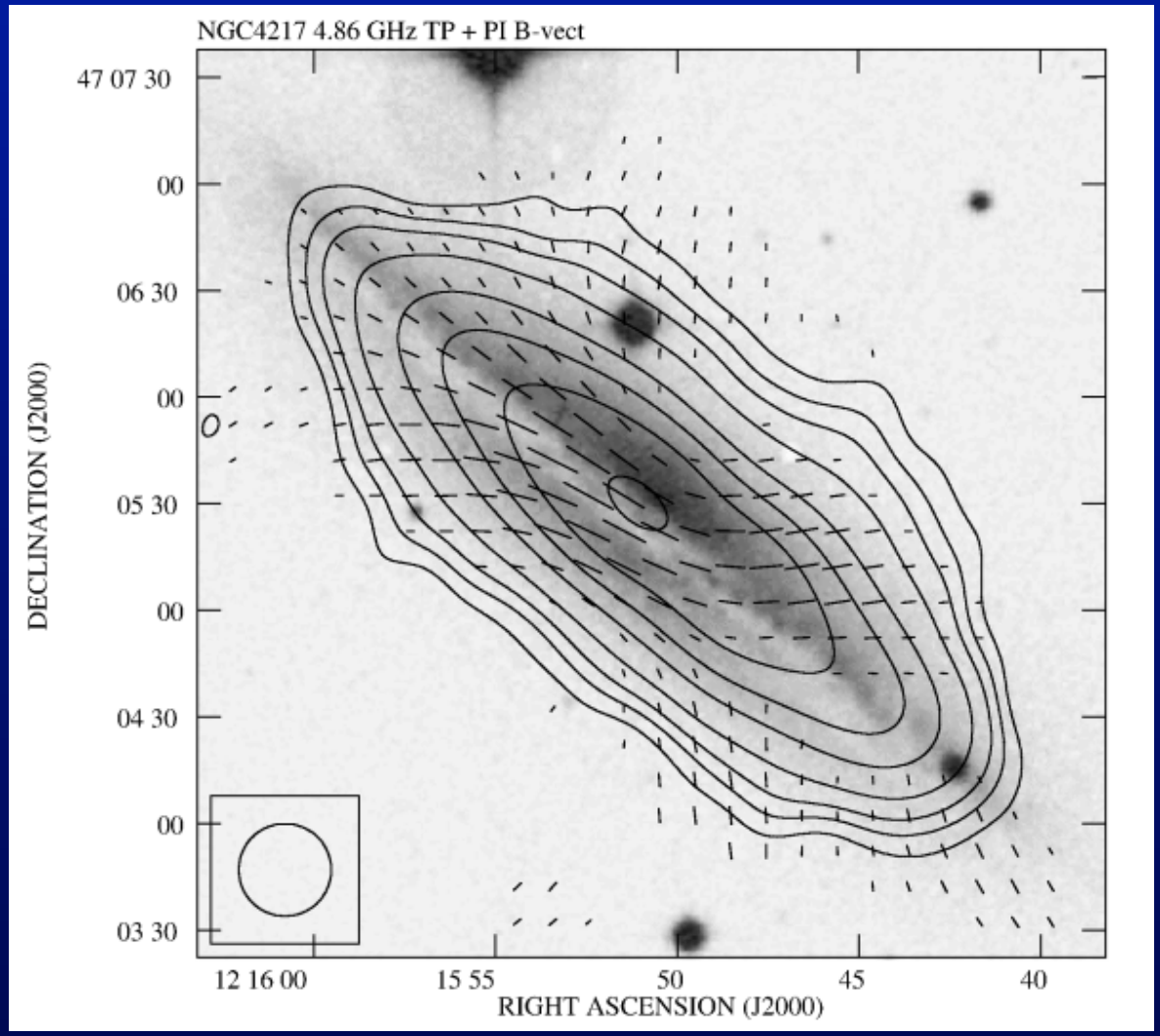




Soida, Krause, Dettmar, Urbanik A&A 2011 in press

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

Summary:

Halos of spiral galaxies have a significant poloidal magnetic field component (quadrupol field)

The propagation of cosmic rays indicate bulk velocities close to escape velocity

Cosmic ray pressure discussed to support galactic winds

The End

Supported by DFG and DLR