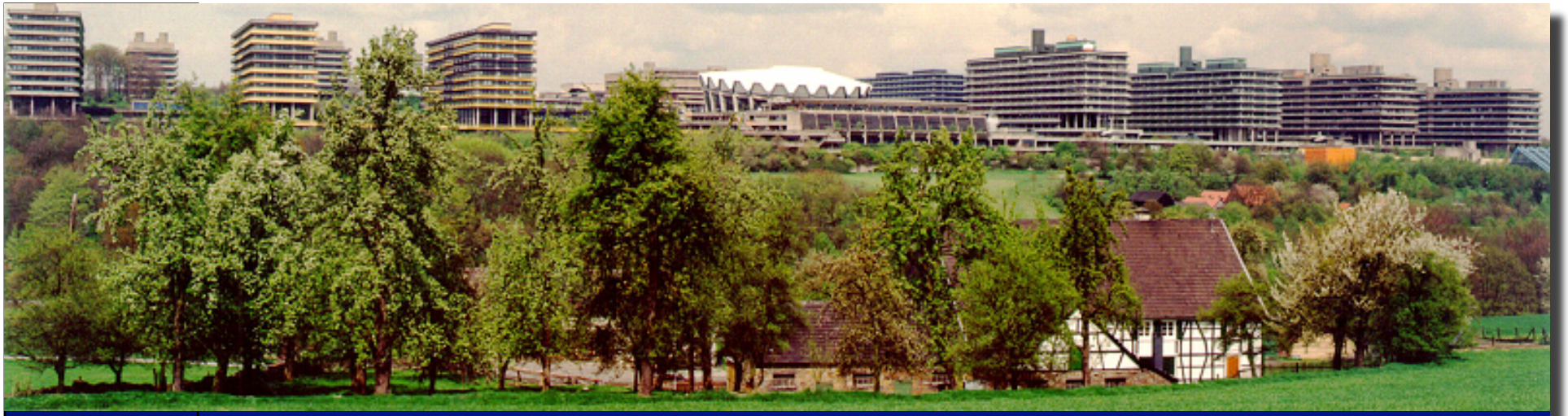


„Extraplanar Gas“ =
Gaseous Halos of Spiral Galaxies and the Interstellar Disk-Halo Connection

Ralf-Jürgen Dettmar

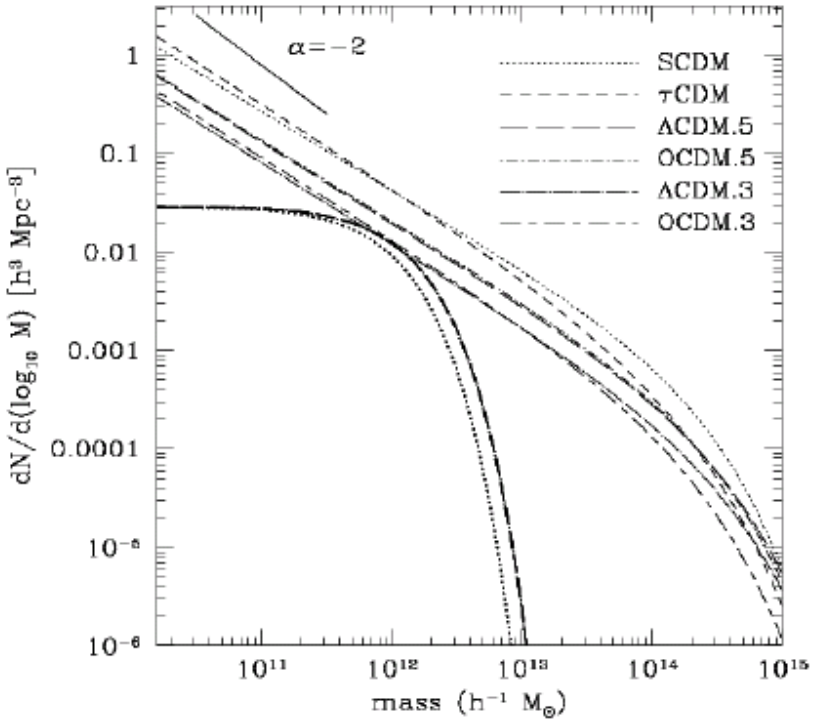
Astronomical Institute

Ruhr-University Bochum

with

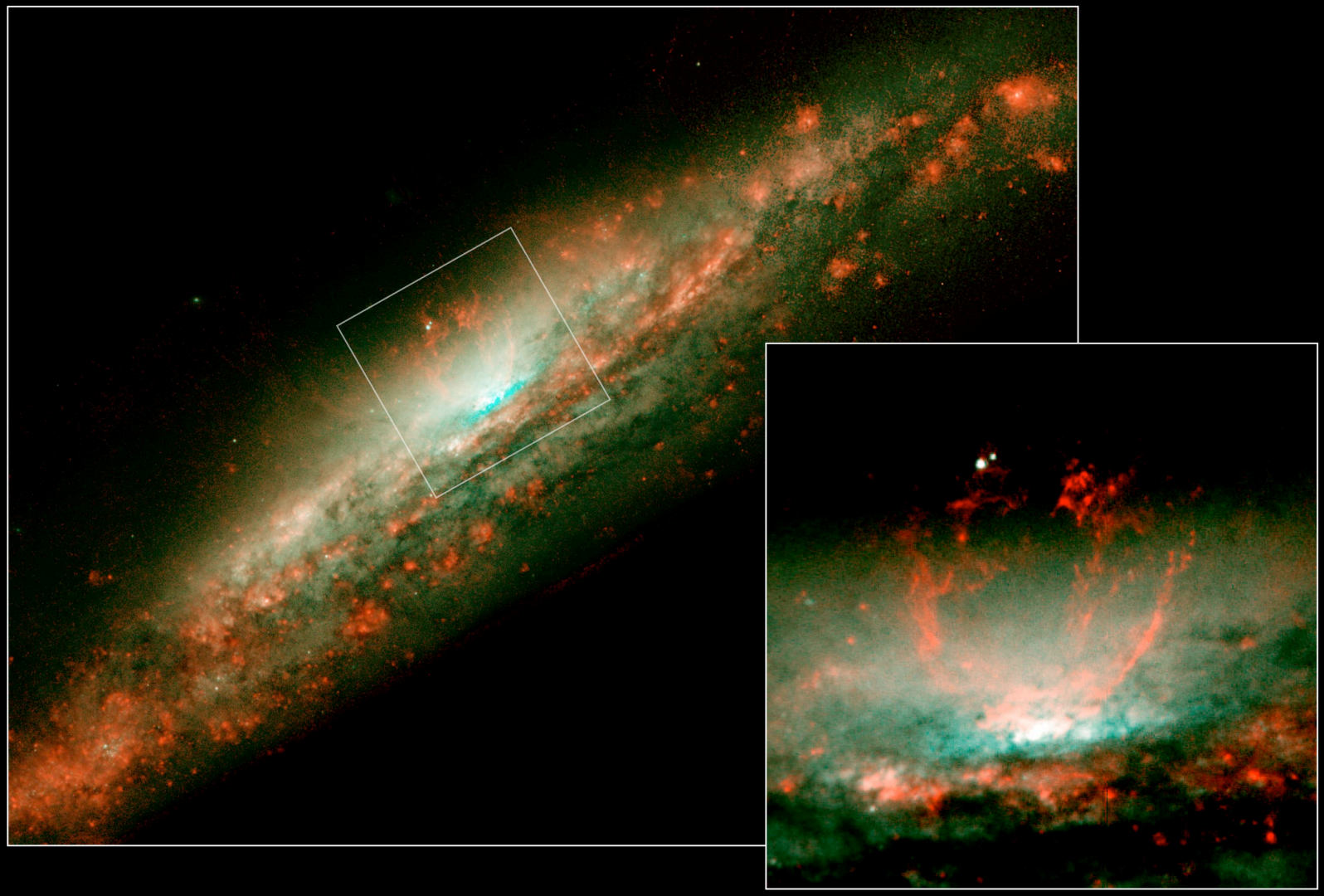
Jörn Rossa, Ralph Tüllmann, Torsten Elwert, Volker Heesen, Michael Rosa, Dieter Breitschwerdt, Miguel Avillez, Michael Dahlem, Matthias Ehle, Rainer Beck, Marita Krause, Marian Soida, Marek Urbanik, Yuri Sheckinov, Peter Kamphuis et al.

Why does the galaxy luminosity function have a Schechter form?



Somerville & Primack 2001

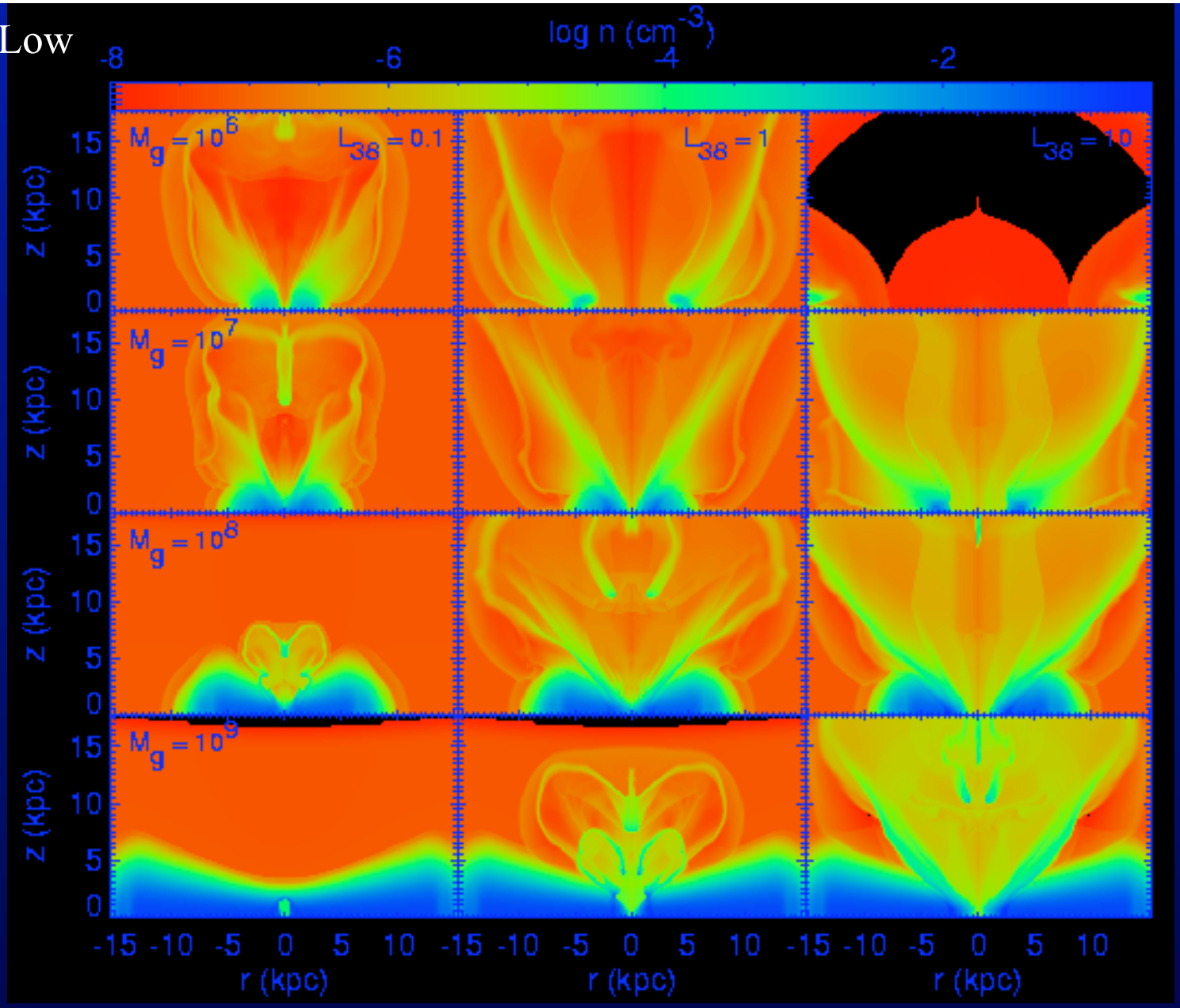
well, this was addressed earlier today



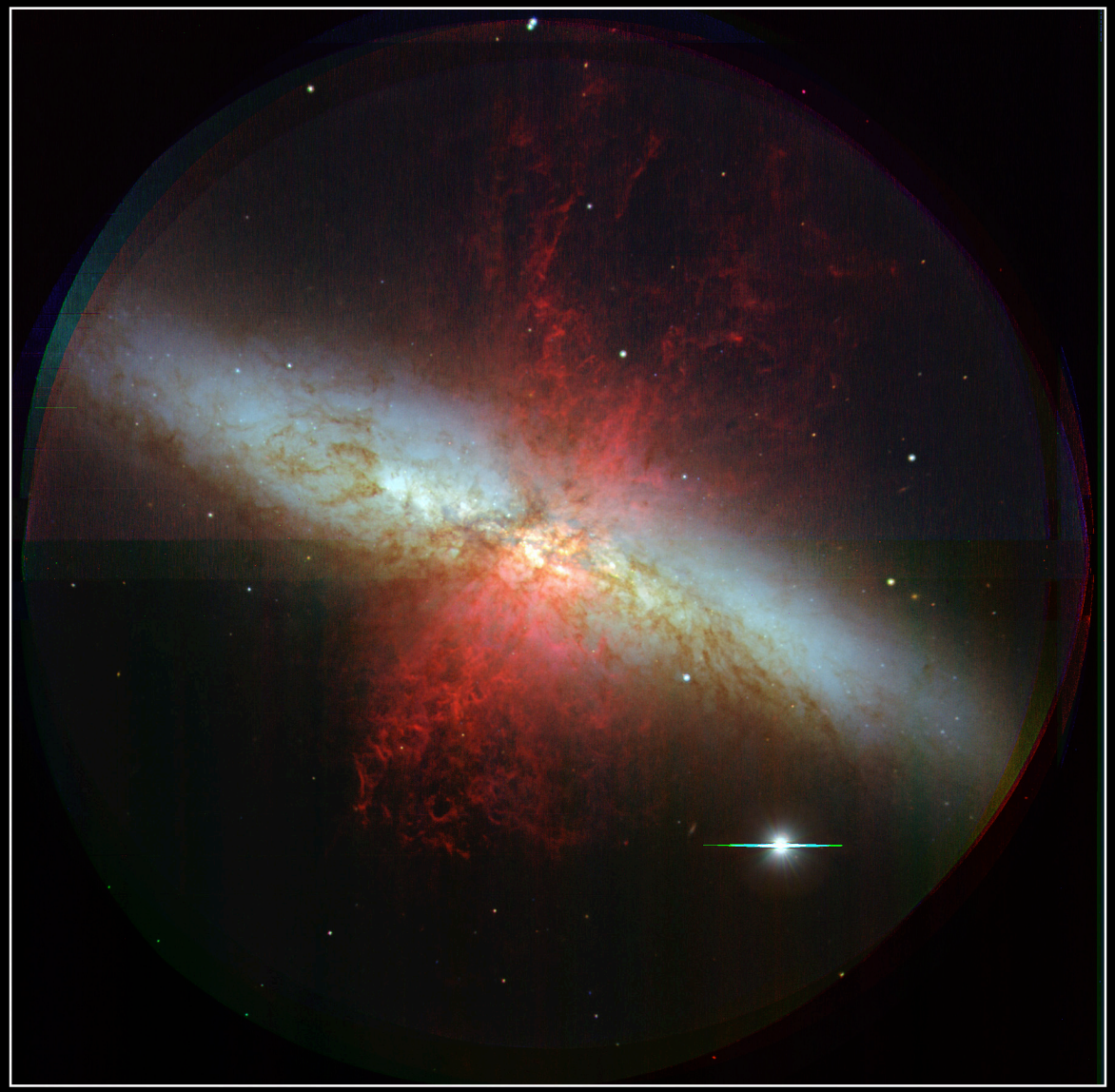
Galaxy NGC 3079
Hubble Space Telescope • WFPC2

NASA and G. Cecil (University of North Carolina) • STScI-PRC01-28

*F*errara & McLow

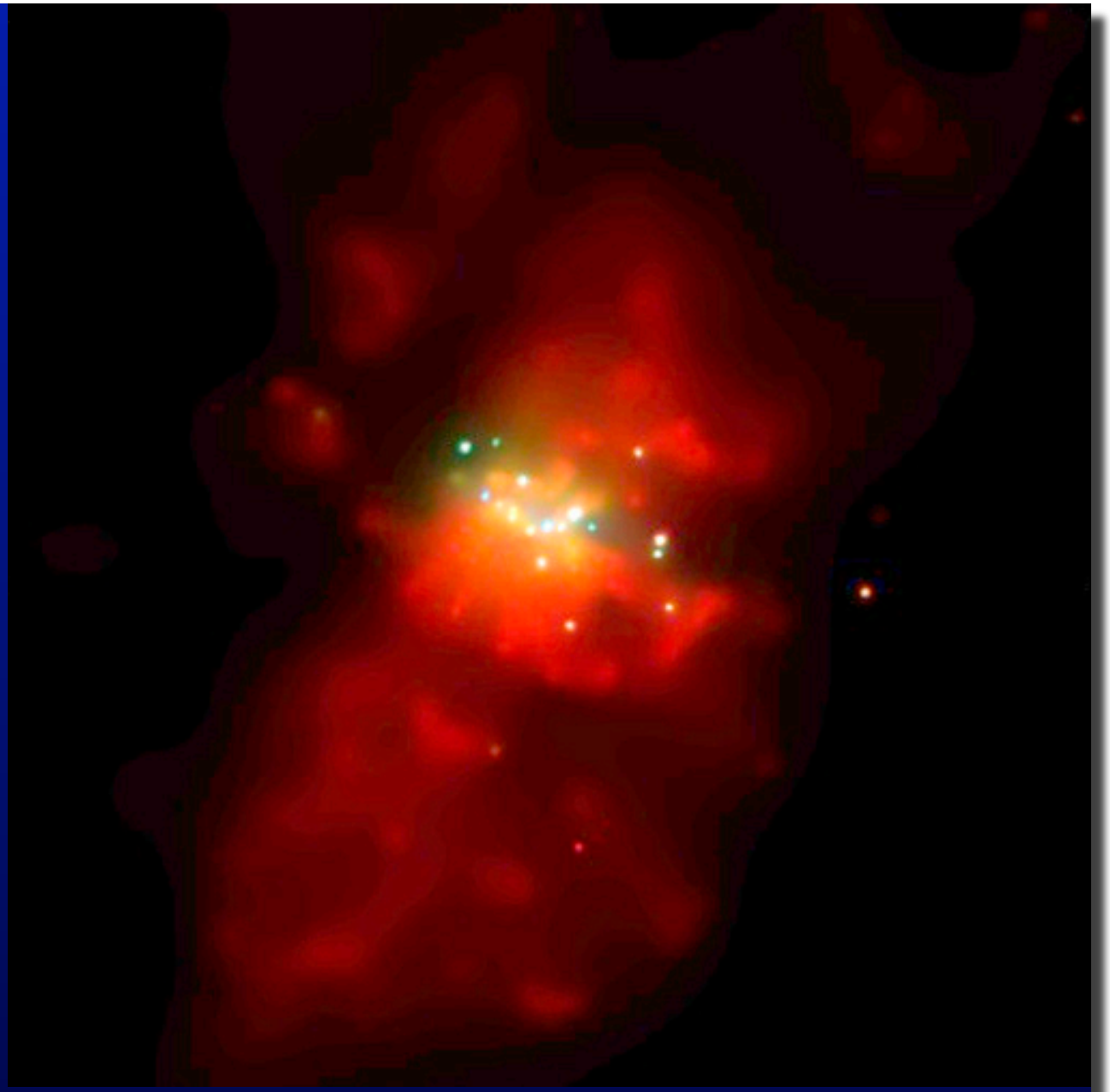


Starburst M82 (Subaru Teleskop)

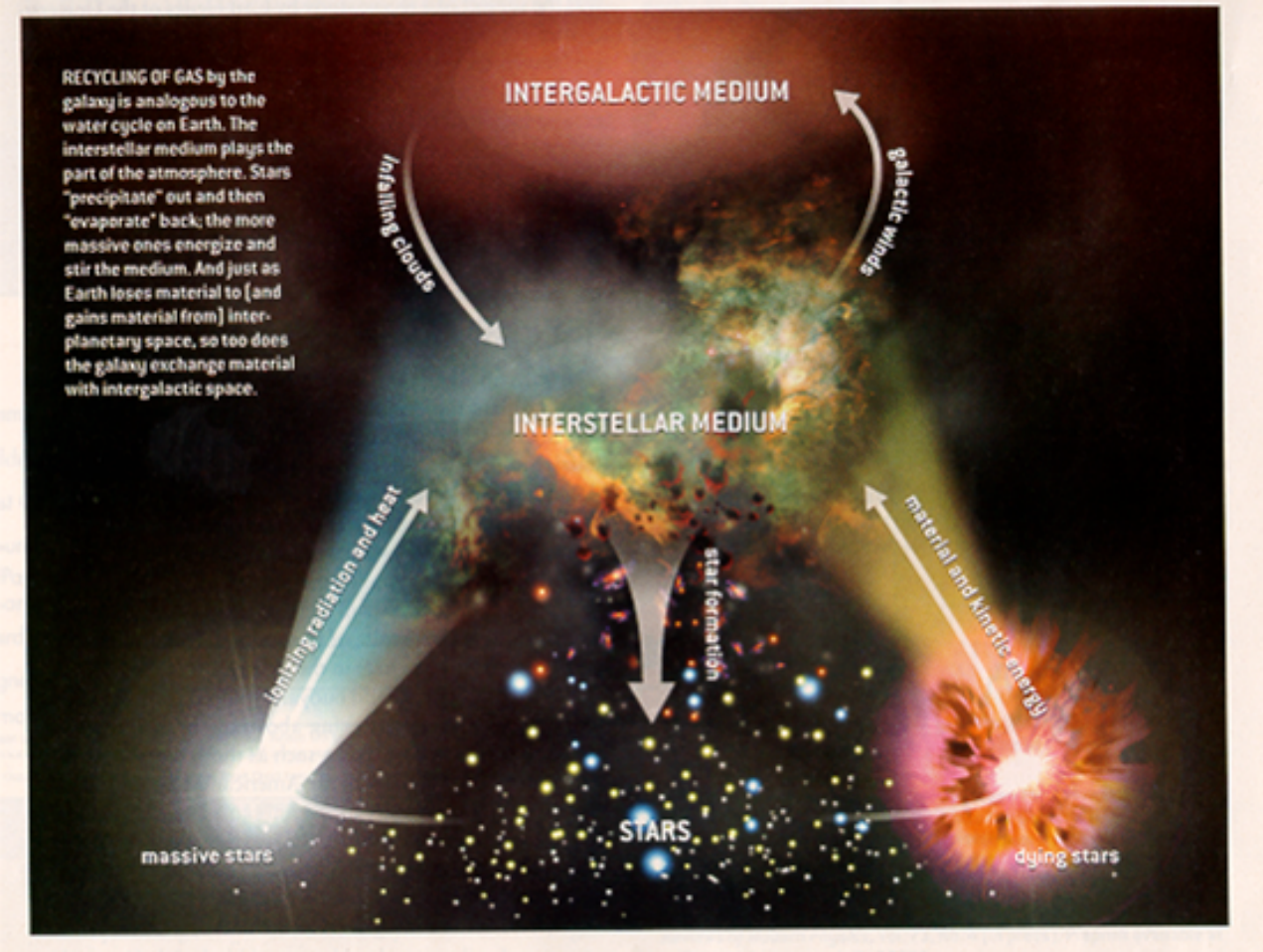


M82 by

Chandra



our paradigm…



from Reynolds in Scientific American

X-RAY, LYα AND Hα EMISSION FROM SIMULATED DISK GALAXIES

JESPER SOMMER-LARSEN
Theoretical Astrophysics Center, Copenhagen, Denmark

SUNE TOFT, JESPER RASMUSSEN and KRISTIAN PEDERSEN
Astronomical Observatory, Copenhagen, Denmark

MARTIN GÖTZ and LAURA PORTINARI
Theoretical Astrophysics Center, Copenhagen, Denmark

Abstract. The X-ray properties of the haloes of disk galaxies formed in fully cosmological, hydro/gravity simulations are discussed. The results are found to be consistent with observational X-ray detections and upper limits. Disk galaxy haloes are predicted to be about an order of magnitude brighter at $z \sim 1$ than at z=0. The Lyα and Hα surface brightness of an edge-on, Milky Way like model galaxy has been determined. The emission is found to be quite extended, with a scale height of about 600 pc, neglecting dust corrections.

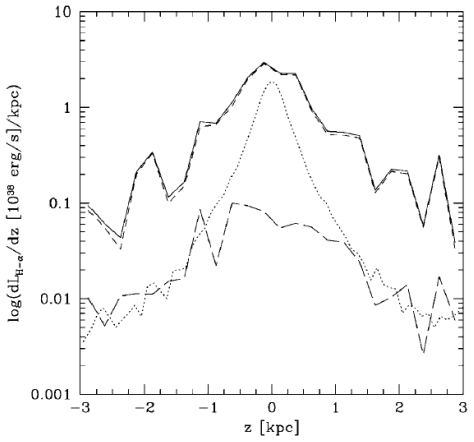


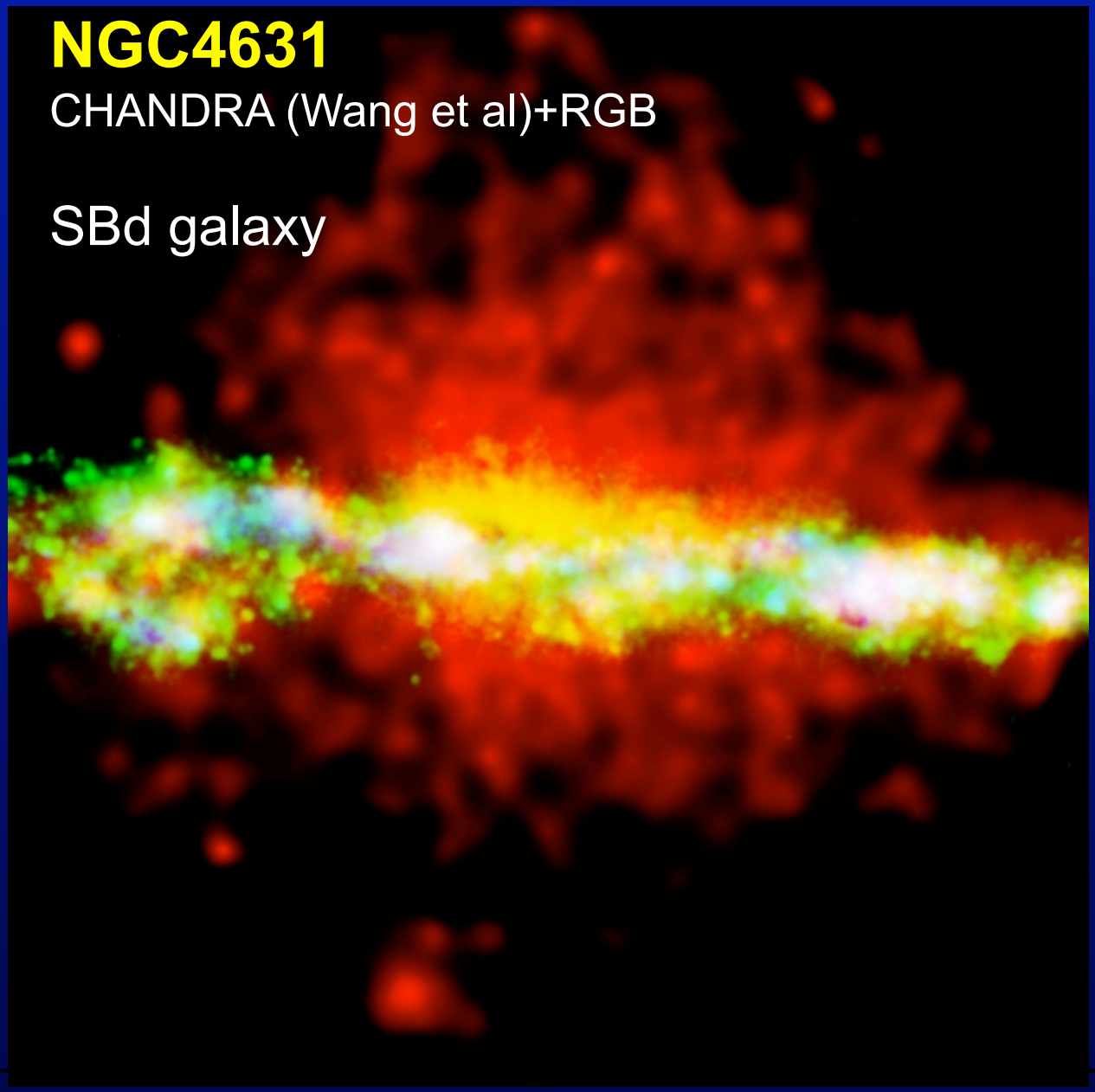
Figure 2. Hα surface brightness of a Milky Way like, edge-on disk galaxy at z=0 (solid curve – contribution from collisional excitation: short-dashed curve, recombination: long-dashed curve) – no dust correction has been applied. Also shown is the surface density of cold ($\sim 10^4$ K) gas (dotted curve).

http://disk-halo2008.multimeios.pt

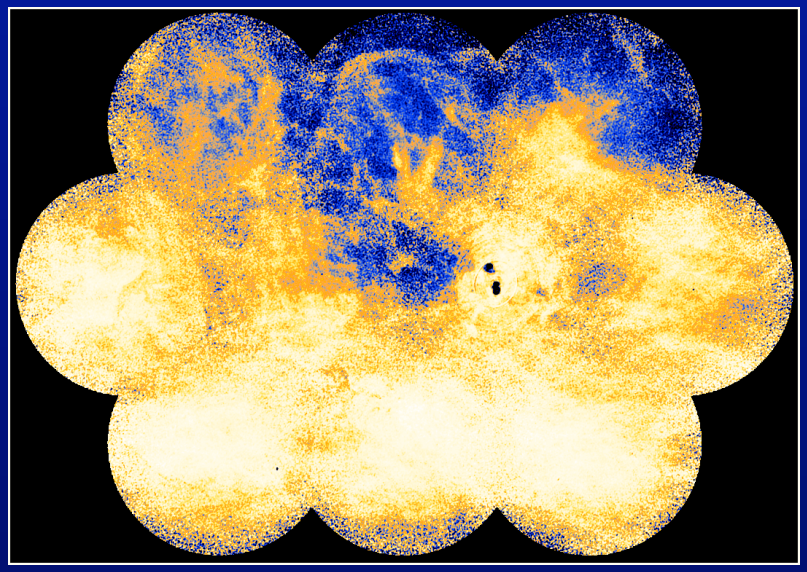
NGC4631

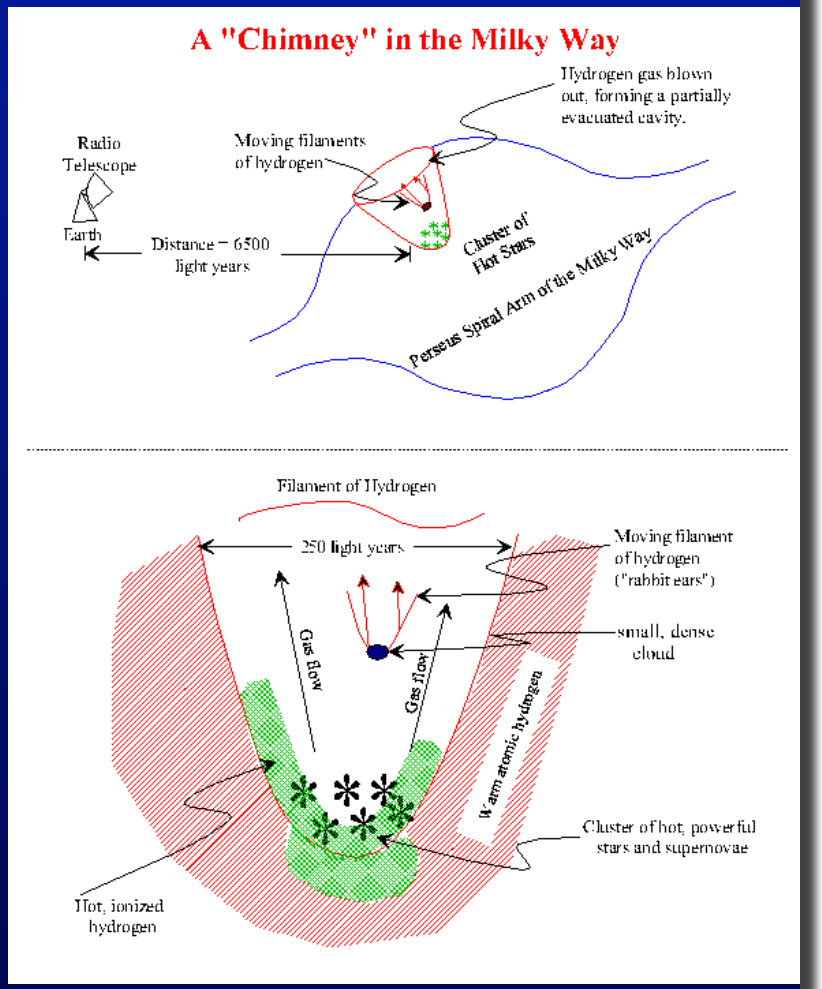
CHANDRA (Wang et al)+RGB

SBd galaxy



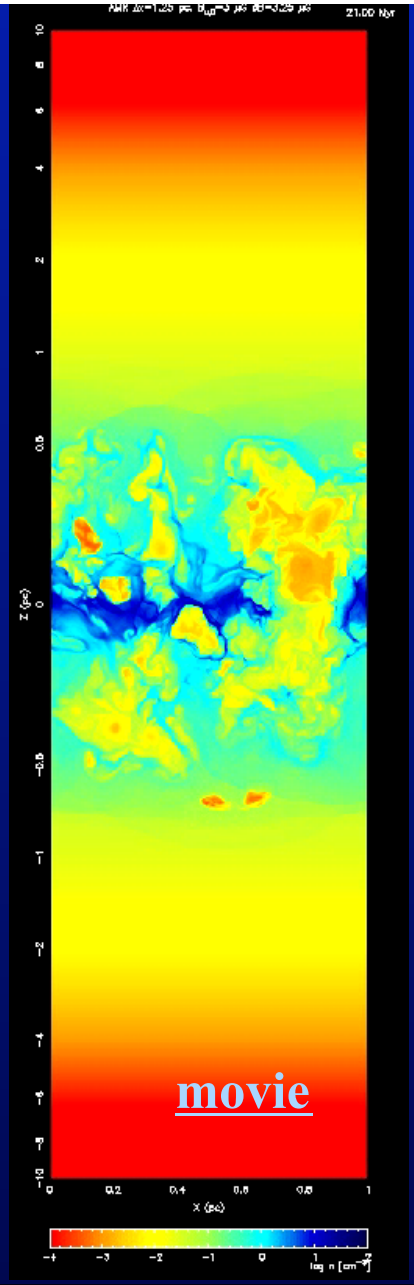
a Galactic chimney (DRAO)



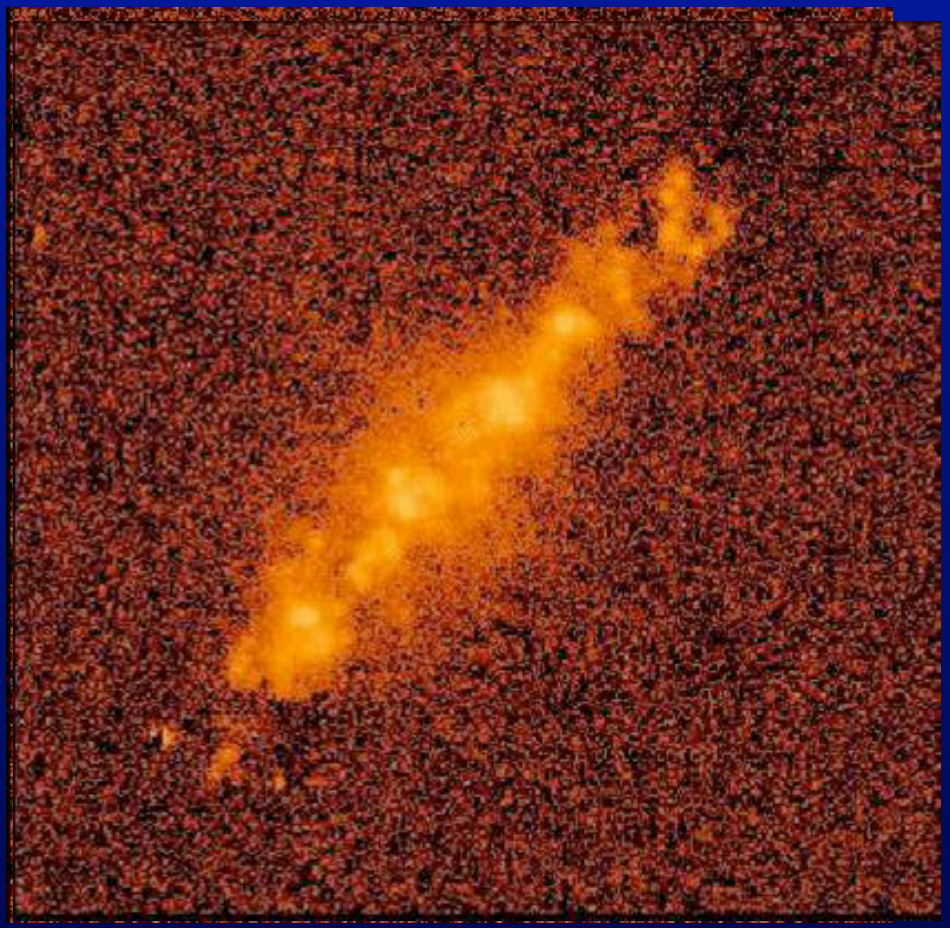


numerical models of the ISM:

Avillez & Breitschwerdt

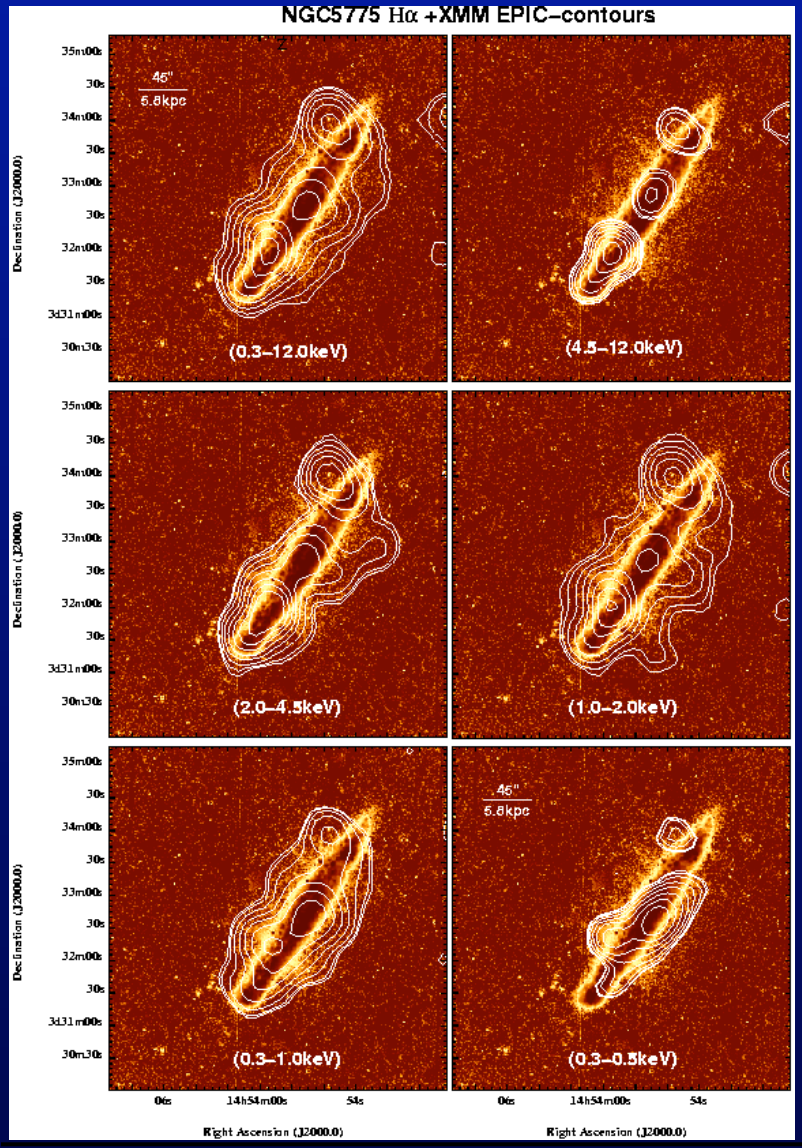


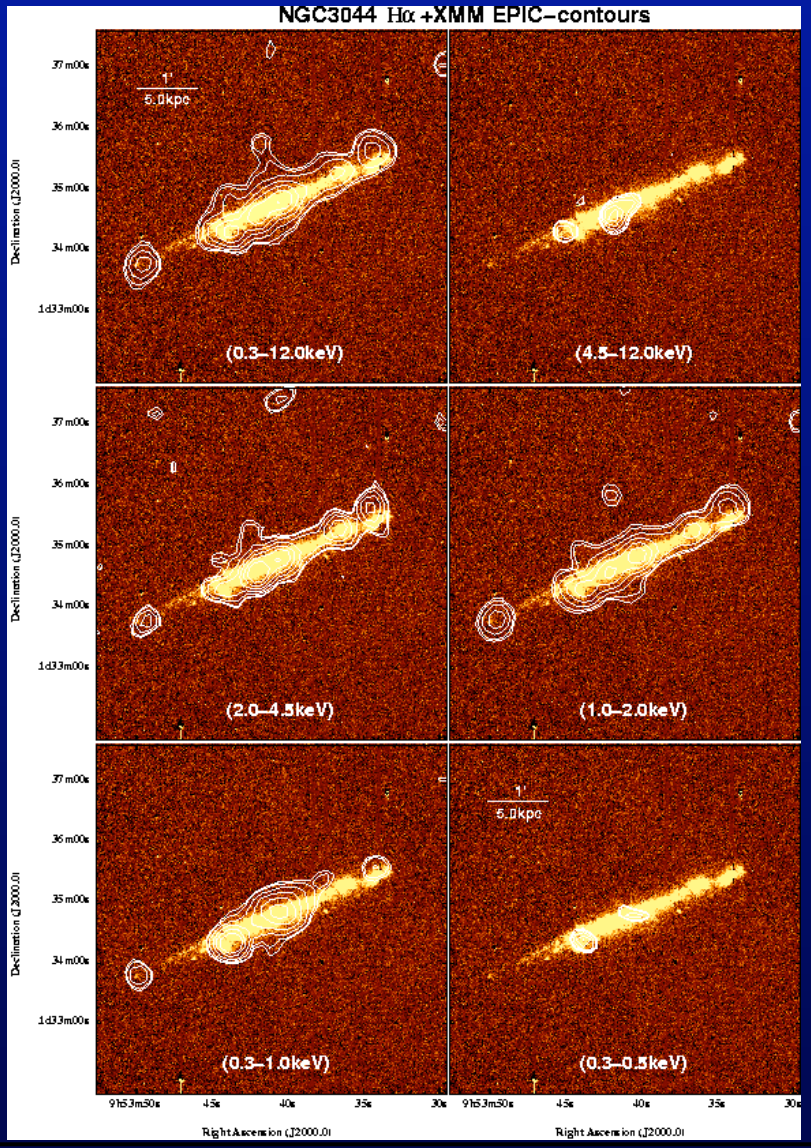
gaseous galactic halos of diffuse ionized gas (DIG) are easily observable in Hα

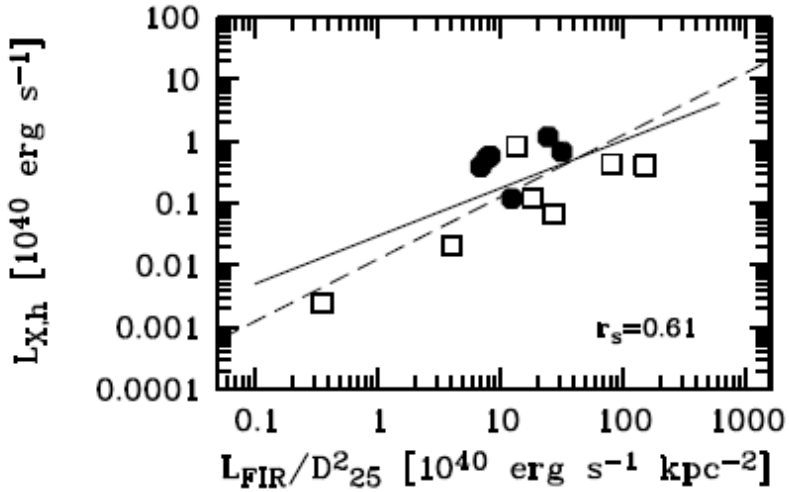


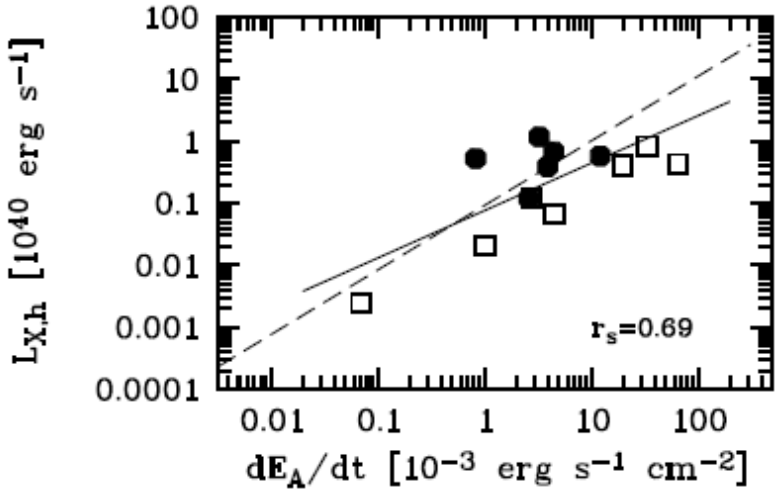
NGC4700
(Rossa&Dettmar 2001)

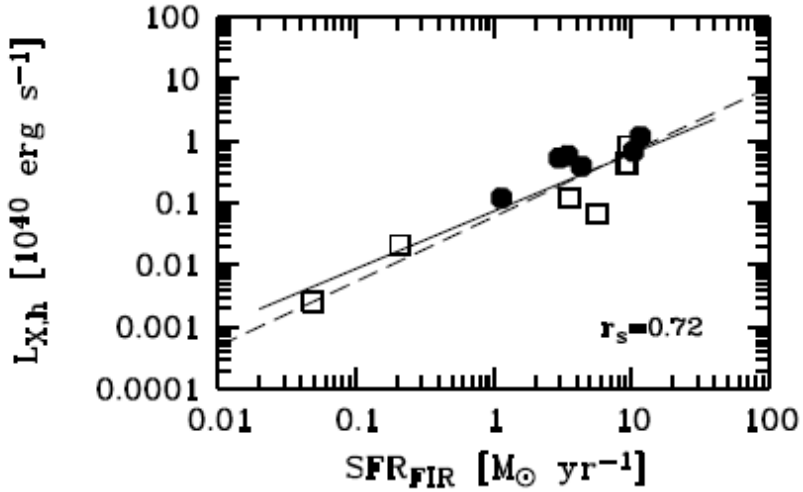
a small survey of disk galaxies with XMM: (Tüllmann et al. 2006 A&A)

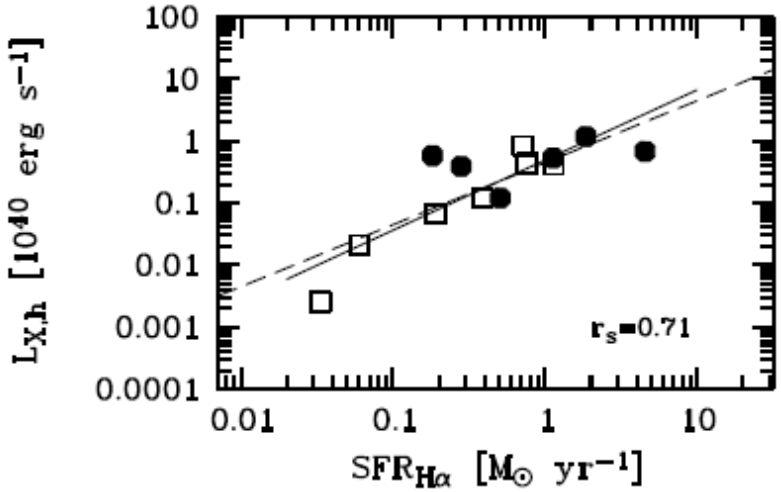





$L_{X,h}$ [10^{40} erg s^{-1}]
L_{FIR}/D^2_{25} [10^{40} erg s^{-1} kpc^{-2}]
r_s=0.61

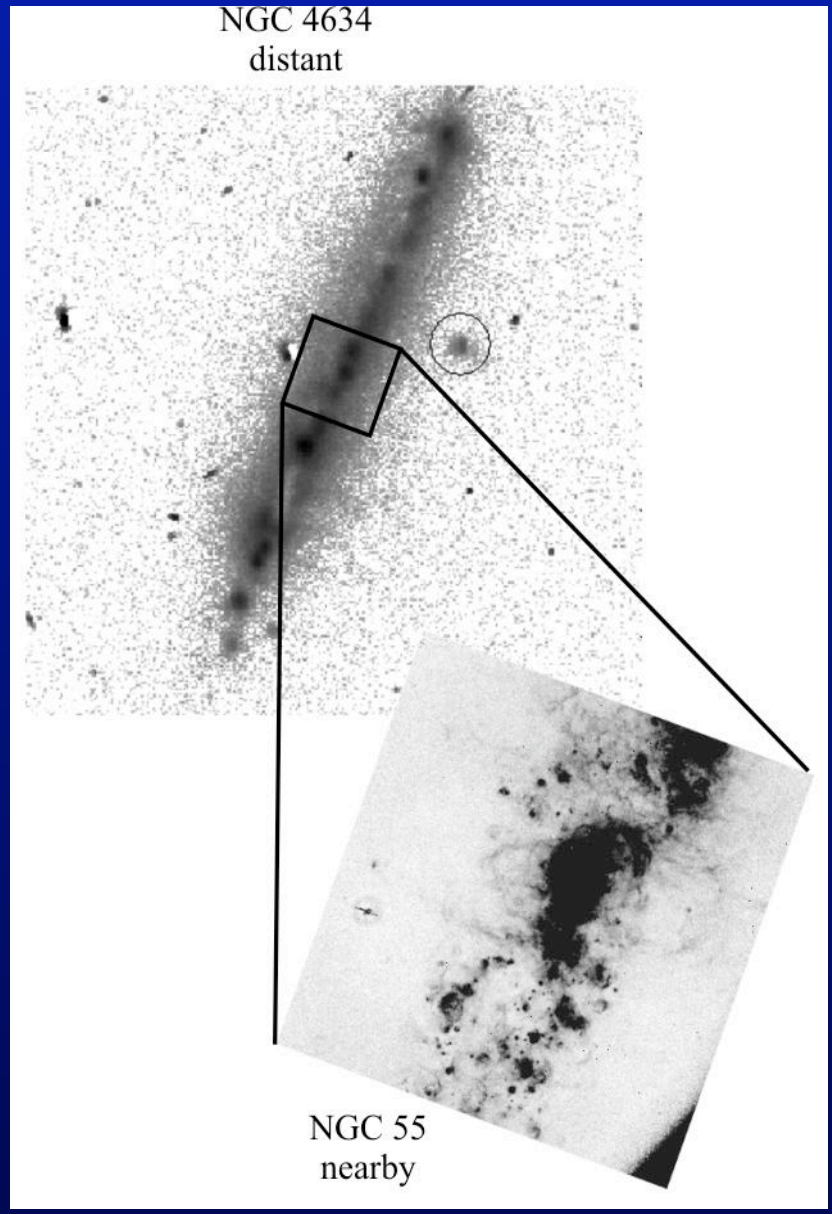

$L_{X,h}$ [10^{40} erg s^{-1}]
dE_A/dt [10^{-3} erg s^{-1} cm^{-2}]
r_s=0.69


$L_{X,h}$ [10^{40} erg s^{-1}]
SFR_{FIR} [$M_\odot$ yr^{-1}]
r_s=0.72

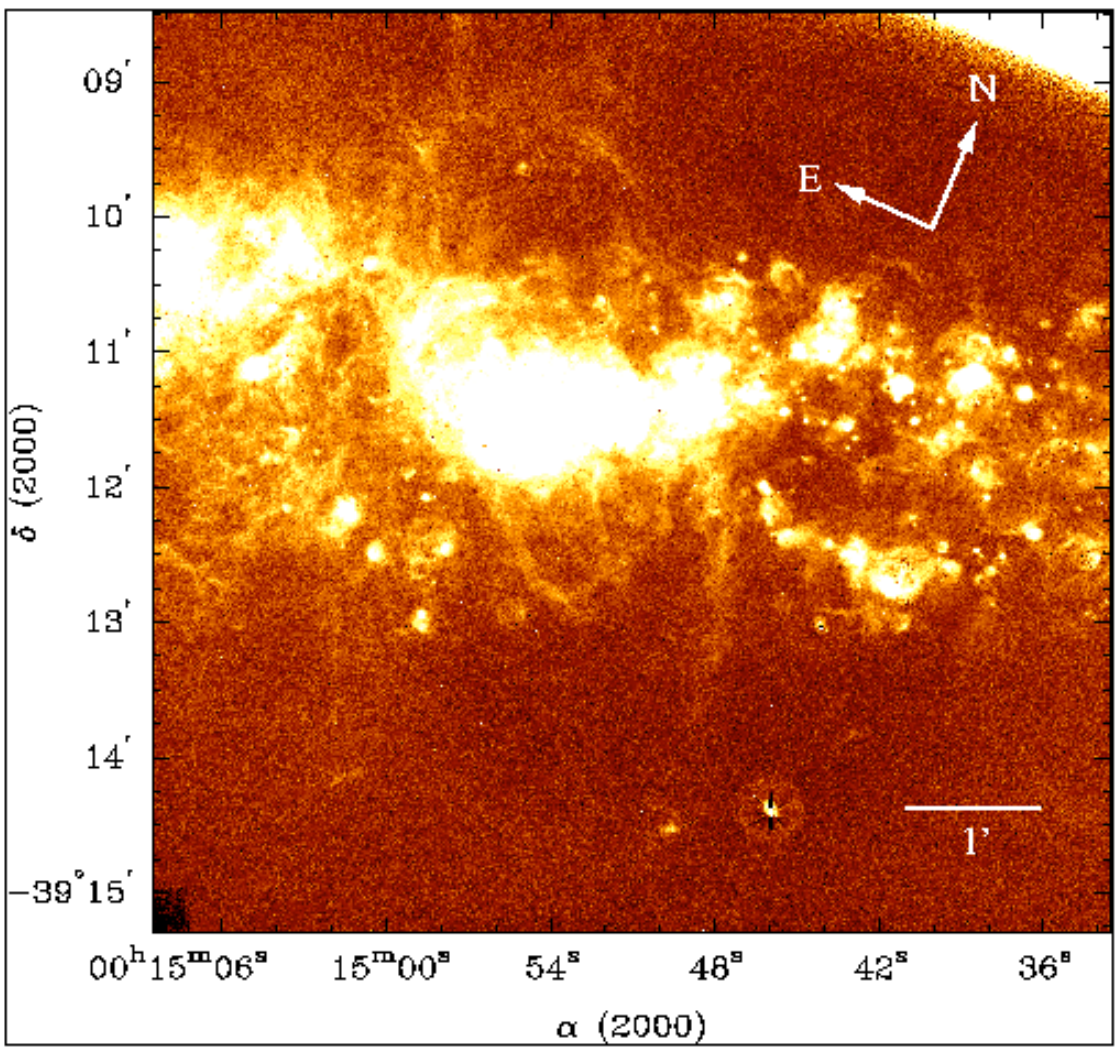

$L_{X,h}$ [10^{40} erg s^{-1}]
$SFR_{H\alpha}$ [$M_\odot$ yr^{-1}]
r_s=0.71

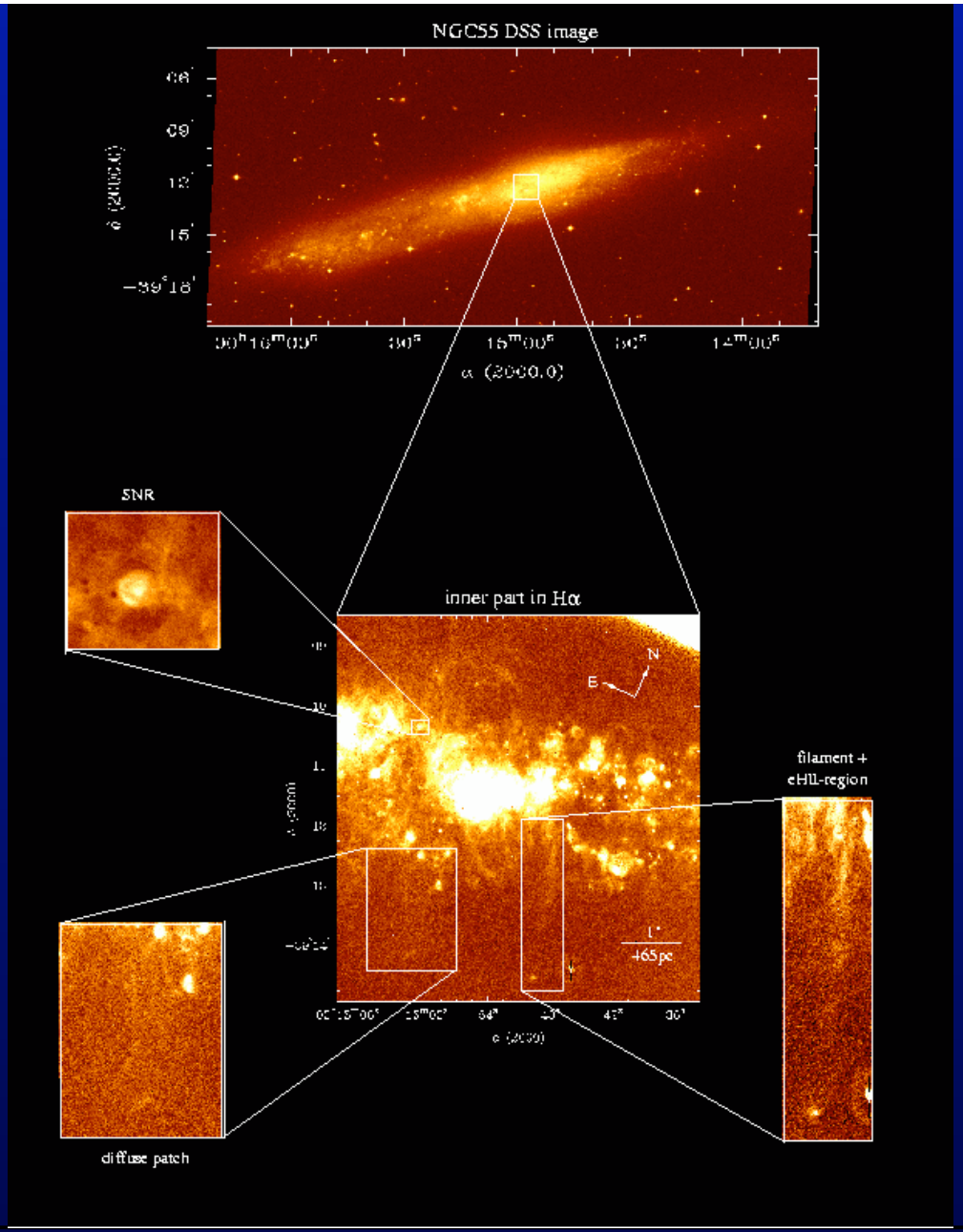
structure of ISM: free pathlengths for UV γs, i.e. filling factors

redistribution of nuclear synthesis products on galactic scales

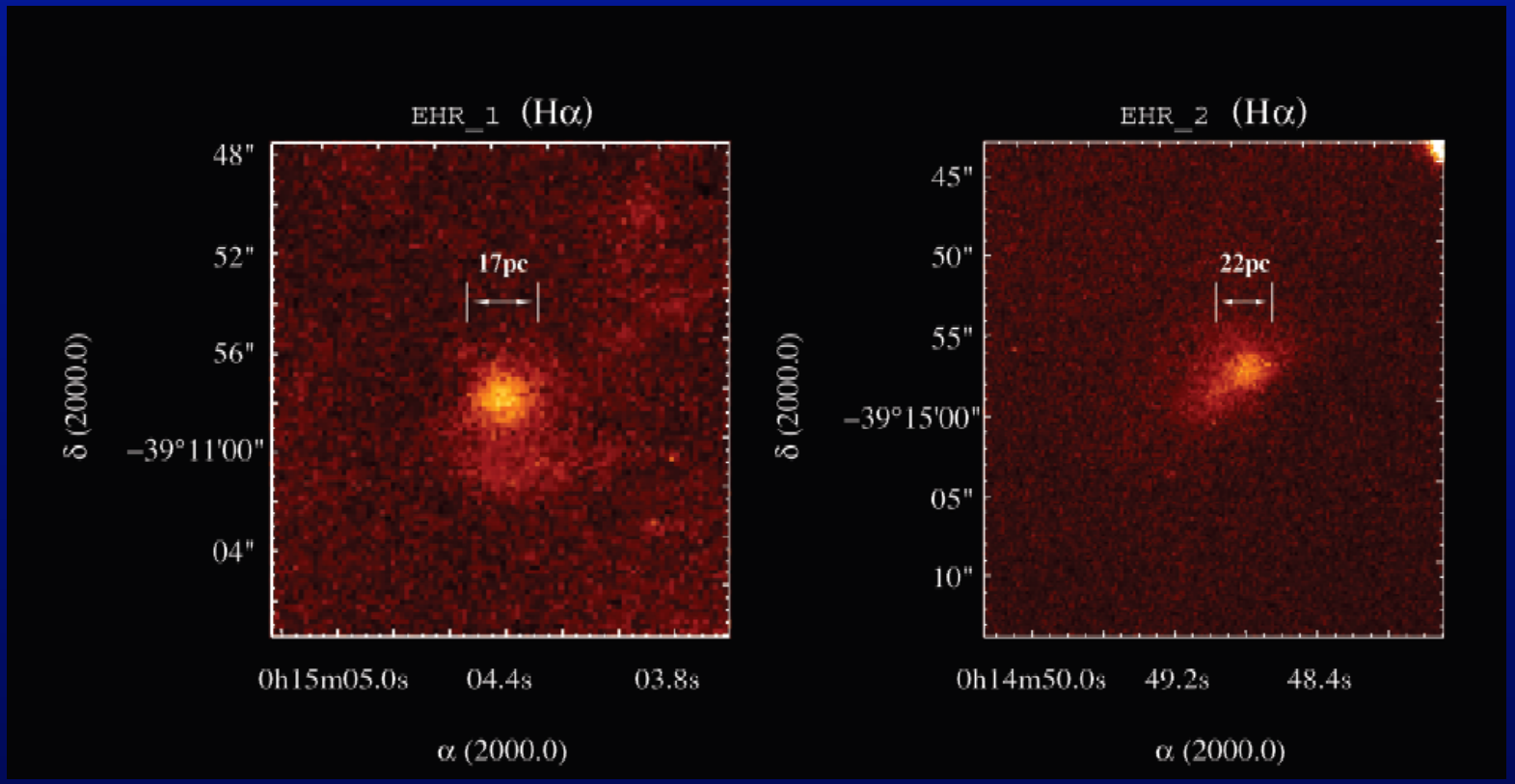


(Tüllmann, Bomans, Elwert, Dettmar, Ferguson A&A 2003)

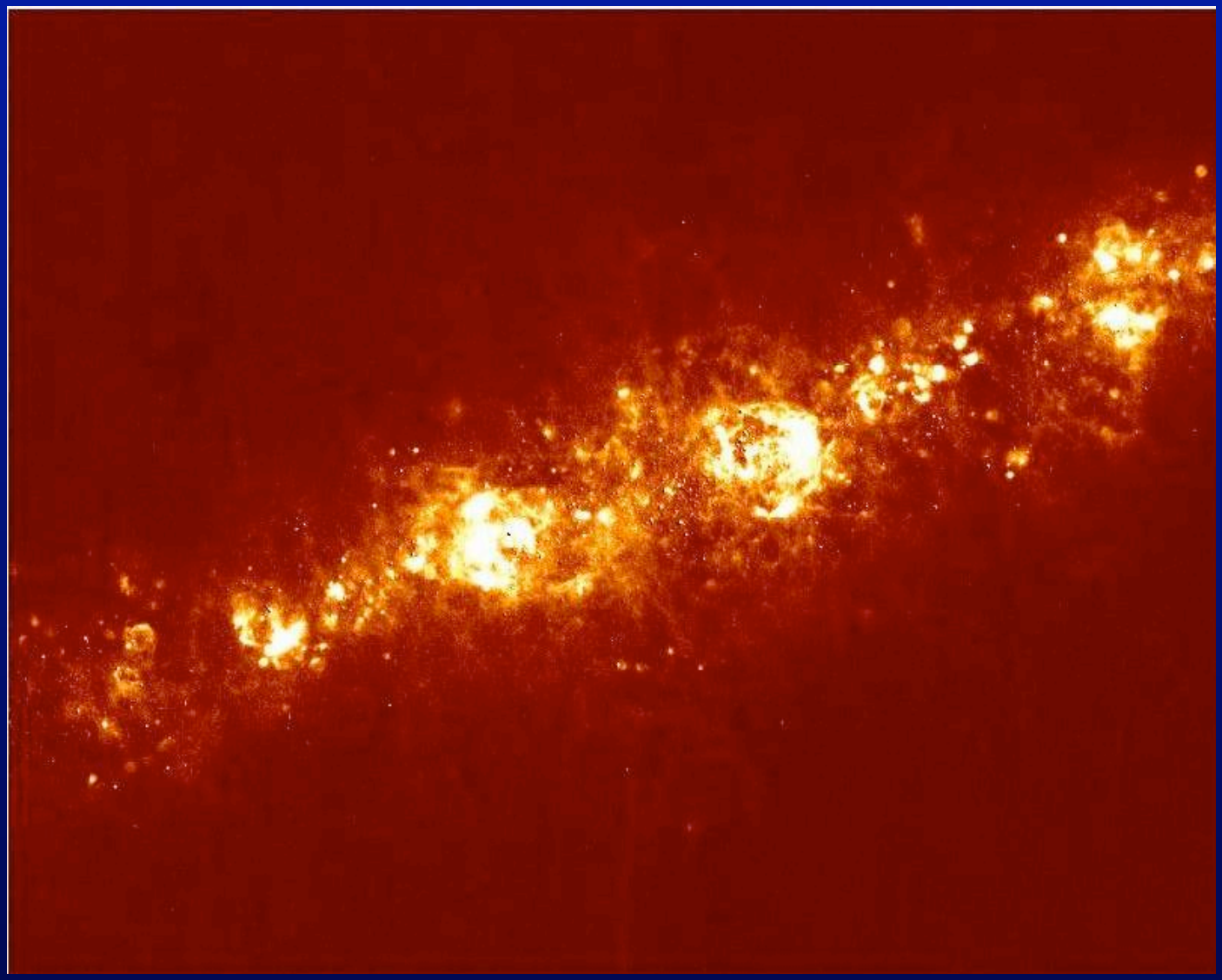



NGC55 DSS image
α (2000.0)
SNR
inner part in Hα
N
E
filament +
eHII-region
diffuse patch

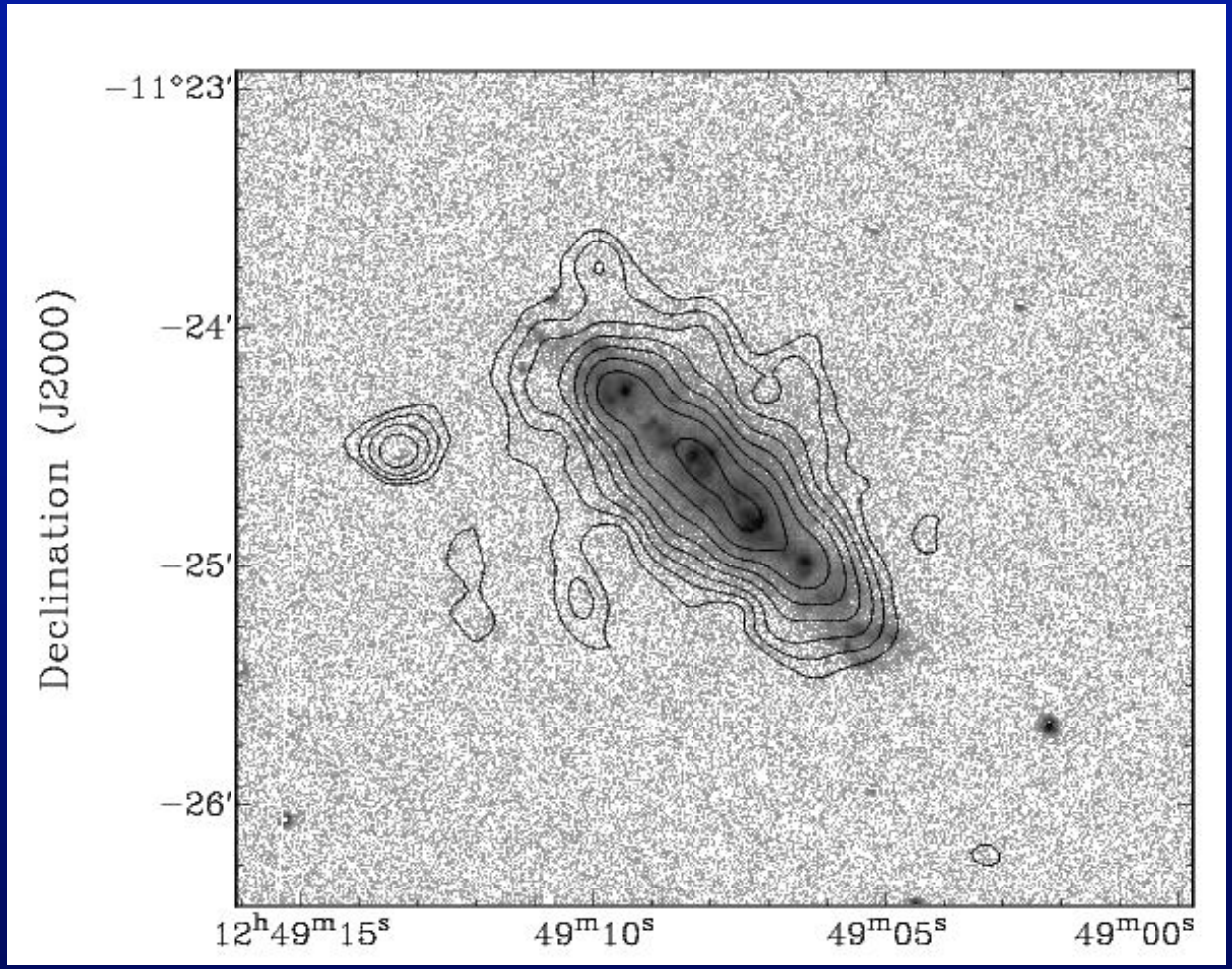
extraplanar HII regions (Tüllmann et al. 2003)



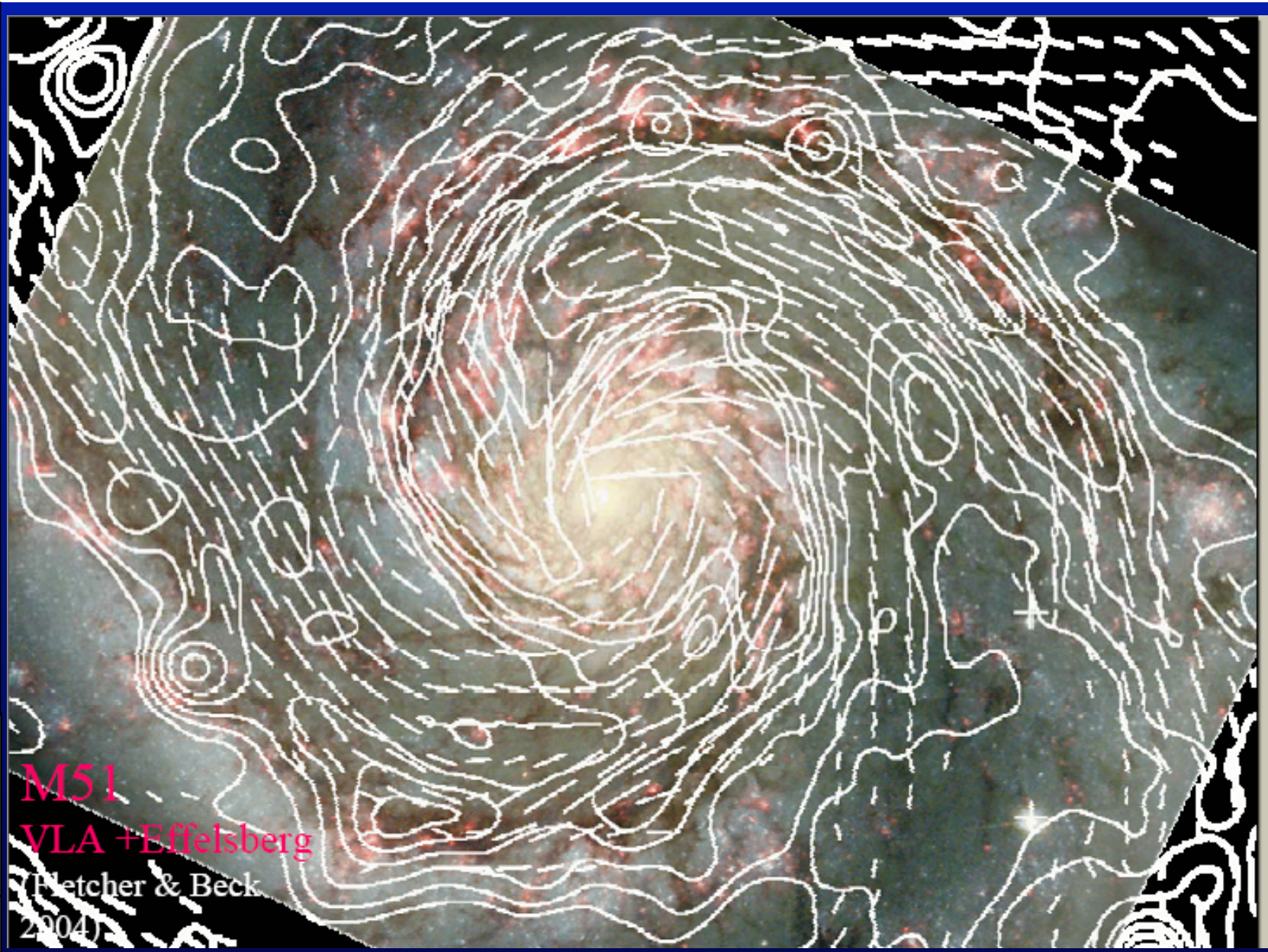
NGC4700 HST/ACS (Rossa, Dahlem, Dettmar, van der Marel)



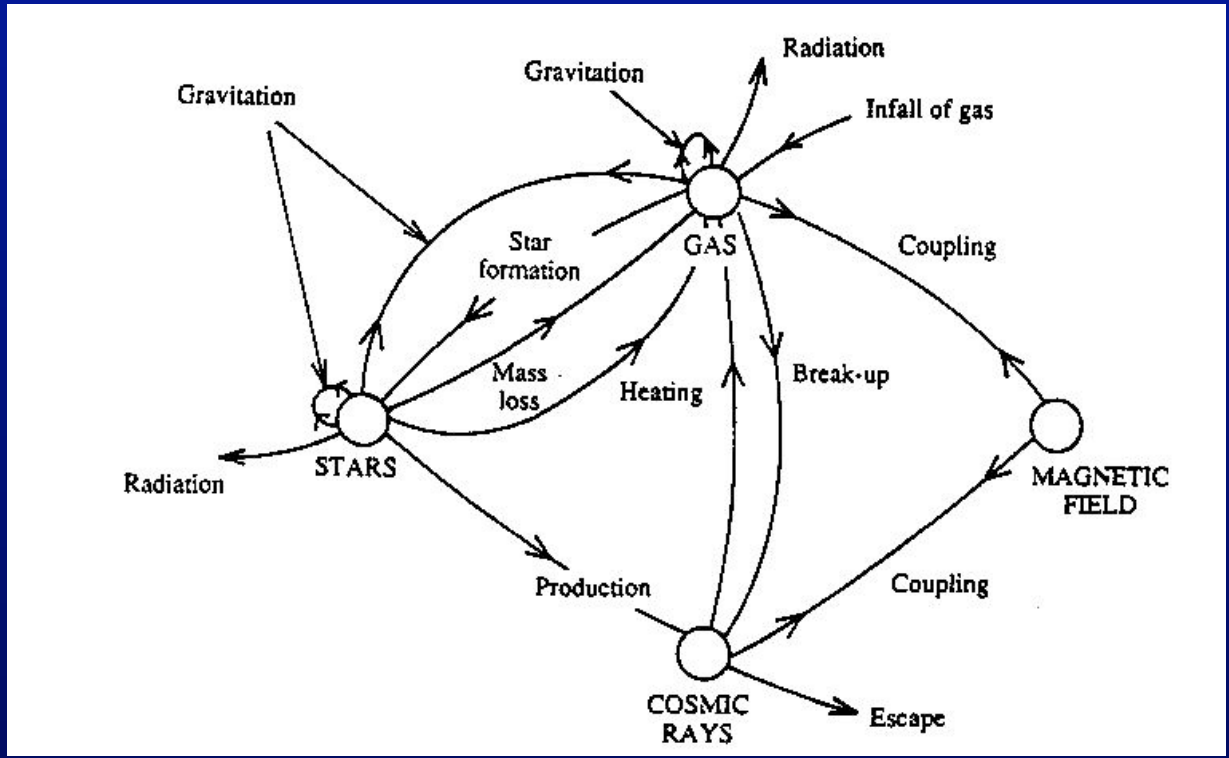
Ok, … seen that before (NGC4700)



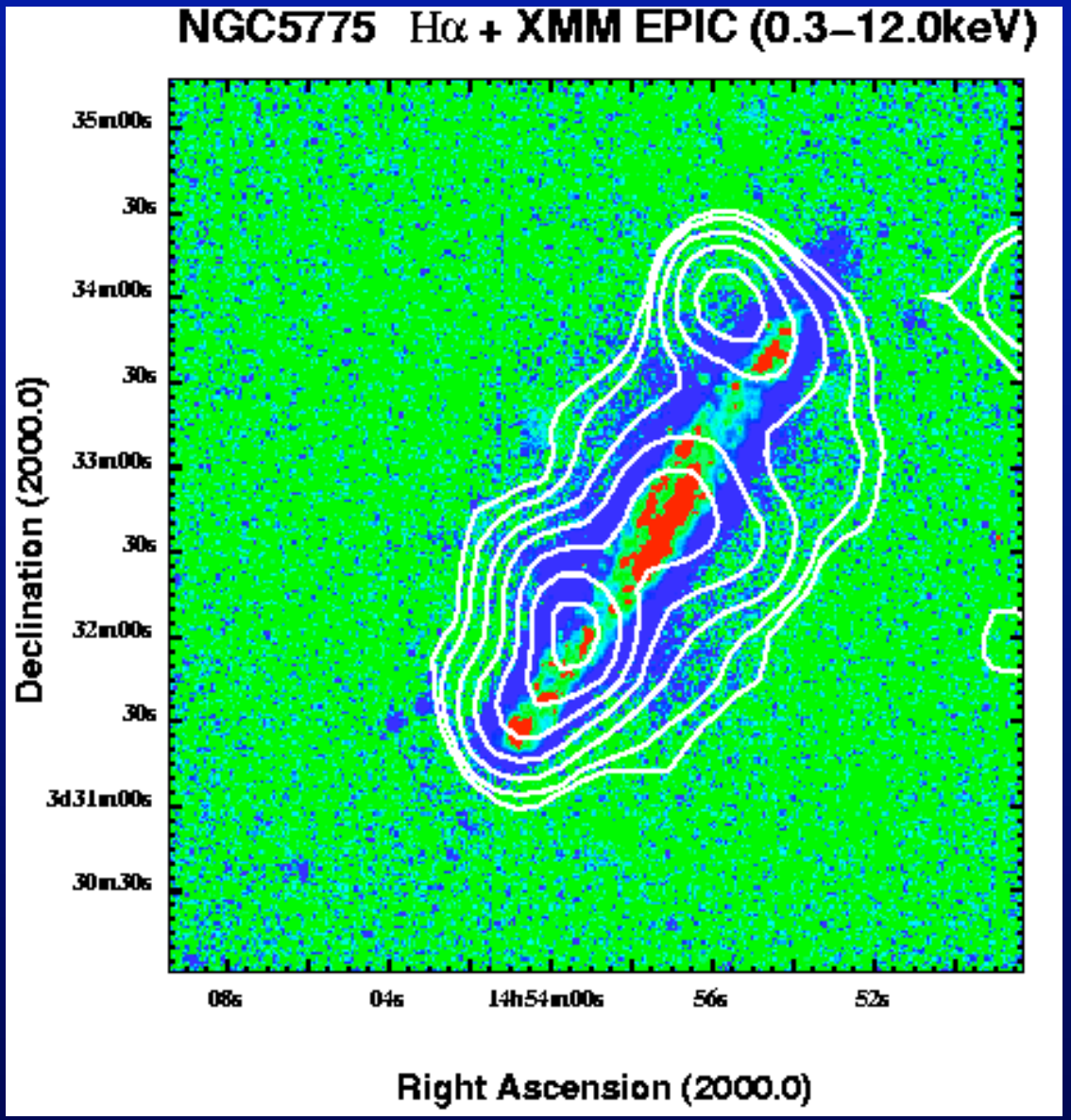
from Dahlem et al.

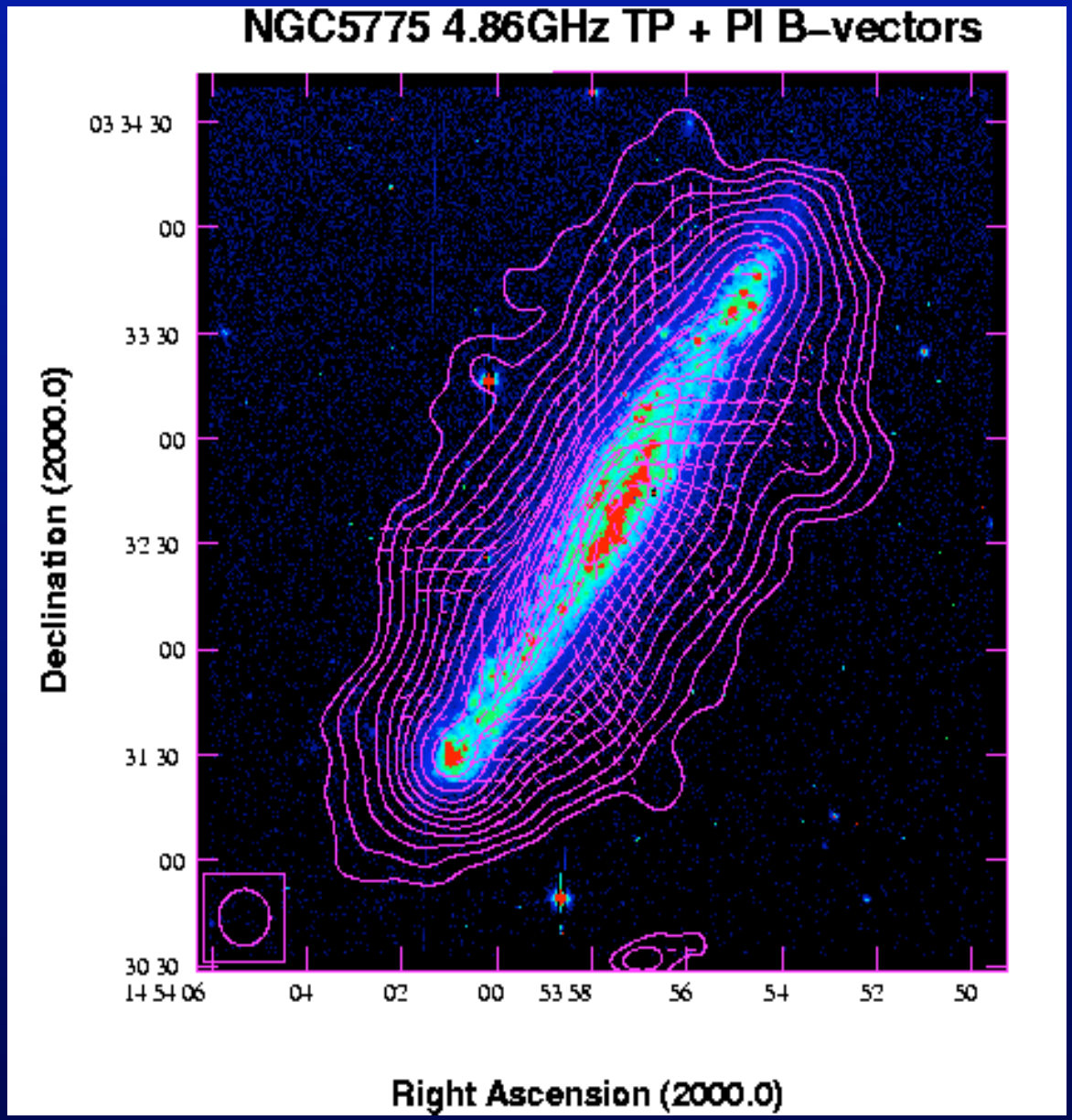

M51
VLA +Effelsberg
(Fletcher & Beck
2004)

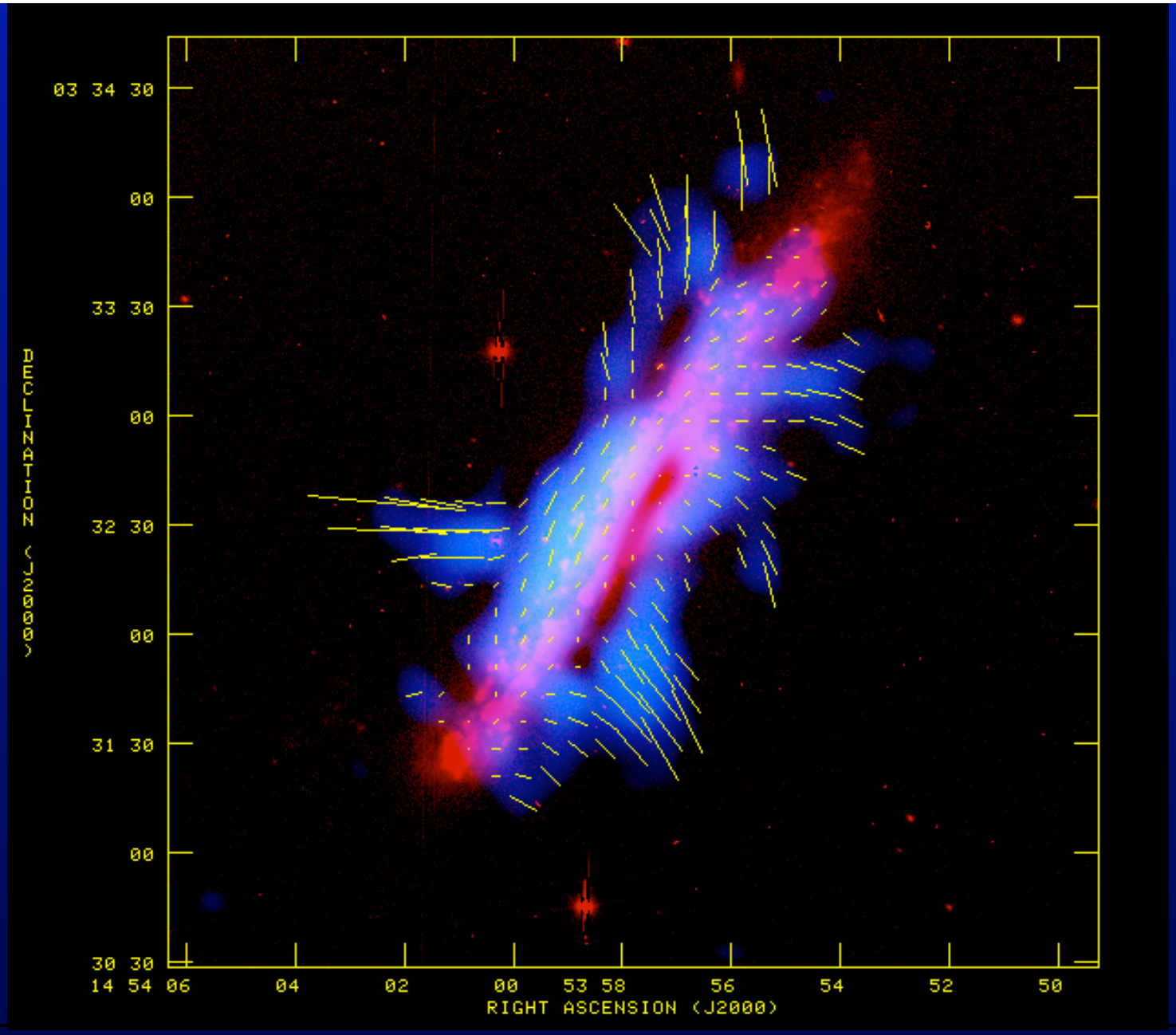
(from Taylor, Cambridge Univ. Press)



Magnetic Fields and Cosmic Rays contribute significantly to the energy density

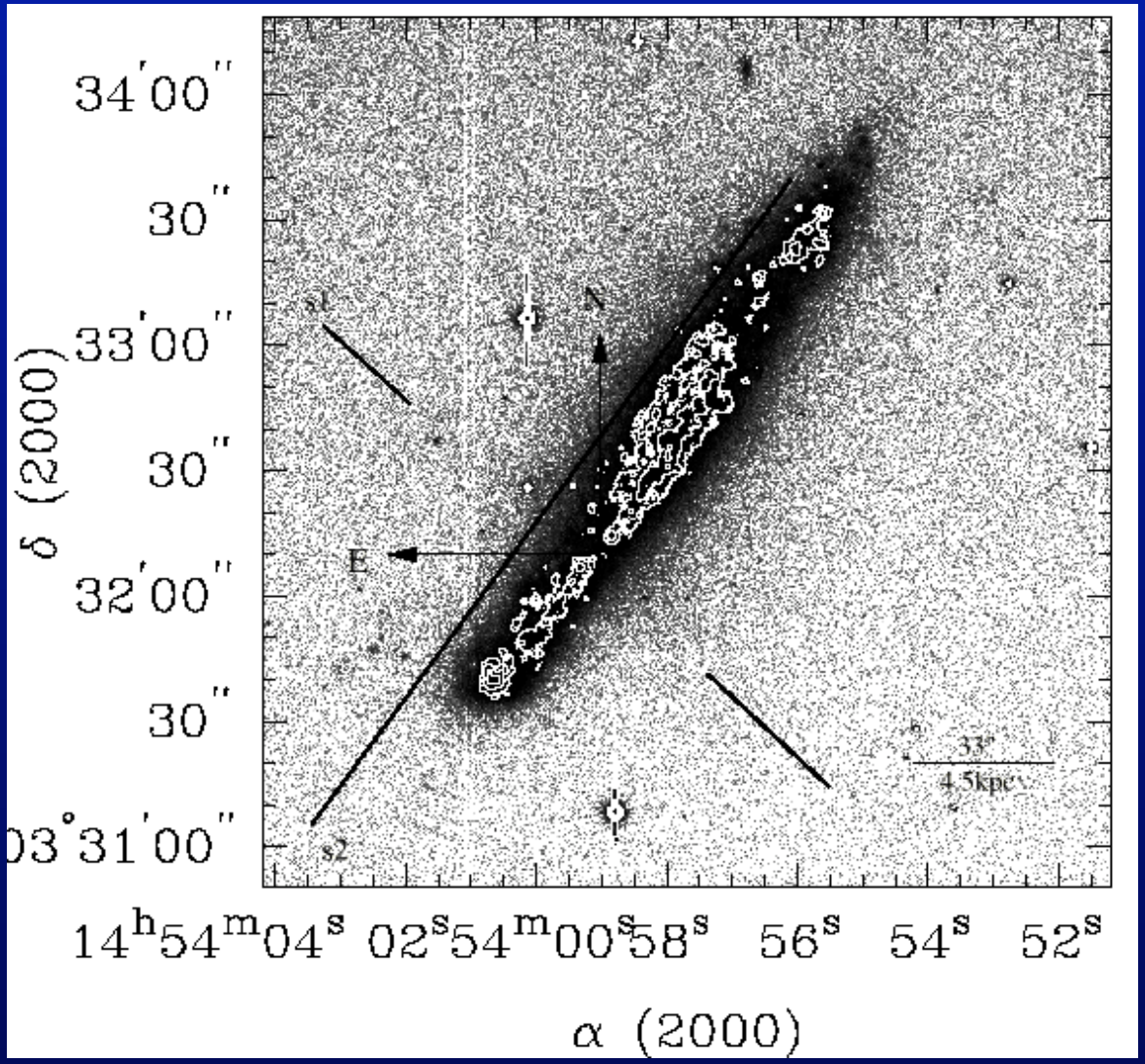

NGC5775 Hα + XMM EPIC (0.3–12.0keV)
35m00s
30s
34m00s
30s
33m00s
30s
32m00s
30s
3d31m00s
30m30s
Declination (2000.0)
08s
04s
14h54m00s
56s
52s
Right Ascension (2000.0)


NGC5775 4.86GHz TP + PI B–vectors
03 34 30
00
33 30
00
32 30
00
31 30
00
30 30
Declination (2000.0)
14 54 06
04
02
00
53 58
56
54
52
50
Right Ascension (2000.0)

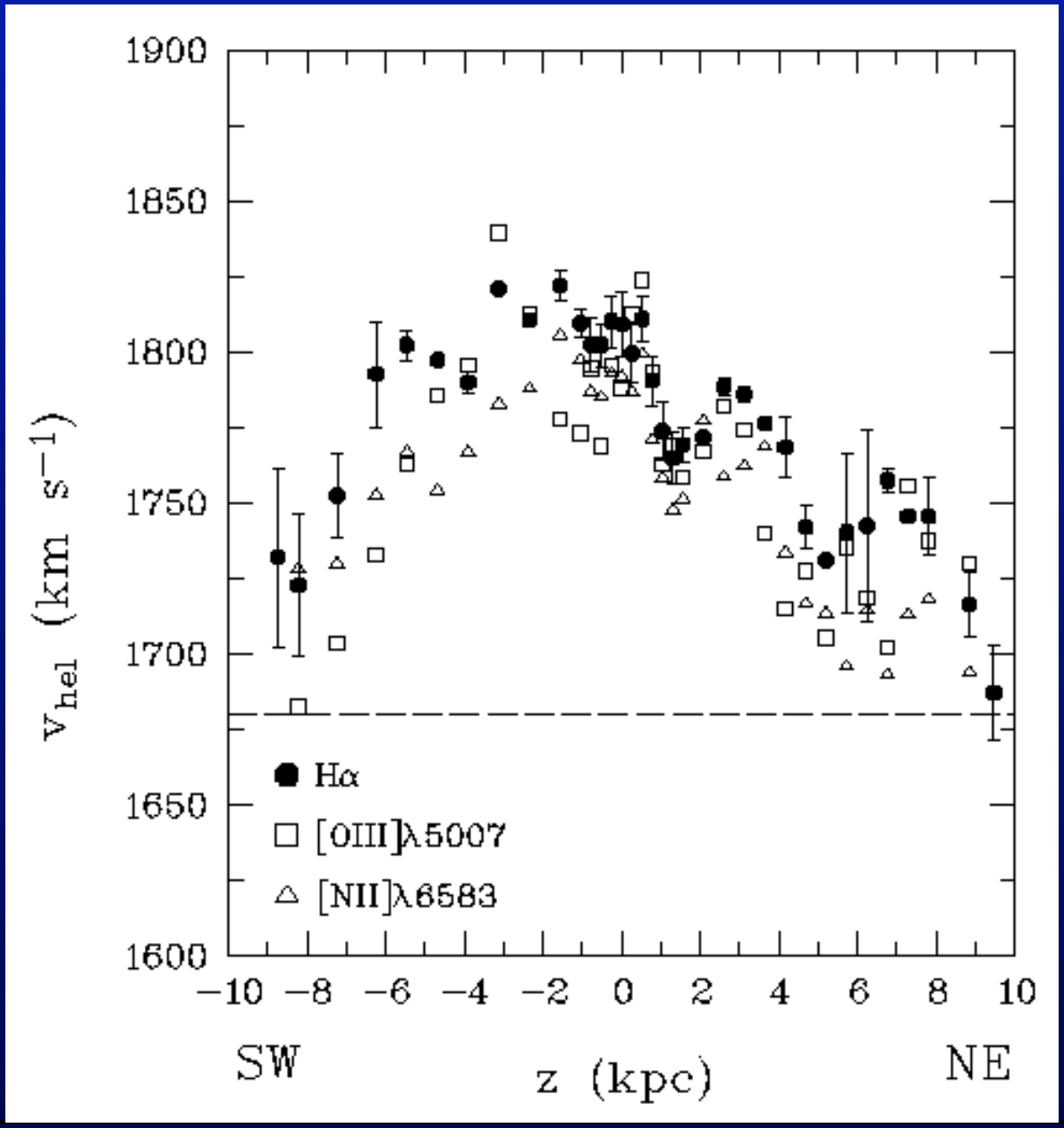

03 34 30
00
33 30
00
32 30
00
31 30
00
30 30
DECLINATION (J2000)
14 54 06
04
02
00
53 58
56
54
52
50
RIGHT ASCENSION (J2000)

DIG halo of
NGC 5775
VLT / FORS1
slit positions

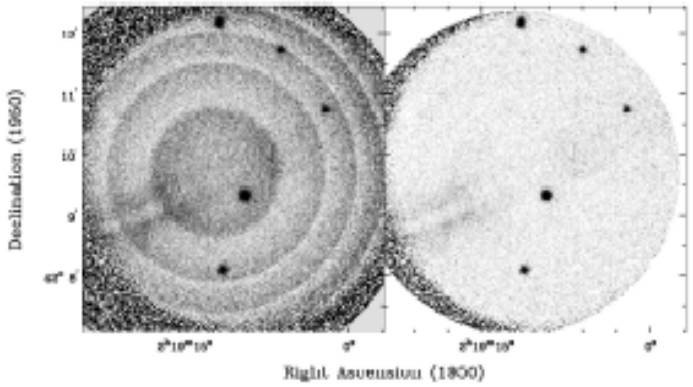
(Tüllmann et al 2000)

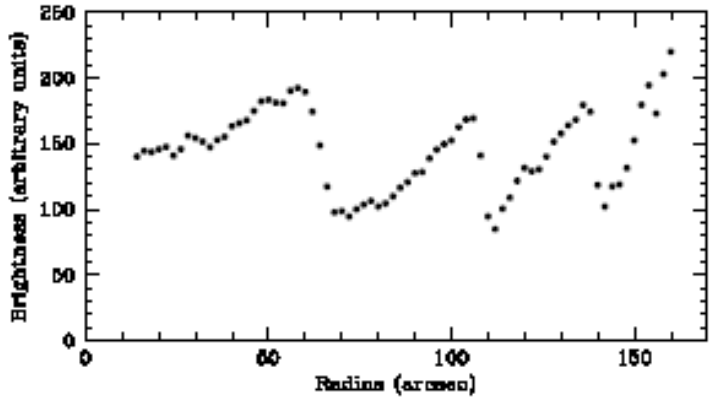


NGC 5775
rotation drops to
systemic



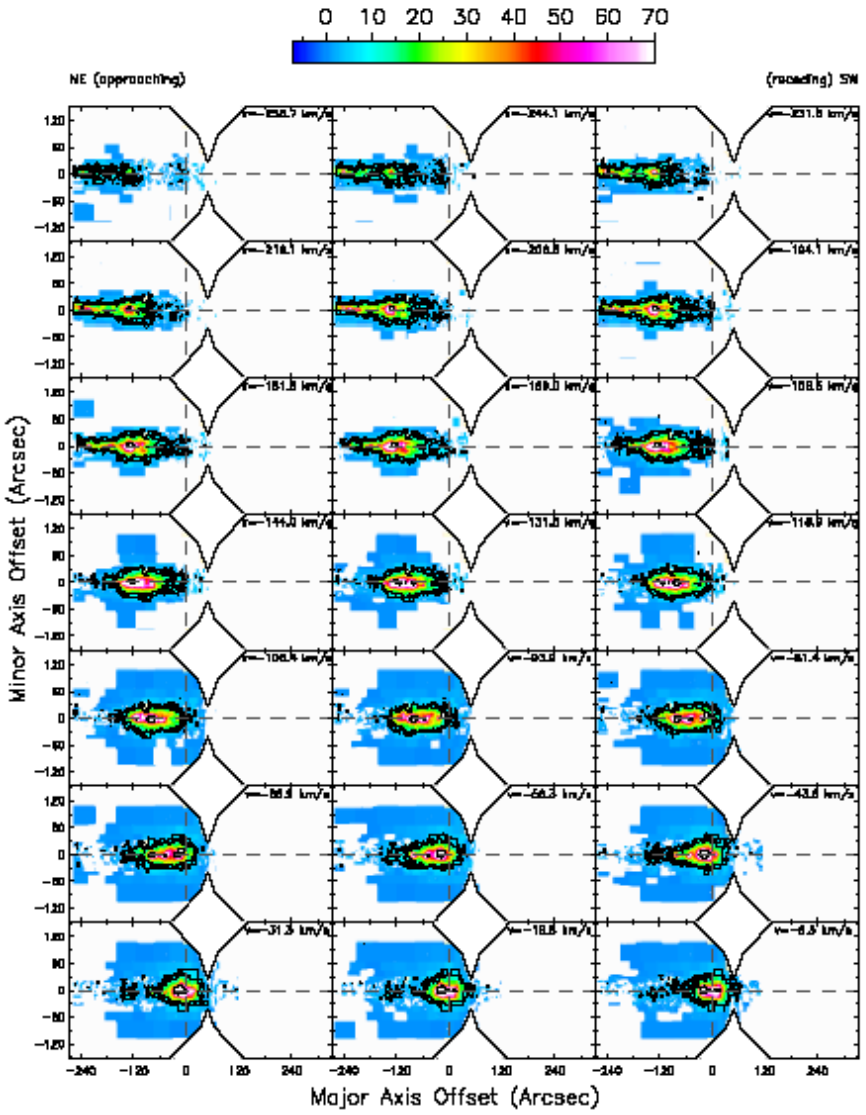
NGC 891
WIYN
Howk et al.





Taurus@WHT 2min/channel

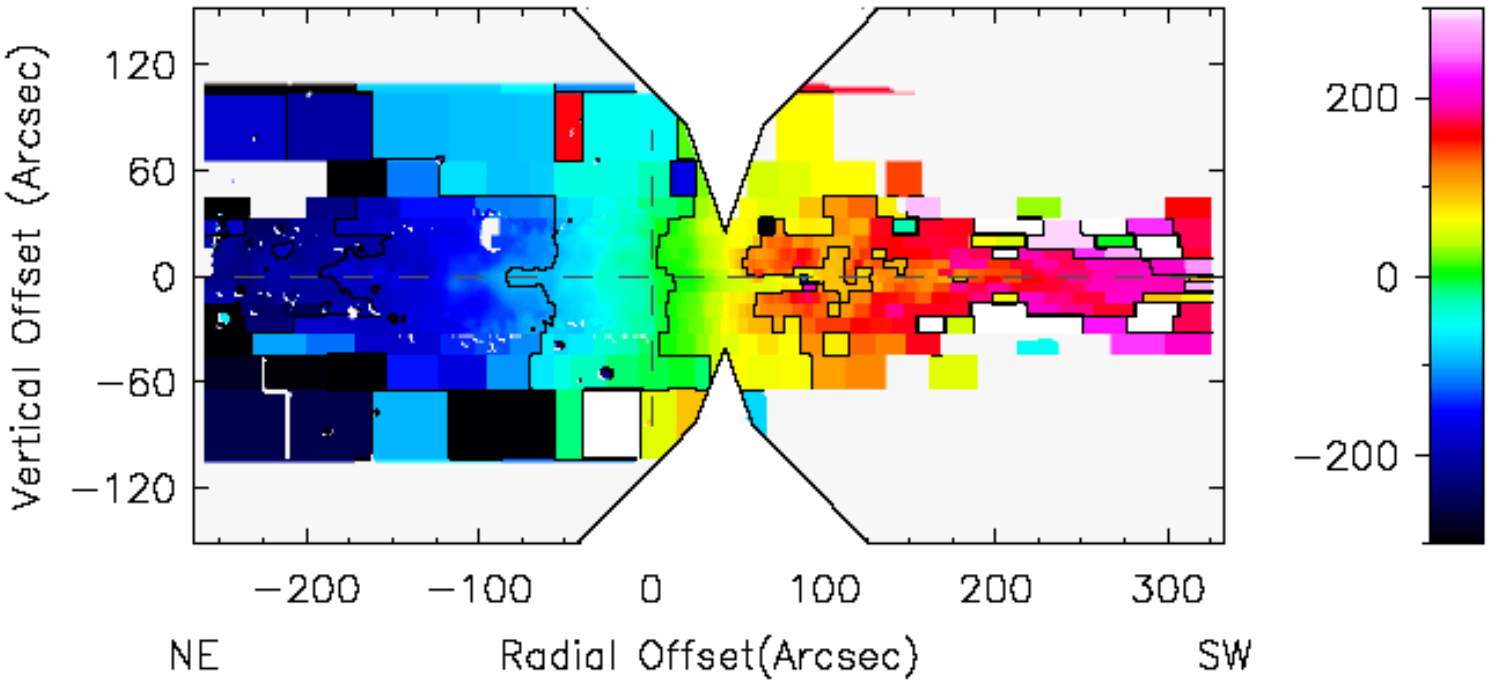
channel maps N891



Kamphuis, Peletier, Dettmar, et al. 2007

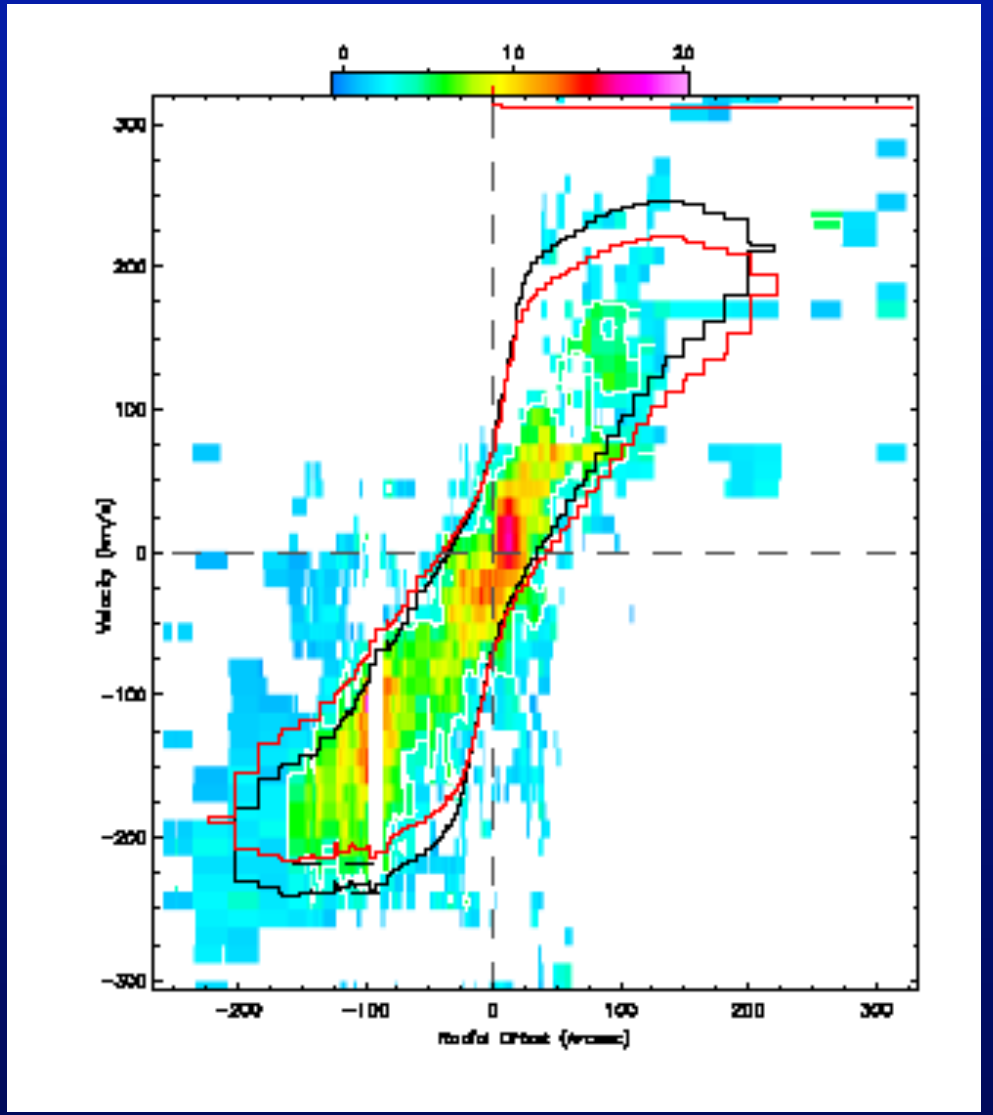
NGC 891 H_α velocity field from Fabry-Perot observations

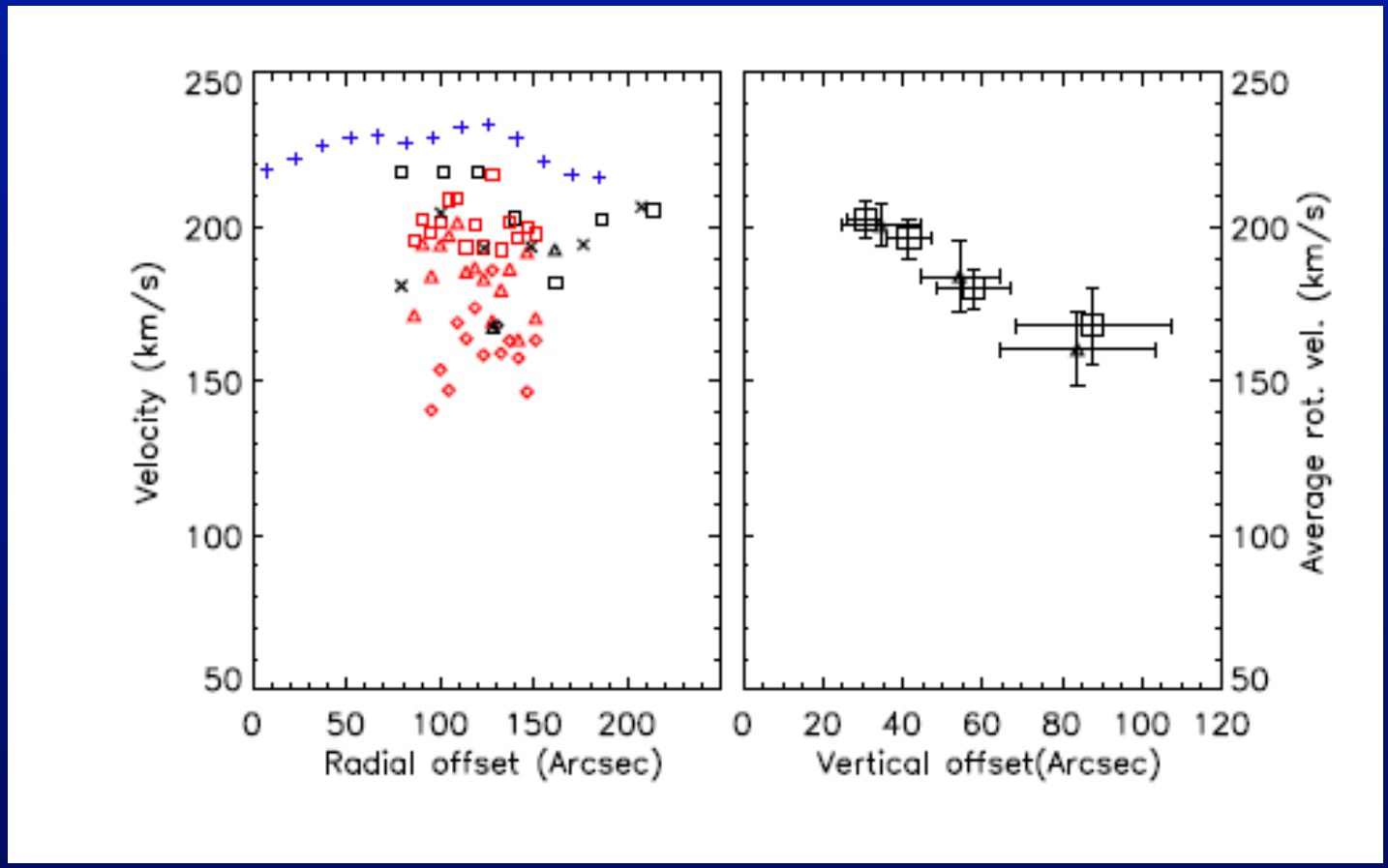
Kamphuis, Peletier, Dettmar et al. A&A 2007



modelling of individual p-v cuts at different z

red: with velocity gradient

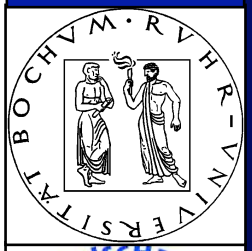




Kamphuis, Peletier, Dettmar, et al. 2007

differential velocities in z important for dynamo models:

$$B_\varphi \sim B_z \; dv/dz$$



Multiwavelengths

ISM Physics

High Sensitivity

What can 3D-NTT contribute:

low res: deep emission line imaging

high res: halo kinematics

both modes: ionisation structure
photoionisation vs shocks

The End

Supported by DFG and DLR