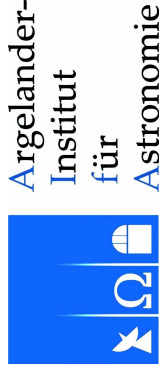


Magnetisation of Interstellar and Intergalactic Media: The Prospects of Low-Frequency Radio Astronomy



D. Elstner



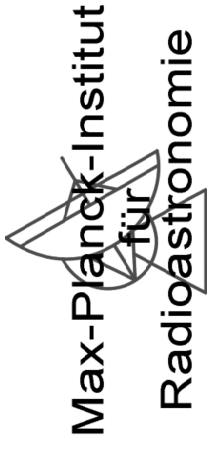
Argelander-
Institut
für
Astronomie

U. Klein



M. Brüggen

DFG Research Unit



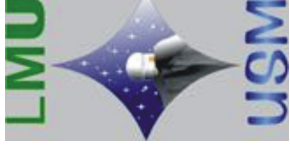
Max-Planck-Institut
für
Radioastronomie

R. Beck

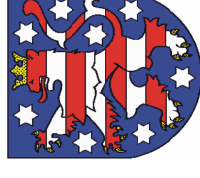
M. Kramer, A. Noutsos



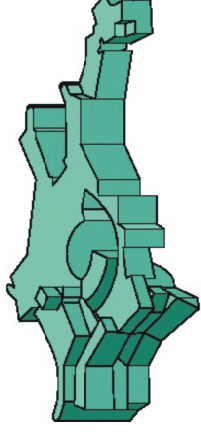
R.-J. Dettmar
D. Bomans



K. Dolag, H. Lesch

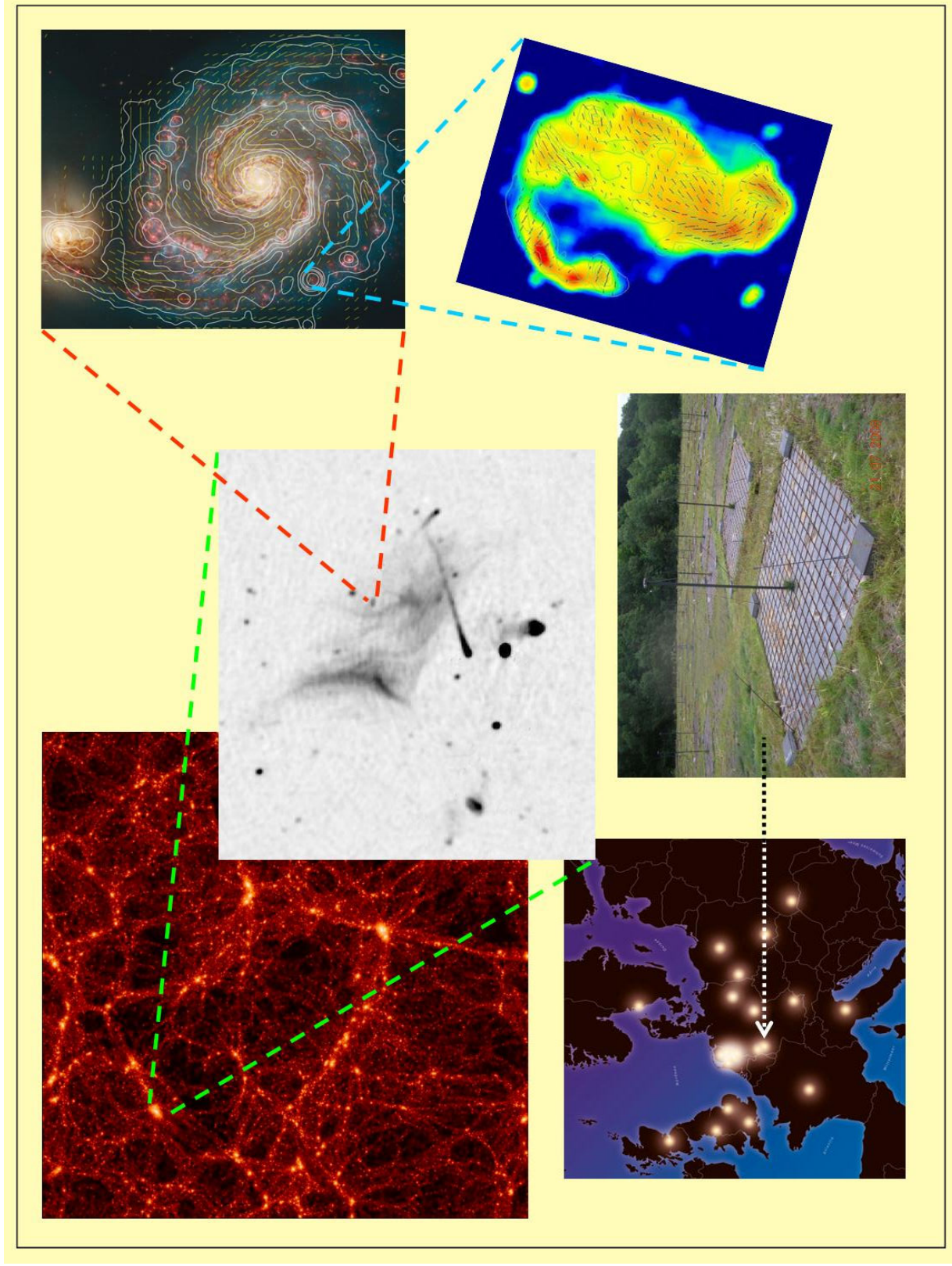


M. Hoeft



T. Enßlin

Overall theme: study magnetic fields on all scales



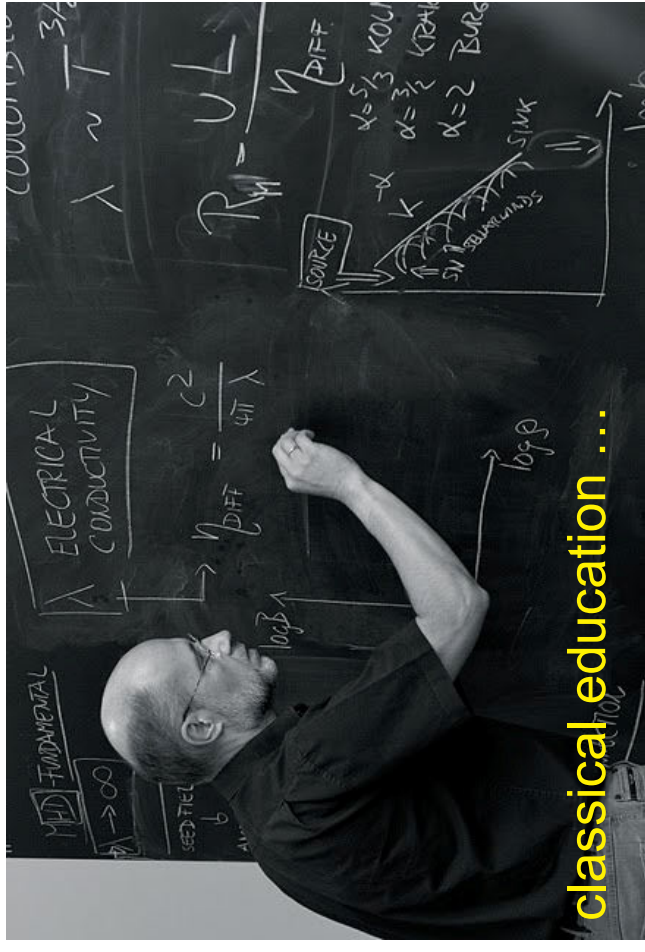
Projects:

- Magnetic fields in the Milky Way
- Magnetic fields in nearby galaxies
- Low-frequency radio halos around dwarf galaxies)
- Dynamo models of galaxies with winds
- Magnetic fields in galaxy clusters (theory)
- Radio relics and halos (observations)
- RM Synthesis and magnetic field statistics
- LOFAR: Pilot and commissioning observations

grant: 11 PhD
 2 Postdocs
 1 Secretary (Alfa)
 non-personnel funds

start funding : June 2010

funding period : 3 years (+ 3 ...?)



classical education ...

Kick-off Meeting Kloster Irsee, October 2010

Summer School, Ringberg Castle, July 2011

further training of students, postdocs, ...:

GLOW Interferometer School, Hamburg, September 2010

European Single Dish School, Bonn, Sept./Oct. 2010

+ series of 'LOFAR busy weeks' ...

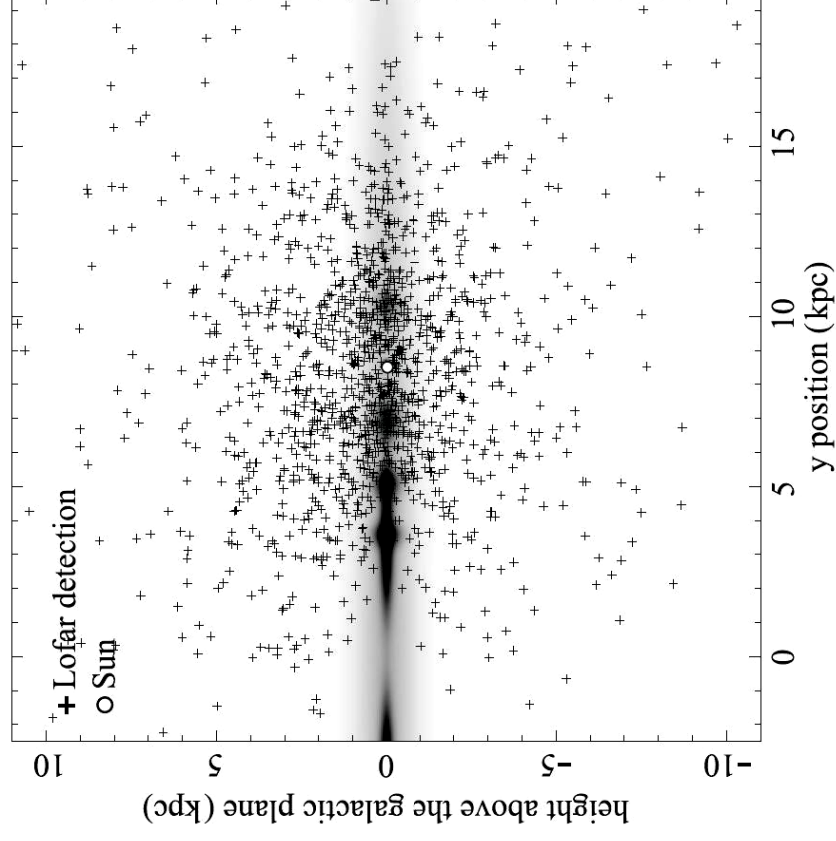
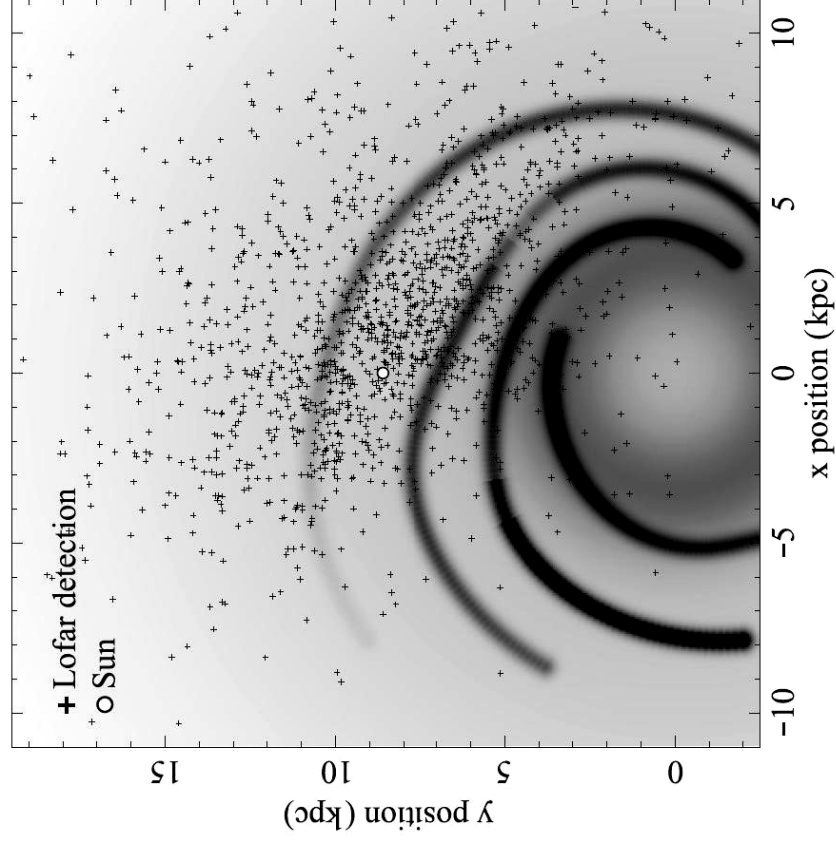
modern education ...



most important ingredients:

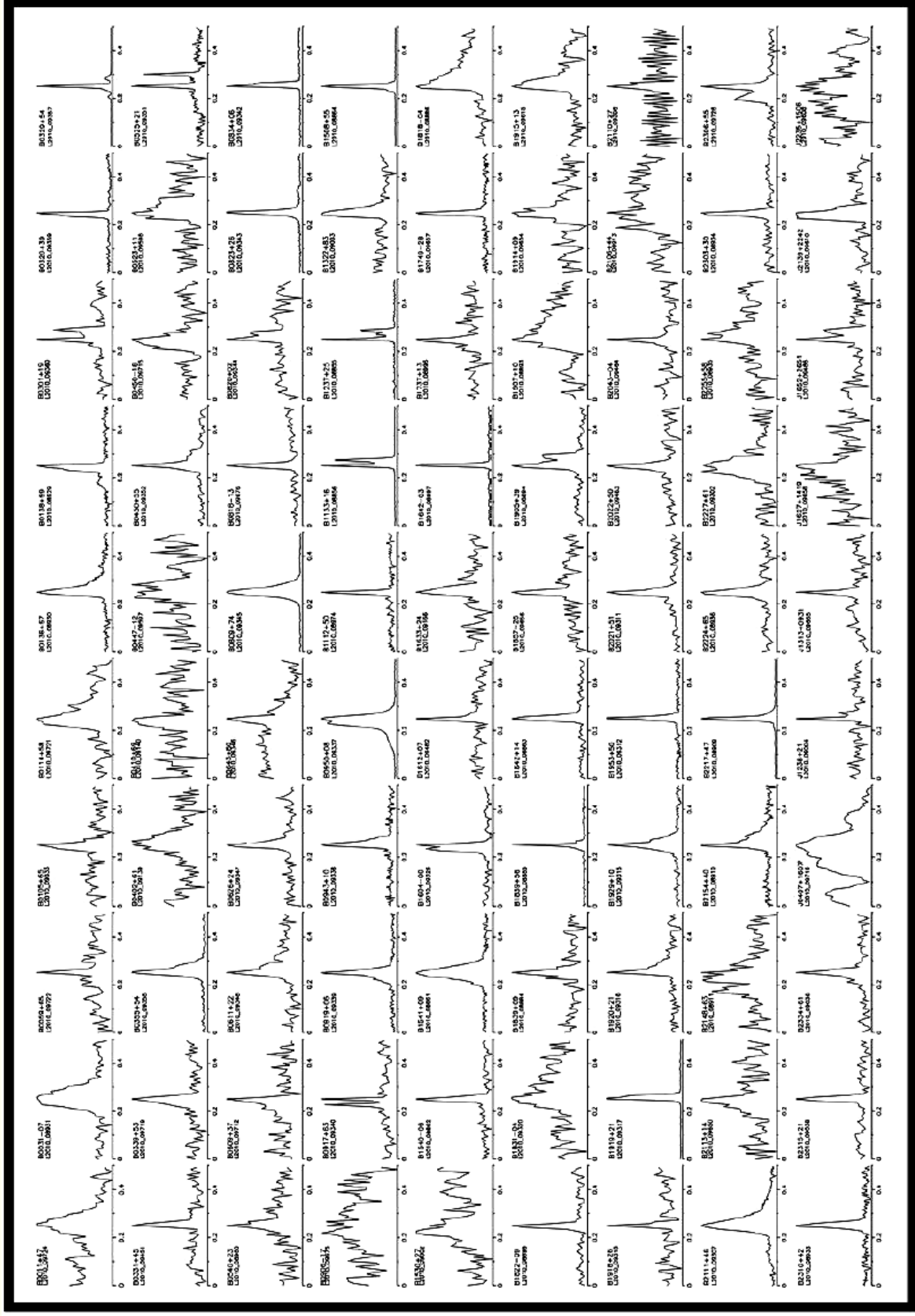


magnetic fields in the Milky Way: pulsar RMs using LOFAR:



simulation by van Leuven & Stappers 2010

pulsars with LOFAR (Sobey, Noutsos, Kramer et al.):



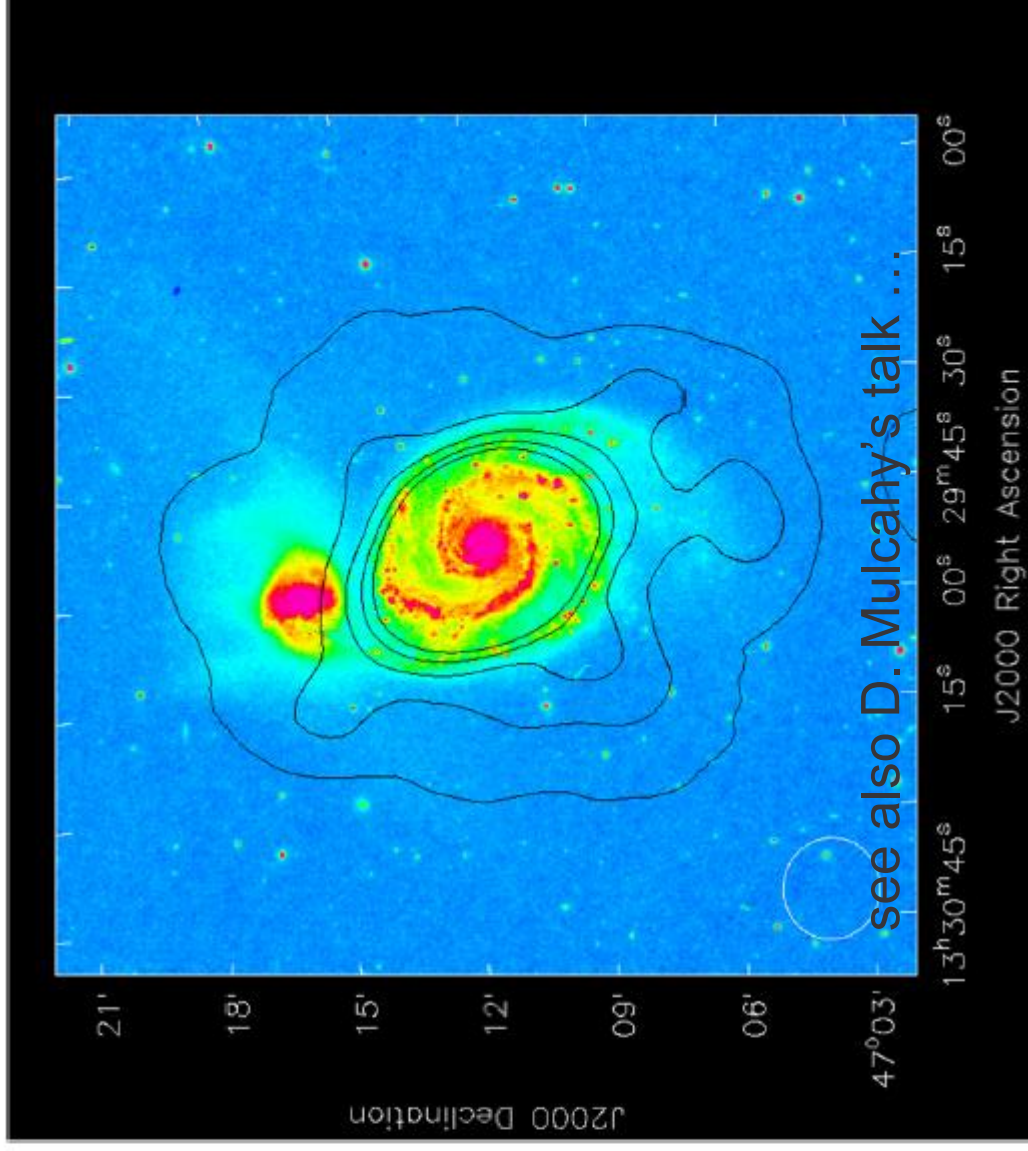
nearby galaxies at lowest radio frequencies
calibration strategies, e.g. M 51 by Mulcahy et al.:

Observing M51 with

LOFAR

- Currently, working on a single subband (SB60 - 139MHz) from a 6hr observation.
- 3C295 was observed simultaneously.
- Experimenting on several methods of calibration:

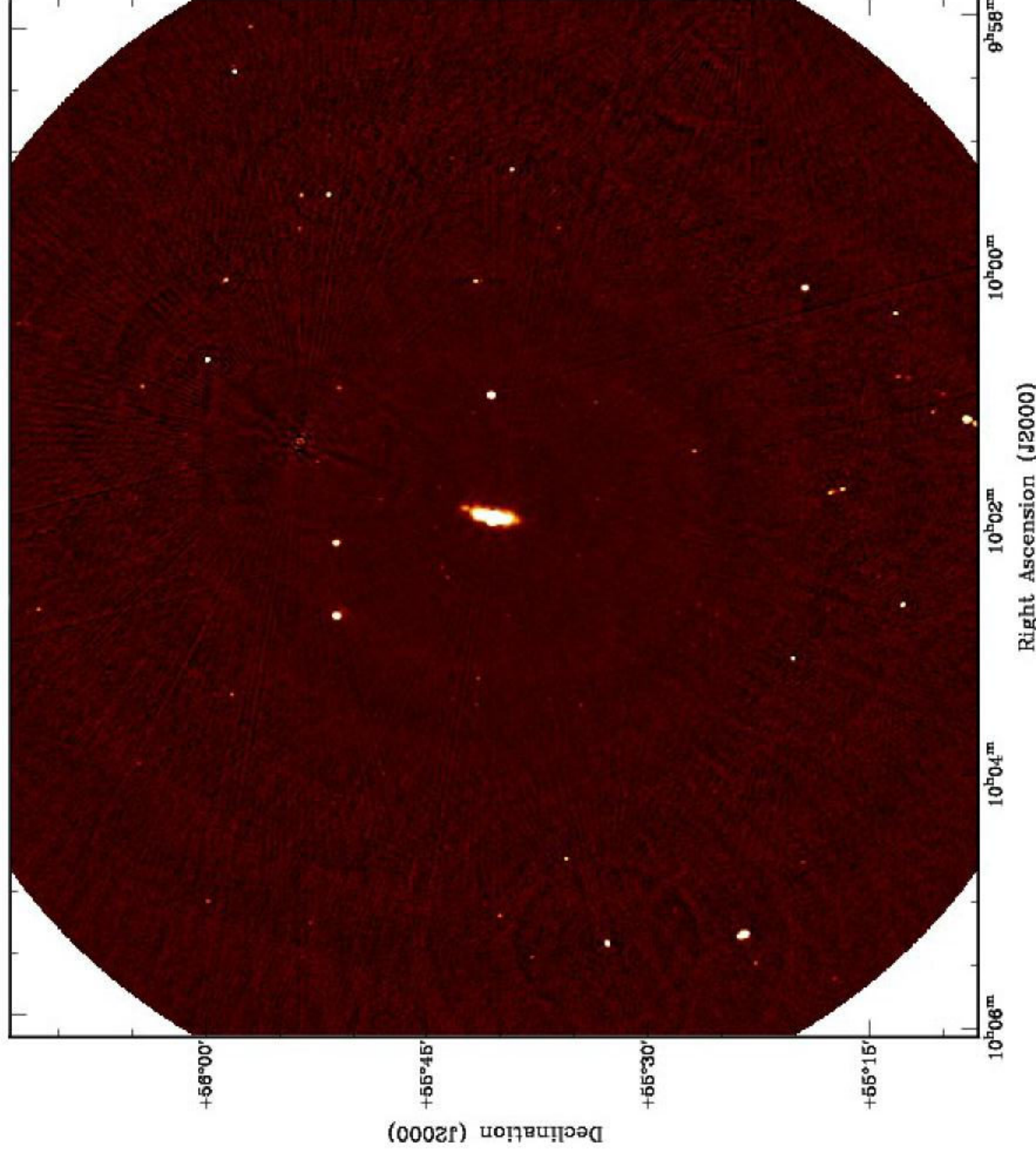
1. Using simple WENSS skymodel
2. Using a model created from GMRT FITS file supplied by Andrew Fletcher. Created through PYBDSM.
3. Transferring the Gain solutions from calibrator to source. (See George Heald's Busy Week presentation on procedure)



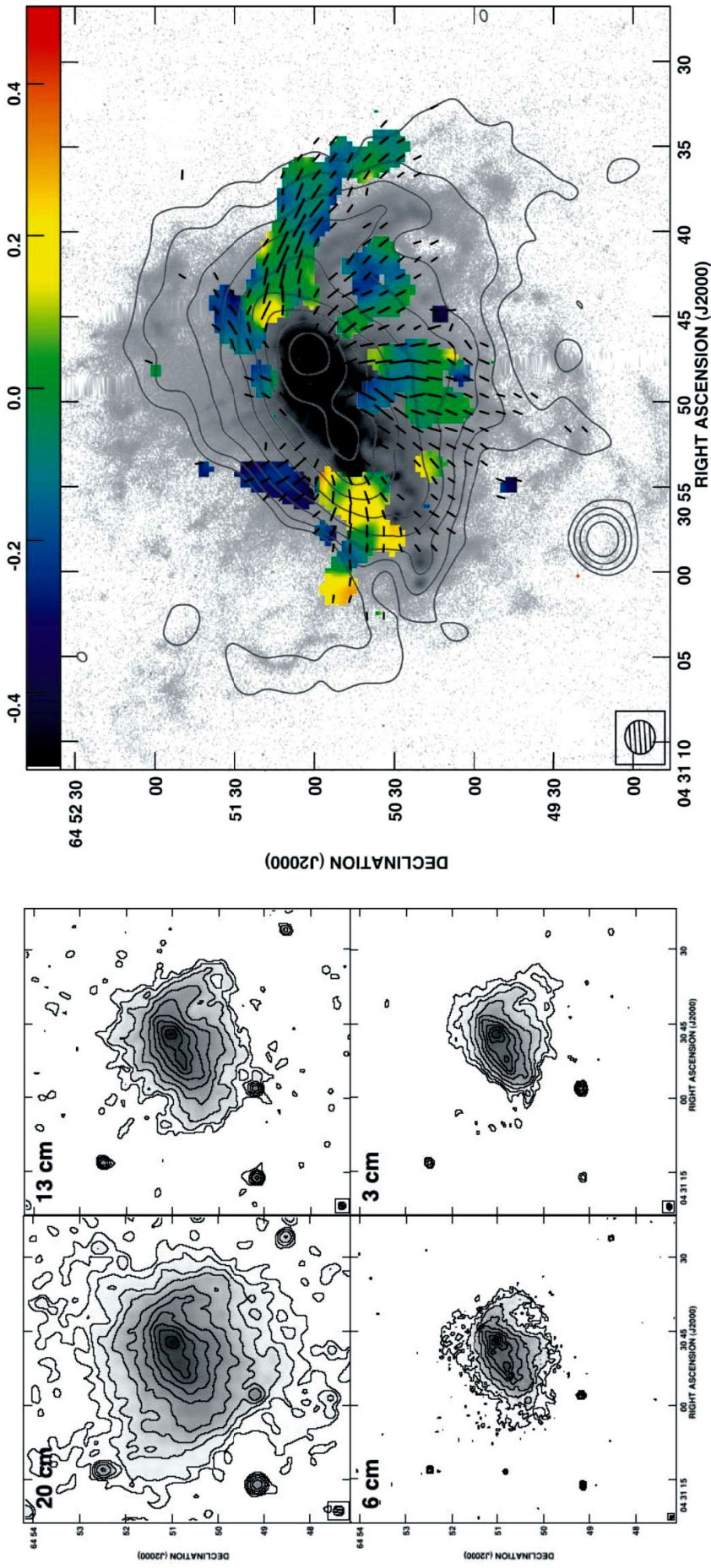
NGC 3079 @ 22 cm, Sotomayor et al.

solving
calibration
problems:

a mandatory
exercise to
handle low-
frequency data!

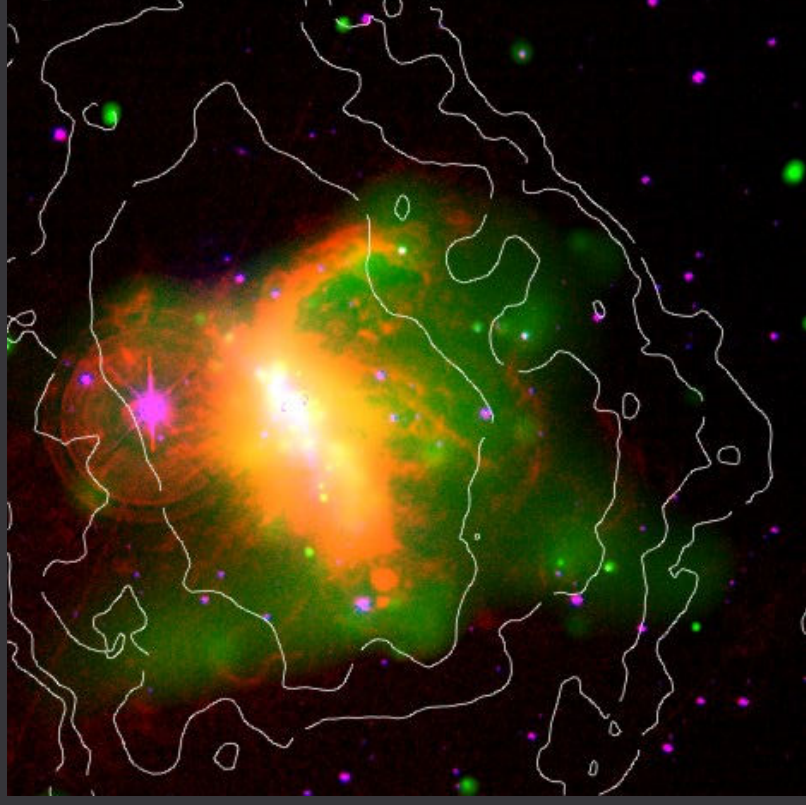
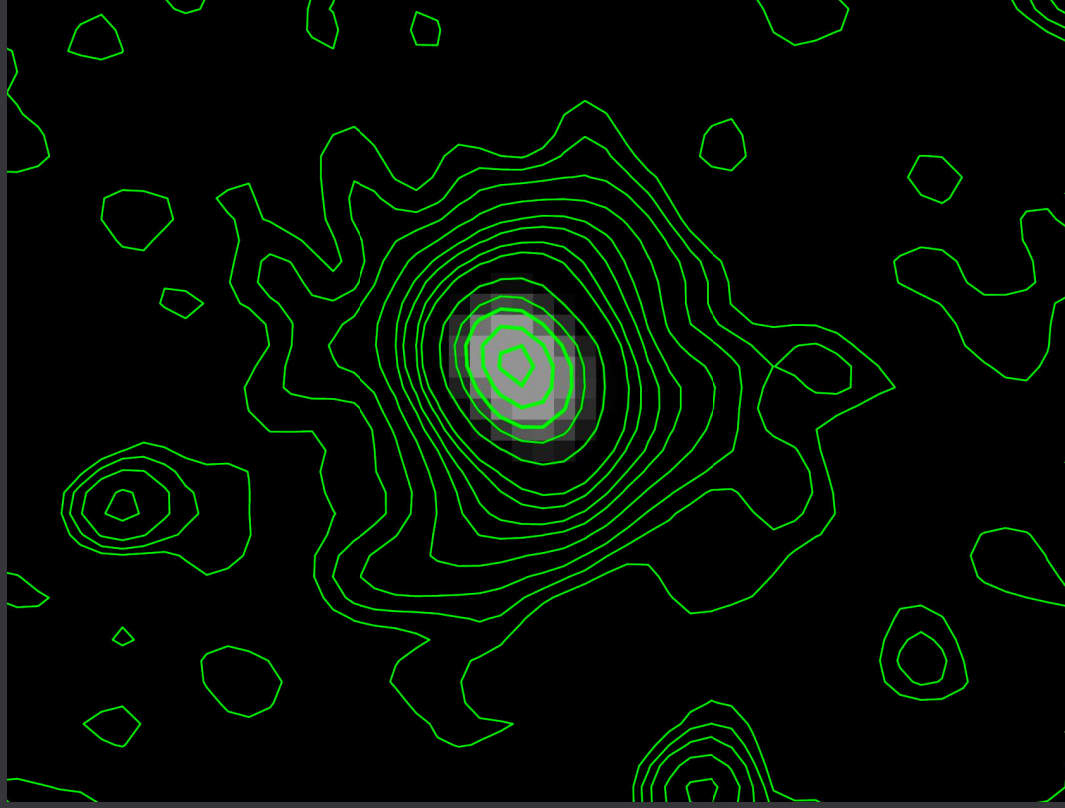


dwarf galaxies: magnetisation of early universe?
 e.g. NGC 1569, radio emission and magnetic field



Kepley et al. 2010

NGC 1569 at 350 MHz, A. Purkayastha et al.



... see also poster!

WSRT 'legacy project': some 20 galaxies being observed at $\lambda = 92$ cm

(PI: U. Klein)

key points:

- cosmic ray propagation
- magnetic fields in galactic halos.
- Faraday rotation, Rotation Measure Synthesis
- calibration strategies \Rightarrow LOFAR

... man-years of work!

theory: dynamo models, A. Bendre, D. Elstner et al.

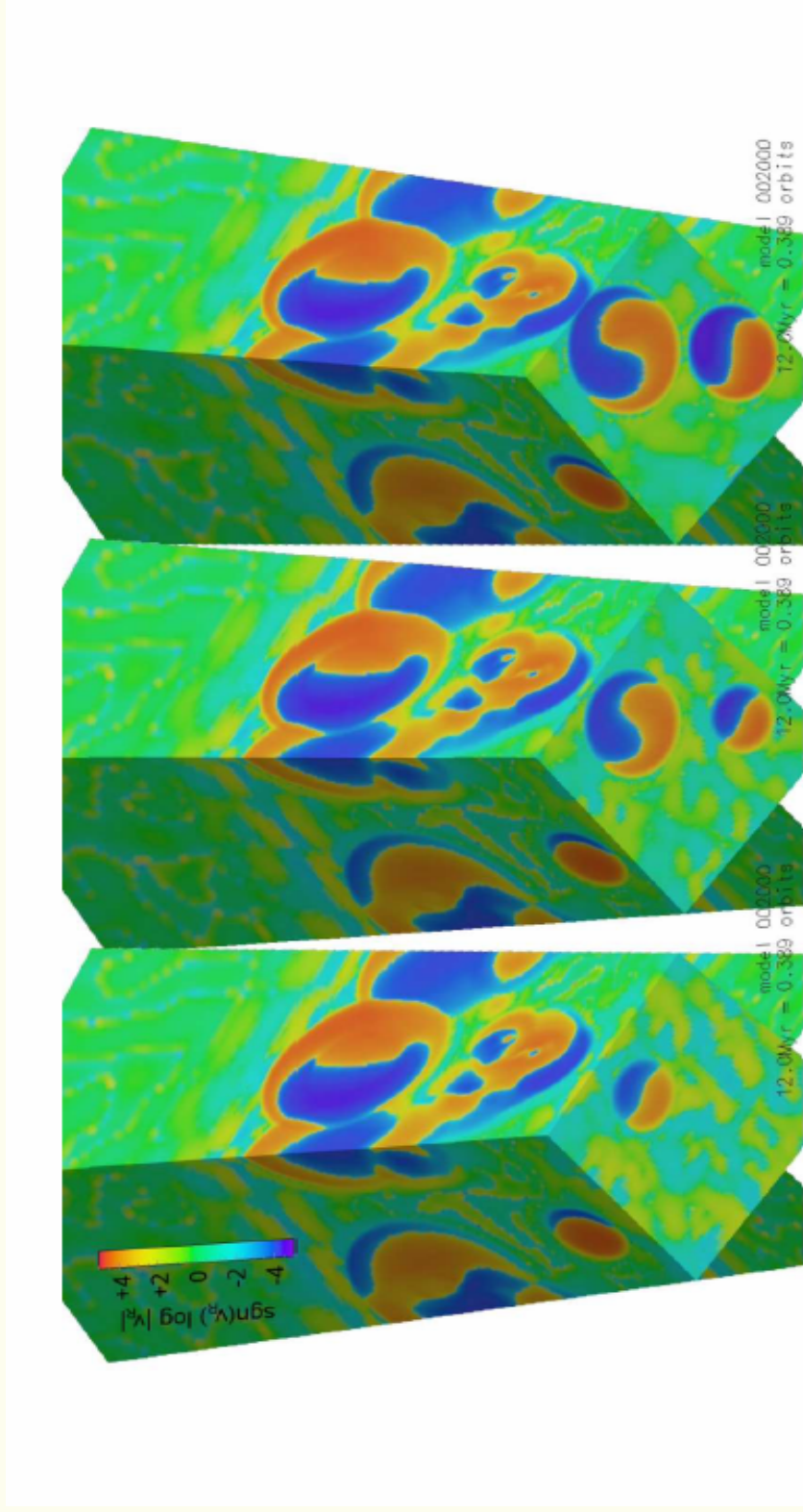


Figure 2.1: Renderings of the simulation box at an early time of the evolution. The colour coding indicates the signed logarithm of the radial velocity v_R . The three representations show horizontal slices at different heights z . At this early stage the single remnants are still visible, highlighting the differential twist within the expanding cavities.

xy plane : 0.8 kpc x 0.8 kpc (96x96 grid cells)
vertical size z : -2 kpc to 2 kpc (512 grid cells)

galaxy clusters: disclosing the nature of diffuse radio sources:

halos & relics

radio halos:

- secondary electrons (from hadronic collisions of relativistic protons with the thermal nuclei)
- in-situ (Fermi-II) re-acceleration by MHD turbulence generated in the ICM during cluster mergers

radio relics:

- compression of fossile radio plasma
- direct (Fermi-I) particle acceleration

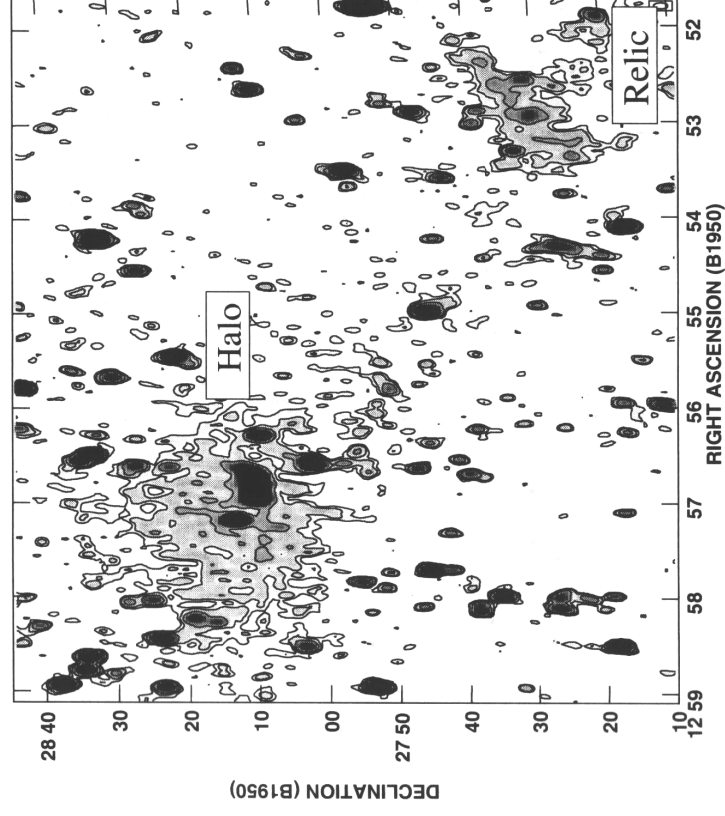
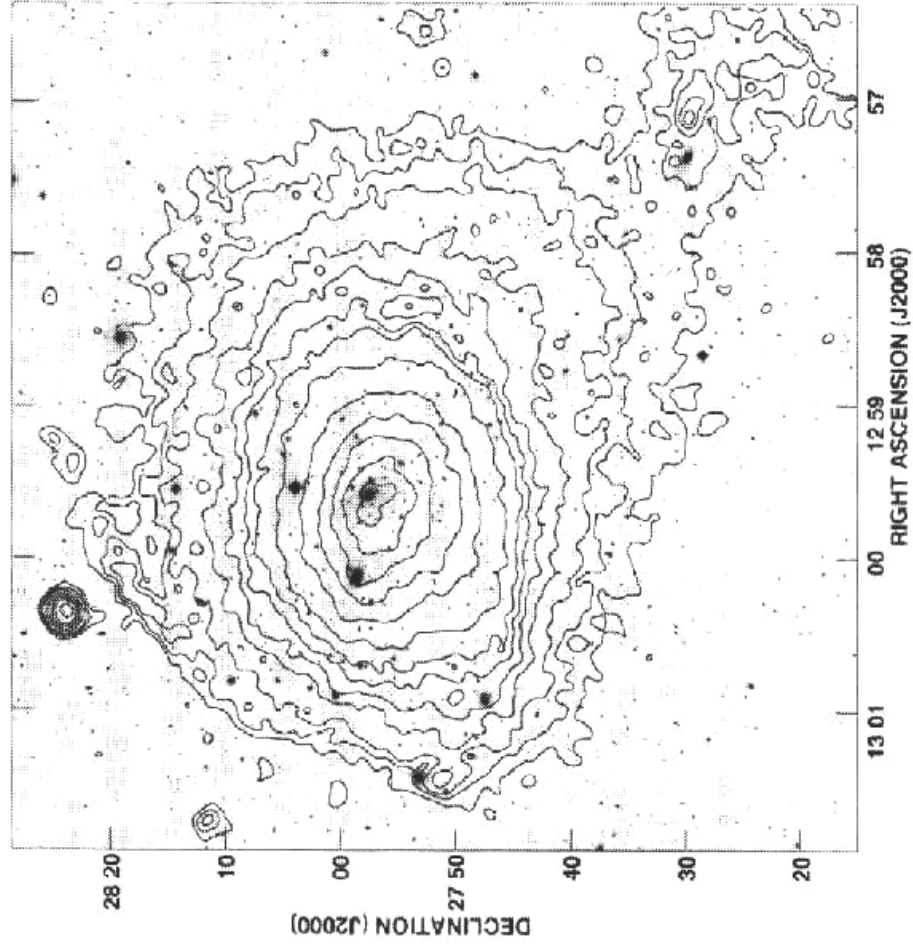
WSRT 'legacy project': some 20 clusters being observed at $\lambda = 92$ cm

(PI: R. Pizzo)

- detecting extended diffuse low-surface emission in clusters
- establishing low-frequency synchrotron spectra of halos and relics
- investigating polarization properties of relics at low frequencies
- performing RM synthesis for halos and relics
- working out detailed models for cluster radio emission

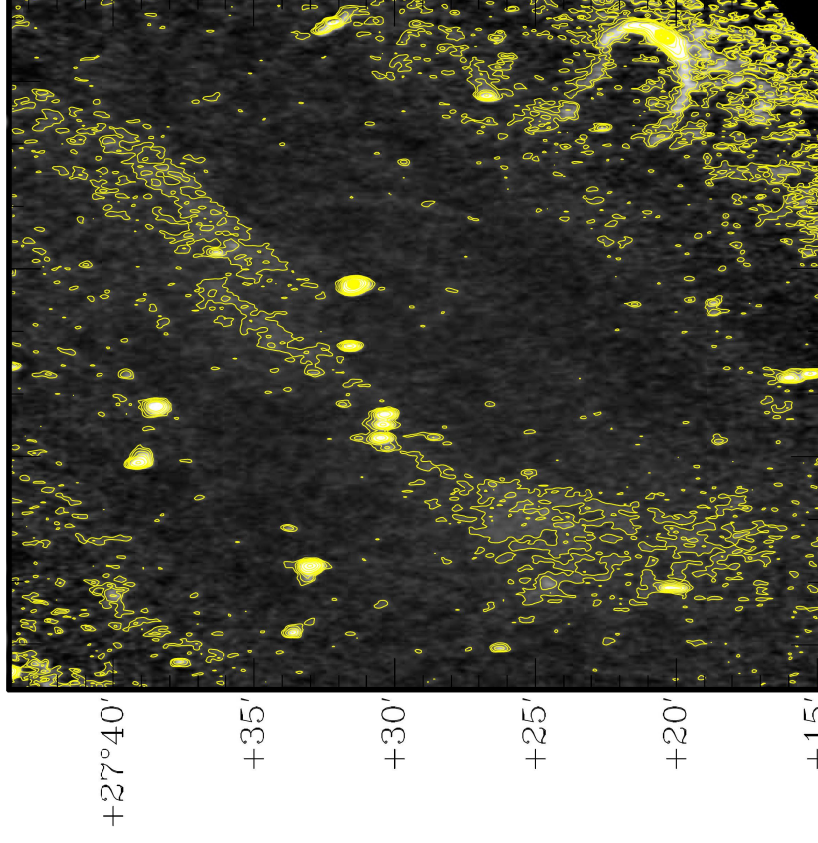
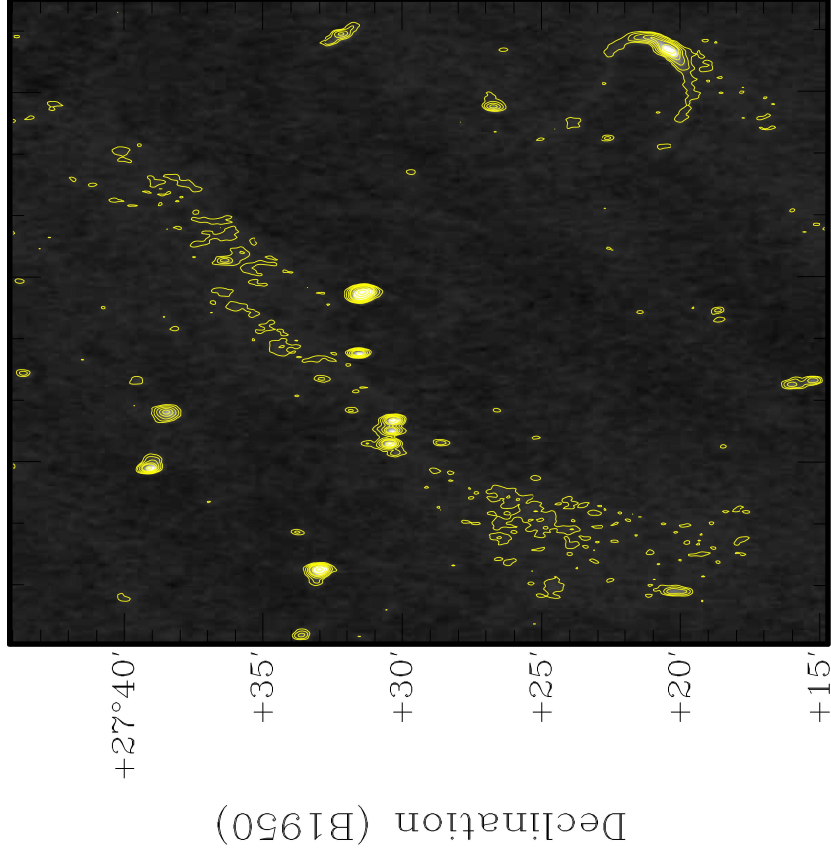
... man-years of work!

classical case: Coma Cluster



thorough study: M. Trasatti et al.

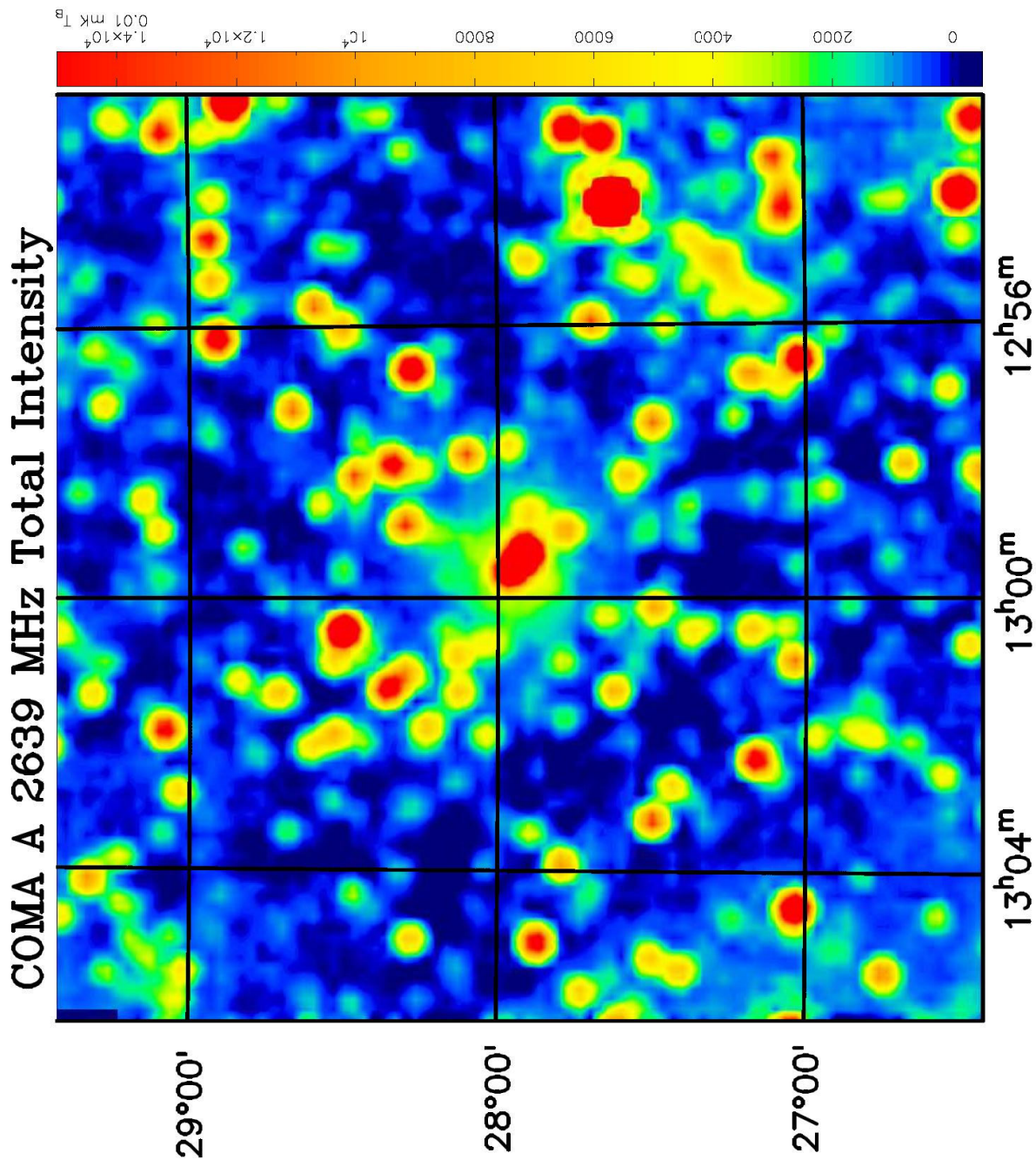
WSRT $\lambda = 13$ cm, Effelsberg $\lambda = 11$ cm



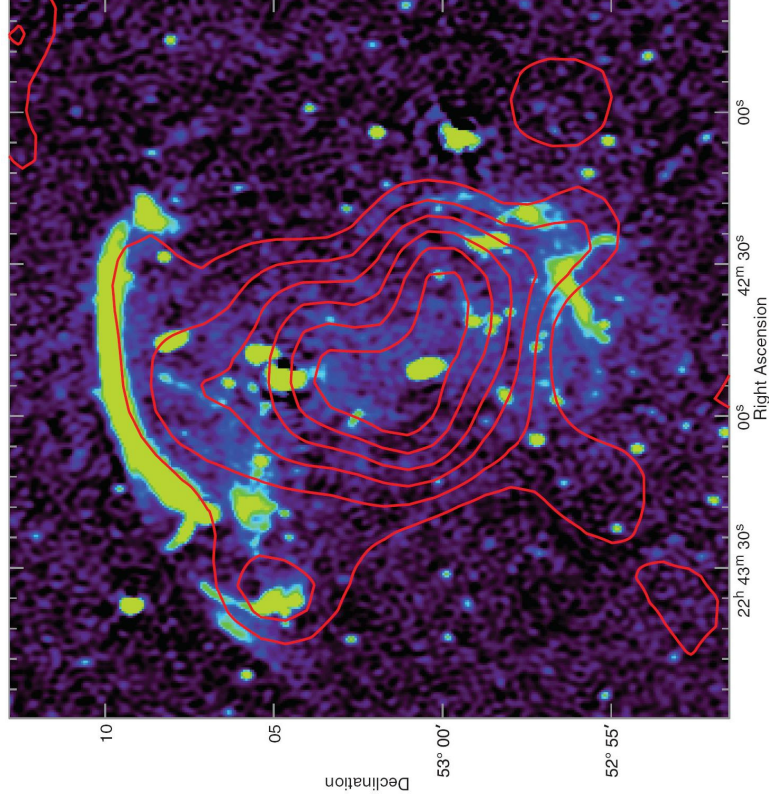
spectral index and polarization between 90 cm and 3.6/2.8 cm

plus other clusters

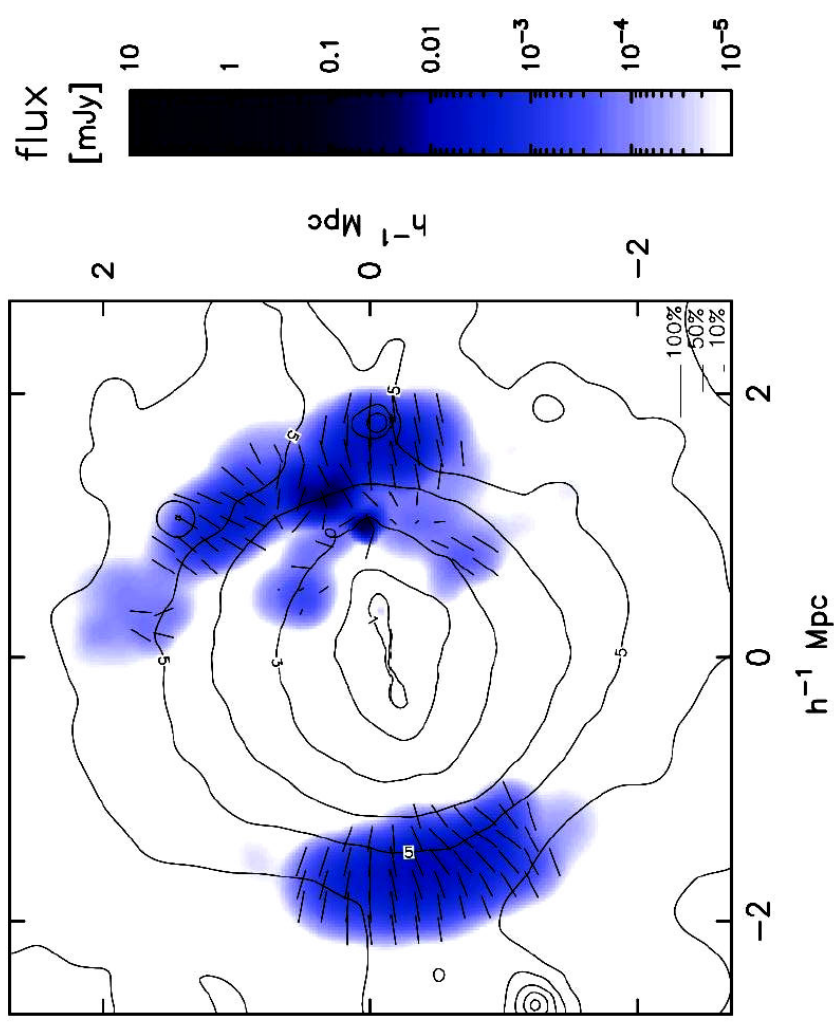
extremely deep 11-cm map (Fürst & Wielebinski) \Rightarrow 'zero-spacings'



CIZA J2242.8+5301 ($z = 0.1921$)



simulation of radio and X-ray
emission from a merging
cluster (Hoefl et al. 2008)



The Role of Simulations in Understanding Cosmic Magnetism

© Klaus Dolag

A. Bonafede, J. Donnert, H. Kotarba, A. Geng, A. Beck and F. Stasyszyn



Prospects of Research Unit:

- expect significant advances in understanding galactic and intergalactic magnetic fields by exploring low-frequency regime and putting theoretical models to the test
- impacts for exploring and understanding
 - local magnetic fields
 - galactic winds
 - halo fields and dynamos
 - magnetisation of the IGM
 - nature of cluster radio halos and relics
 - large-scale filaments
 - CR propagation