Radio observations of galaxy clusters

Chiara Ferrari
(OCA, Lagrange)

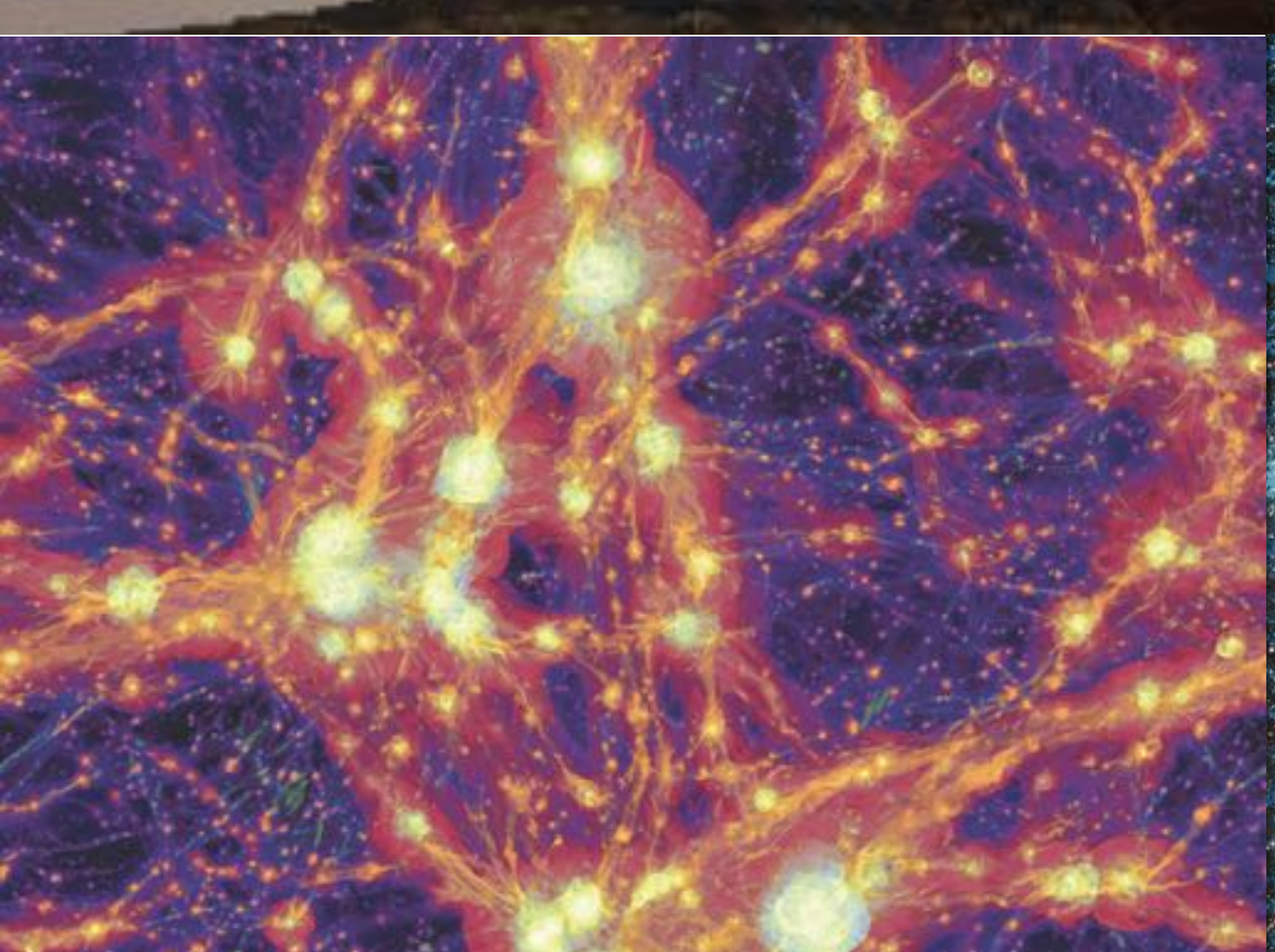
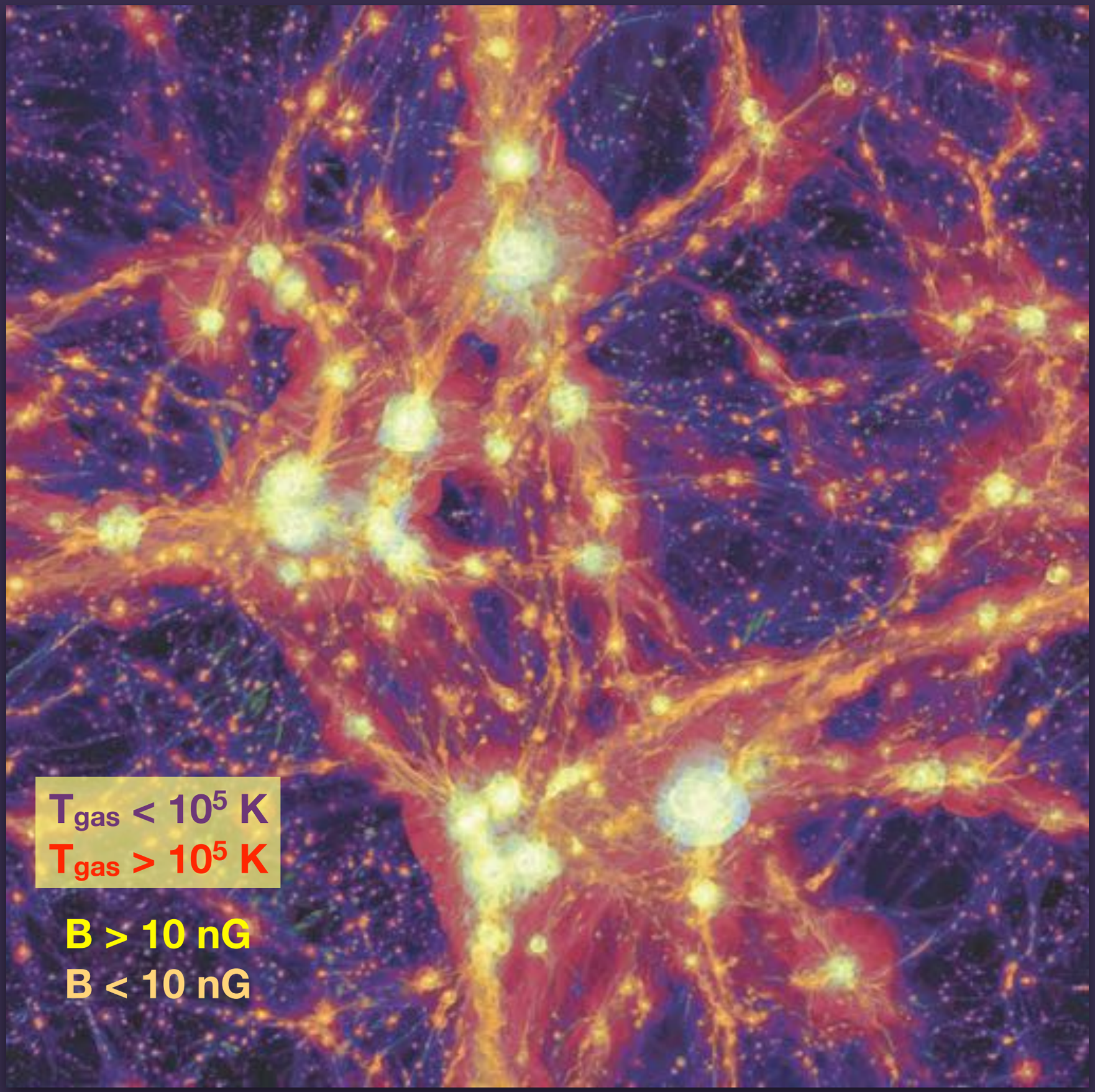
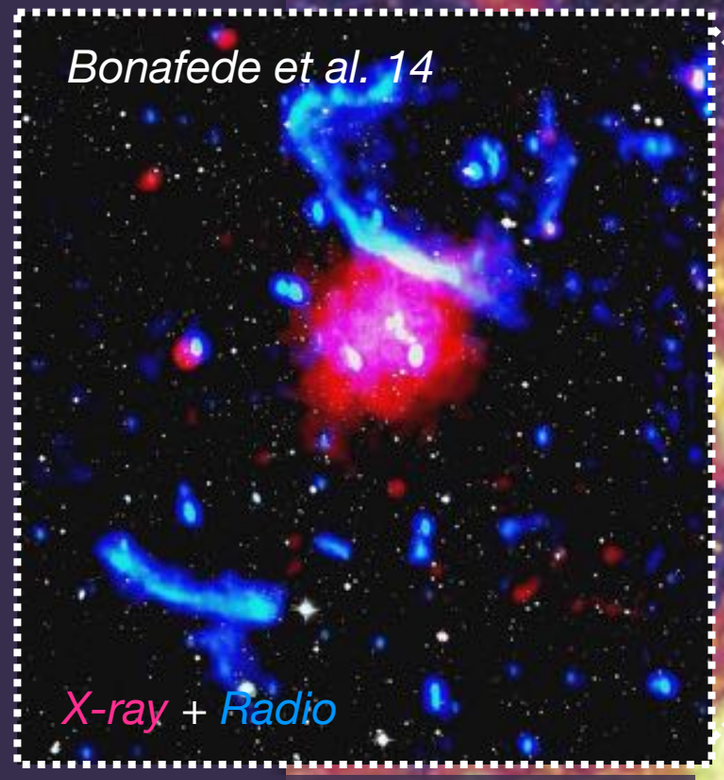


Image courtesy:
F. Vazza &
www.skatelescope.org



Vazza et al. 15

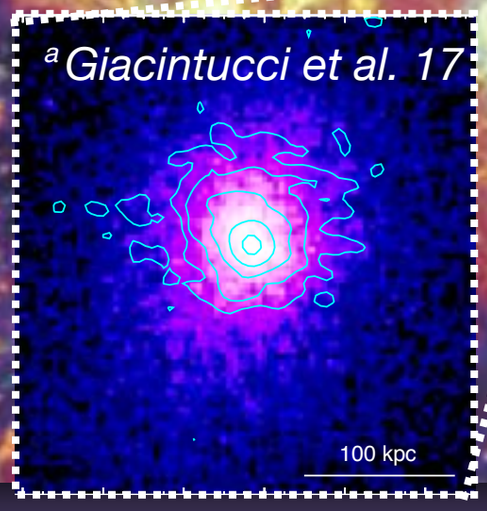


- Can we use radio observations to detect clusters ?
- Can we get hints of their dynamical state & merging scenario ?

- Can we detect the magnetised cosmic web ?

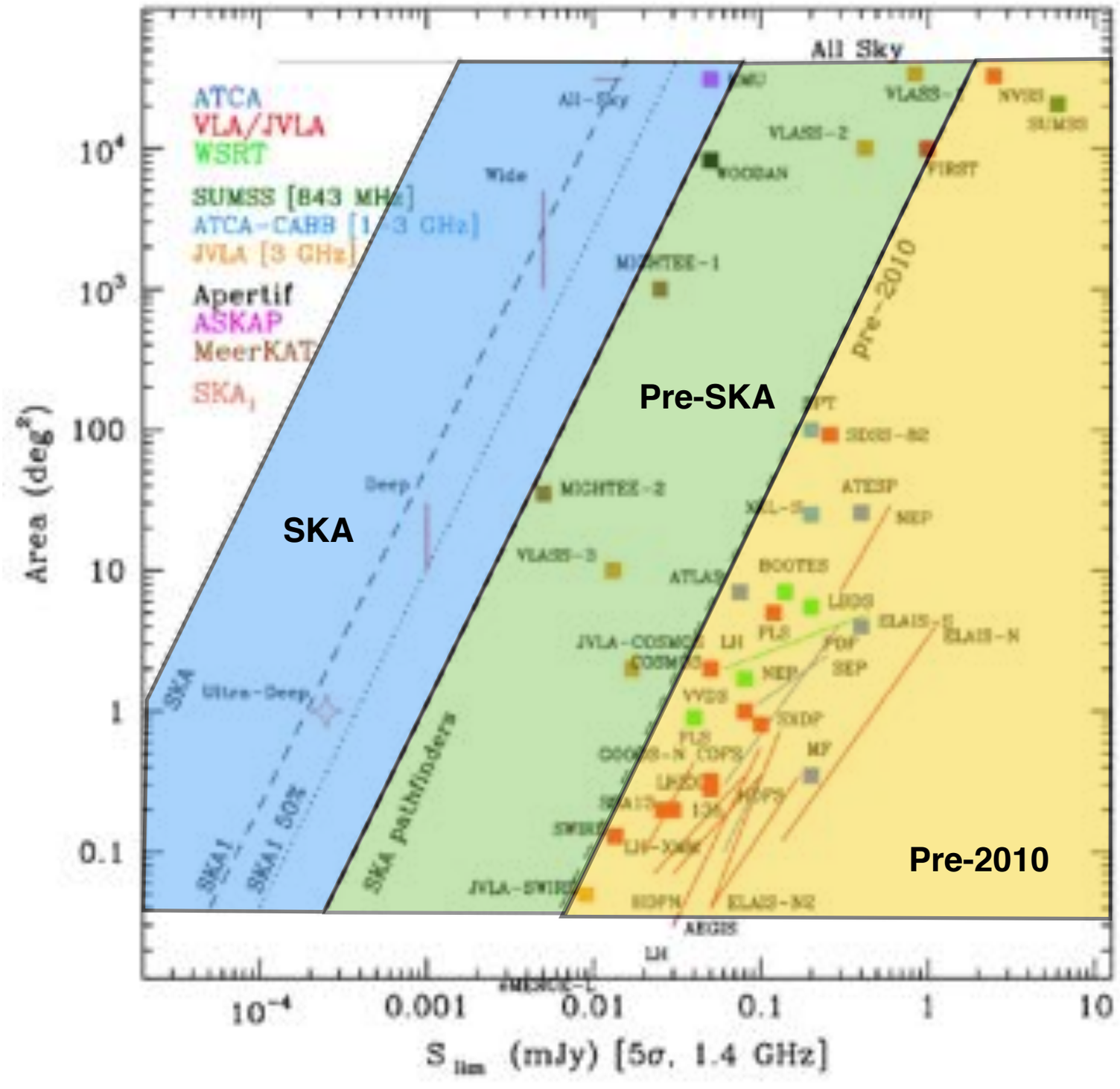
- What is the origin of relativistic particles ?
- What is the intensity & structure of magnetic fields ?

- How is the non-thermal component affecting heating transport & energy feedback in cluster cores ?



Vazza et al. 15

SKA1 radio continuum surveys

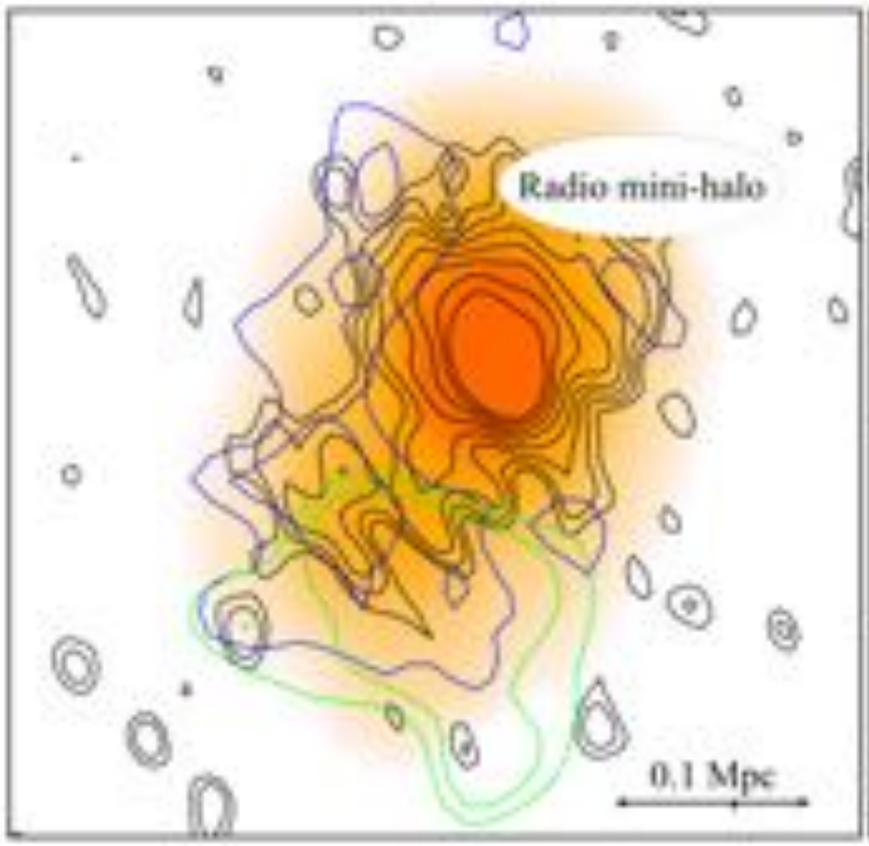


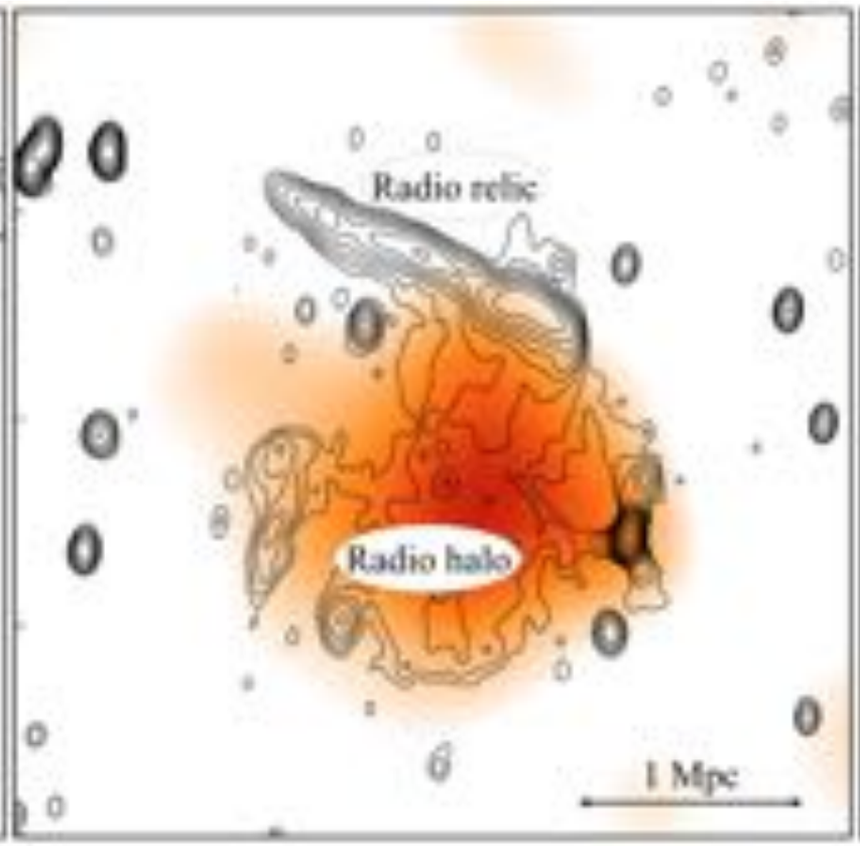
Adapted from Prandoni & Seymour 15

- What is the origin of relativistic particles ?
- What is the intensity & structure of magnetic fields ?

Vazza et al. 15

Diffuse radio emission in galaxy clusters

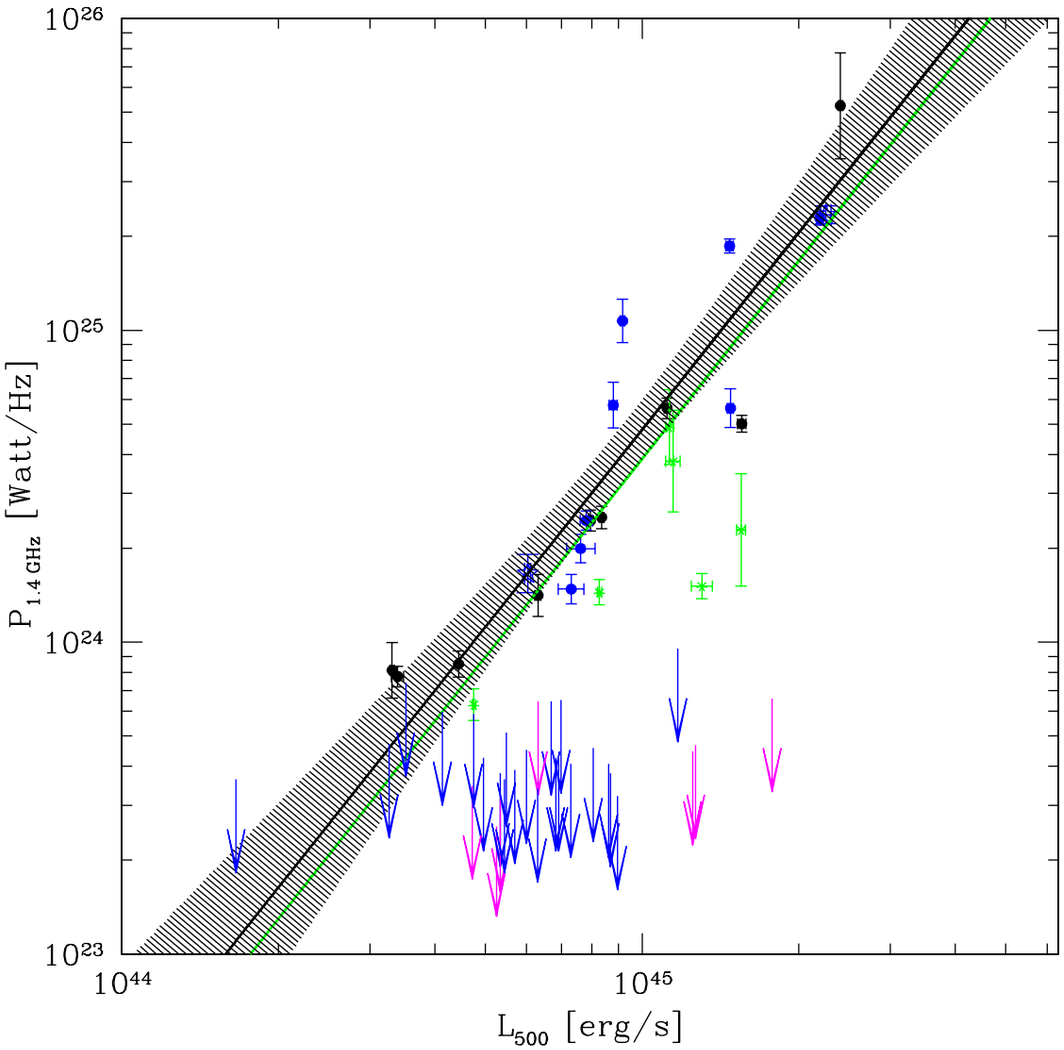


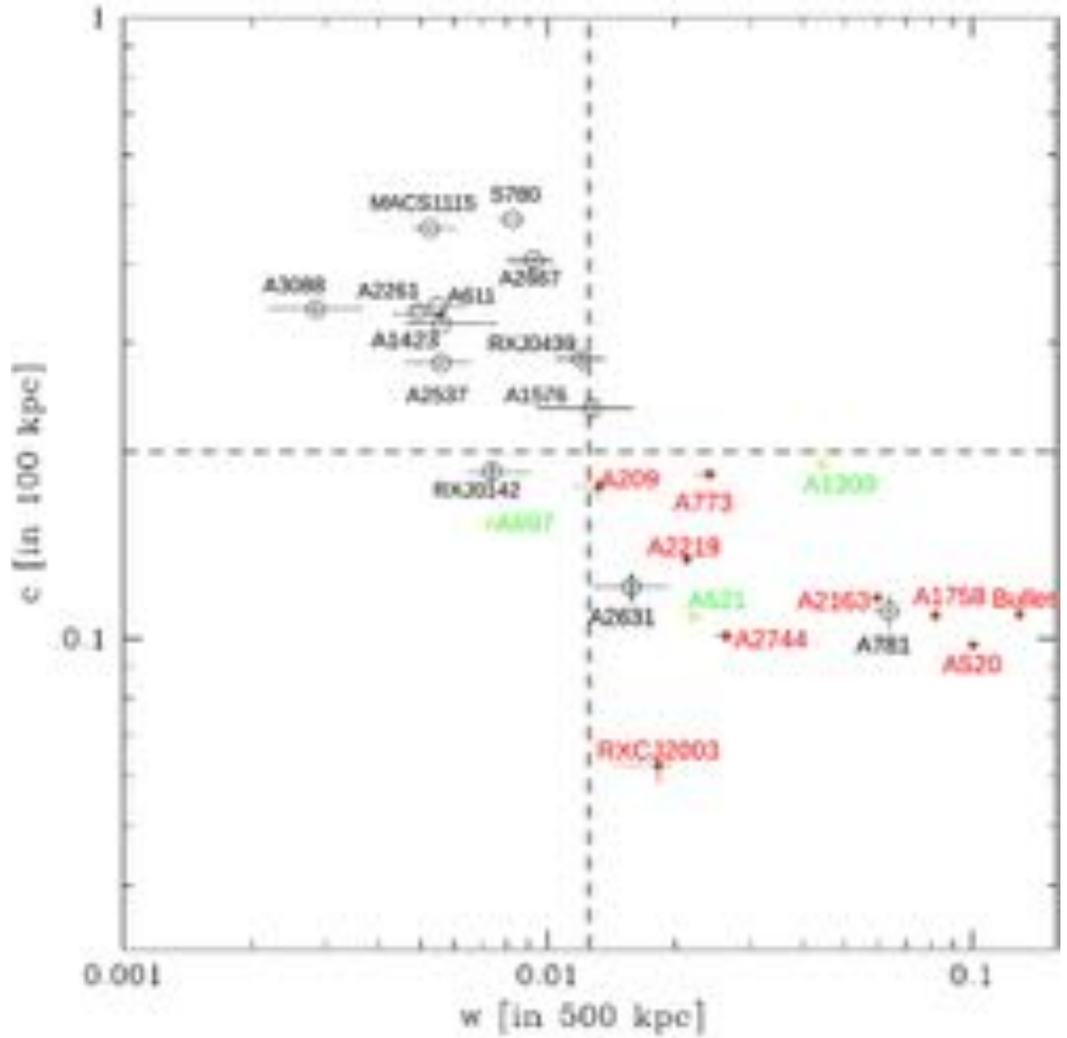


Contours of radio emission
on X-ray thermal emission

Extracted from the French SKA White Book

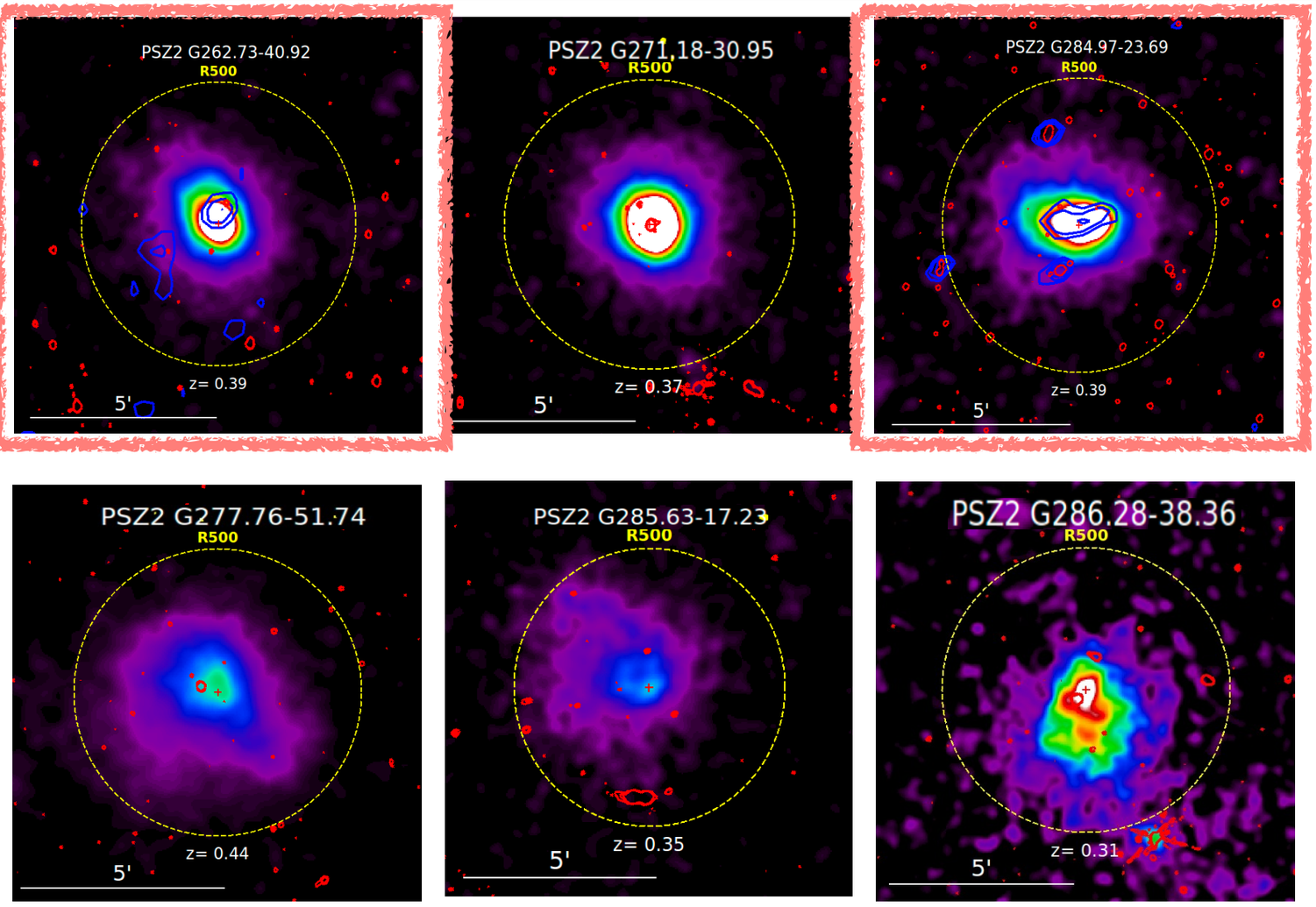
What is the origin of relativistic particles ?





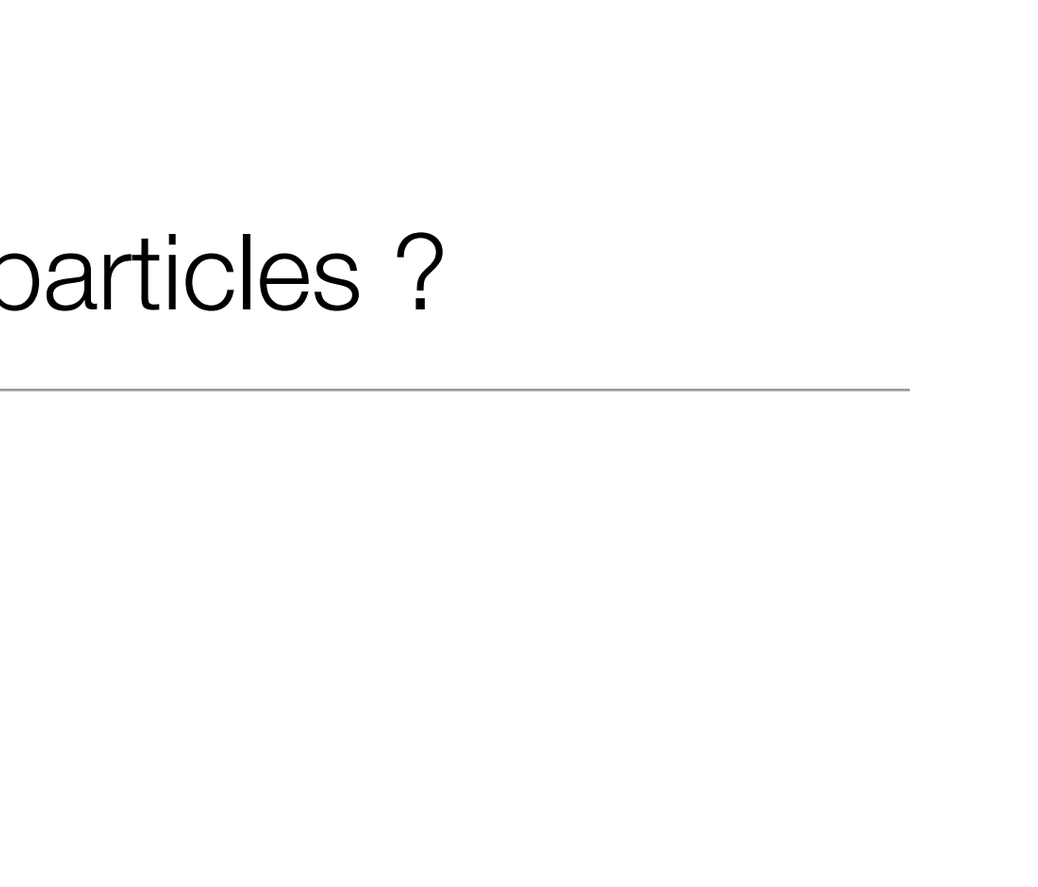
Cassano et al.13

What is the origin of relativistic particles ?

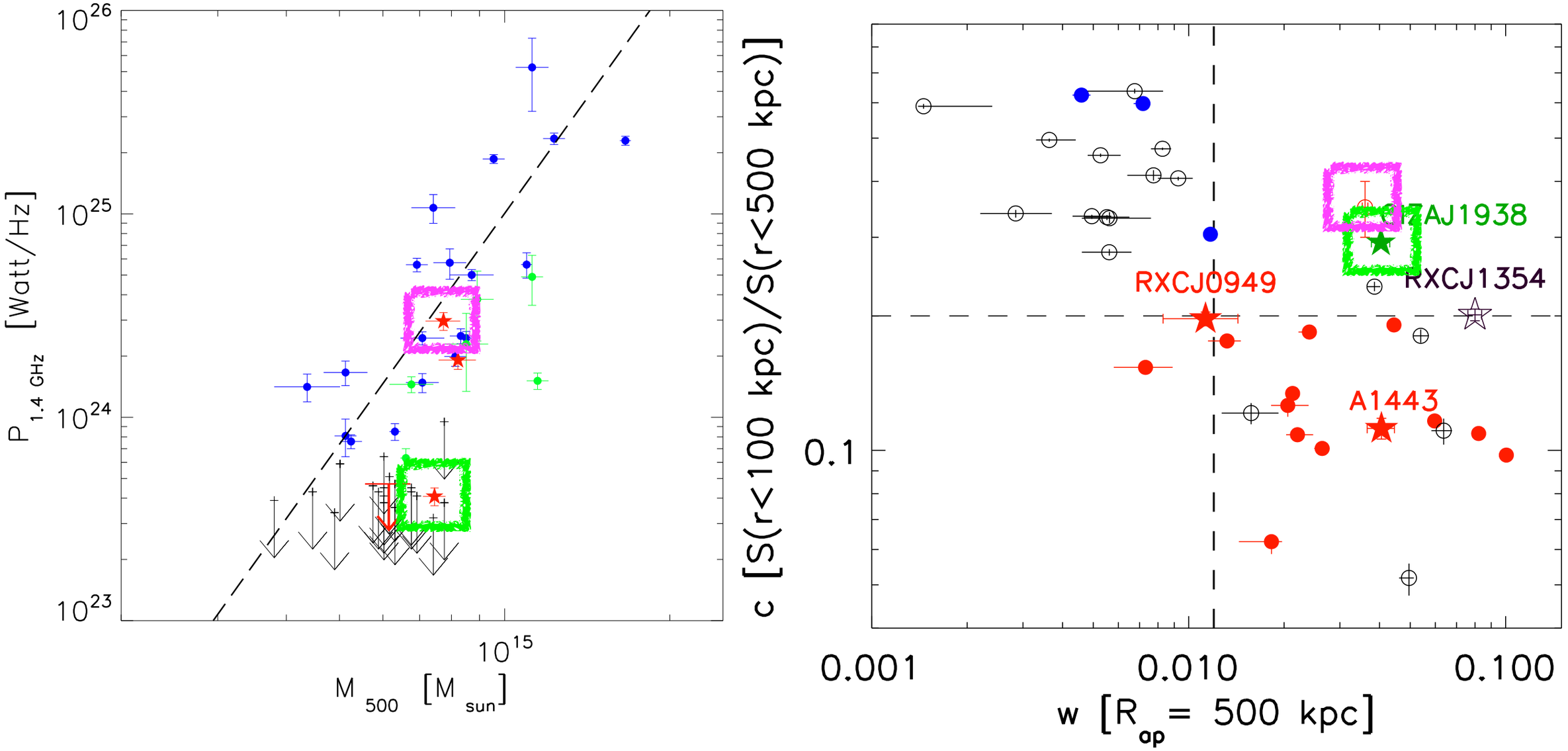


Martinez-Aviles et al. 16, 17
ATCA observations
(1.1 - 3.1 GHz)

Southern Sky Telescope



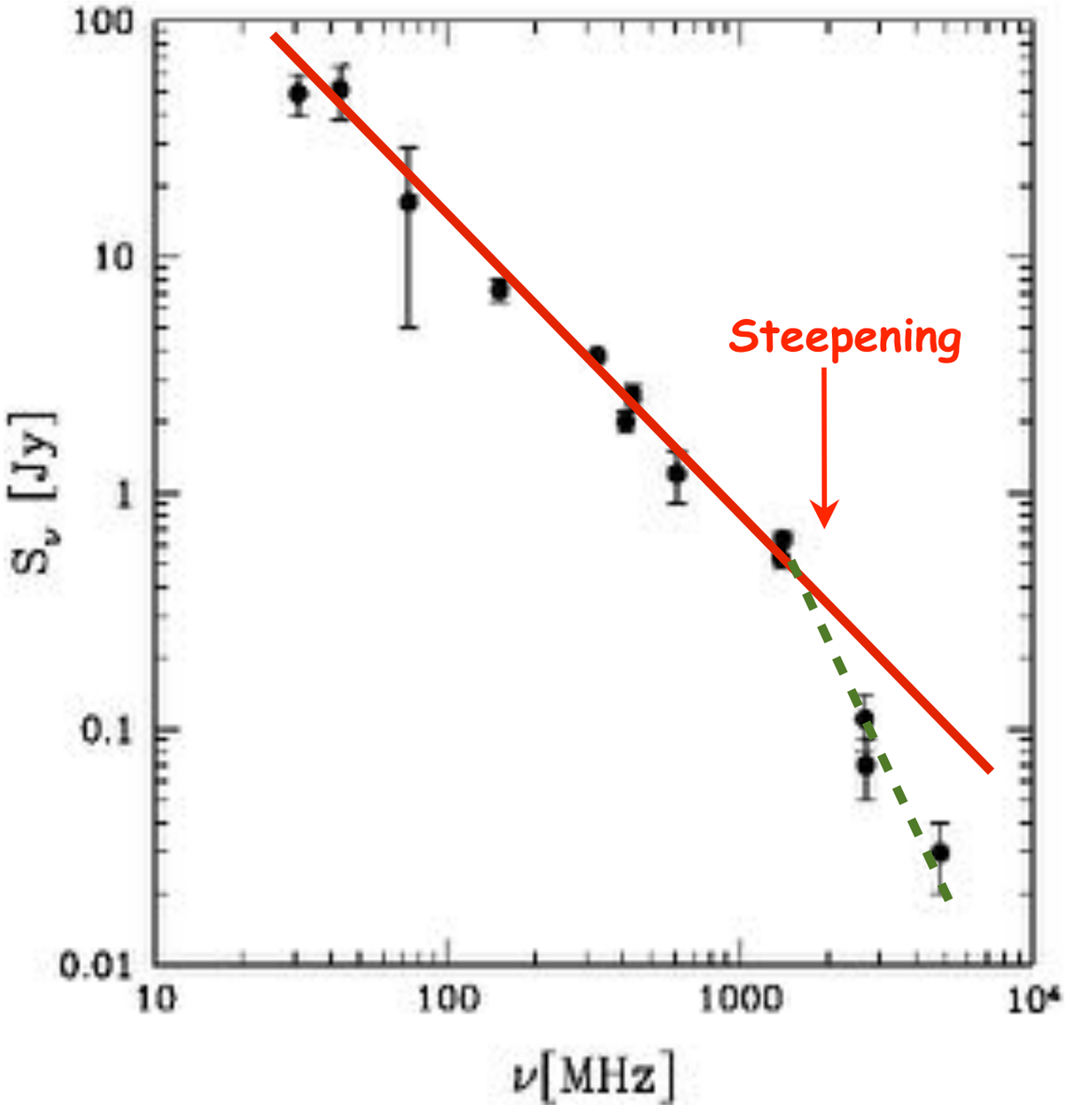
What is the origin of relativistic particles ?



Bonafede et al. 14a, 15

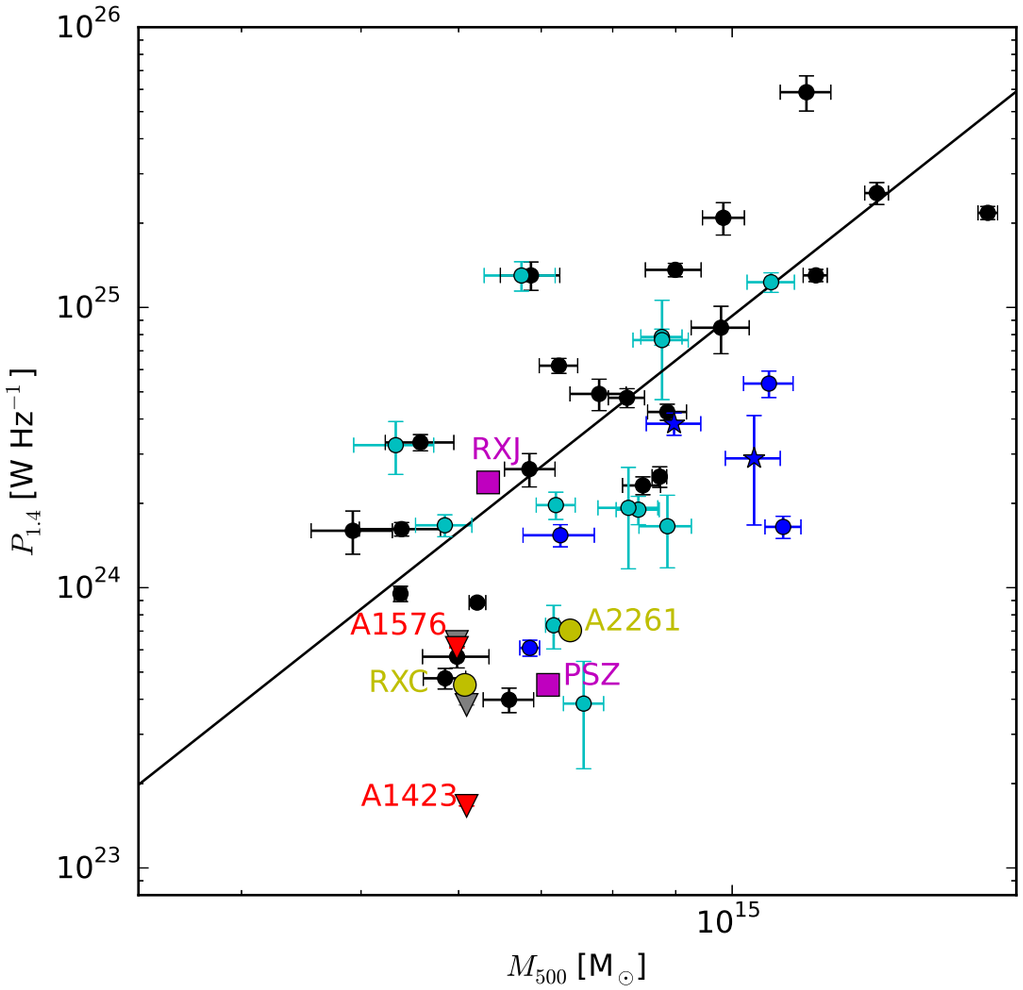
GMRT observations (~300 / 600 MHz)

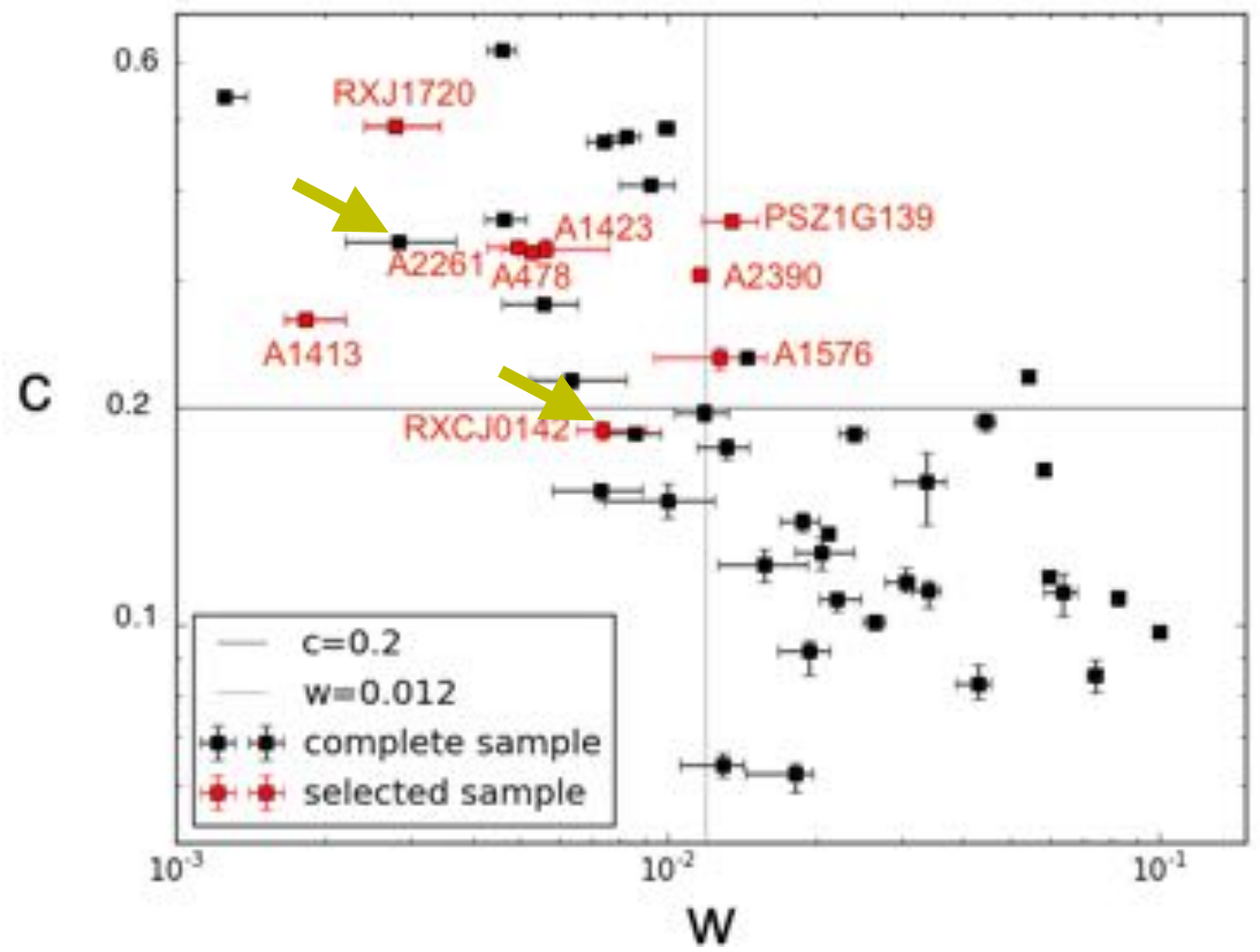
What is the origin of relativistic particles ?



Adapted from Ferrari et al. 08

What is the origin of relativistic particles ?





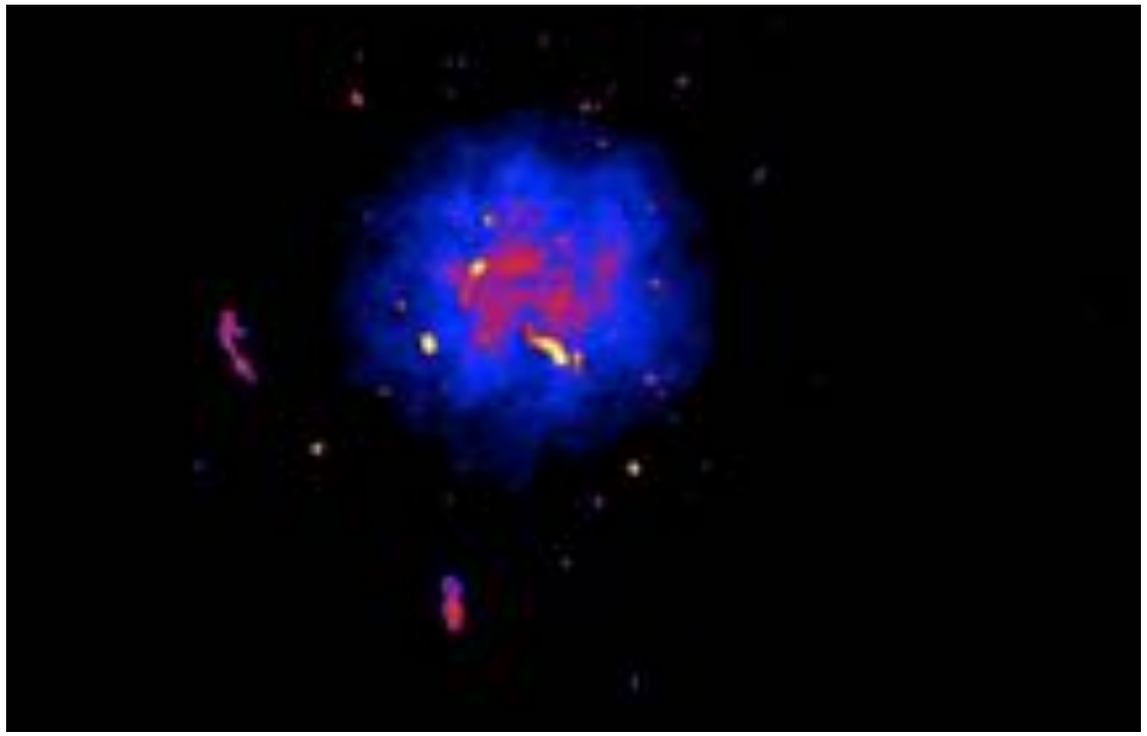
Courtesy: Salvini et al. - to be submitted
LOFAR observations
(120-168 MHz)

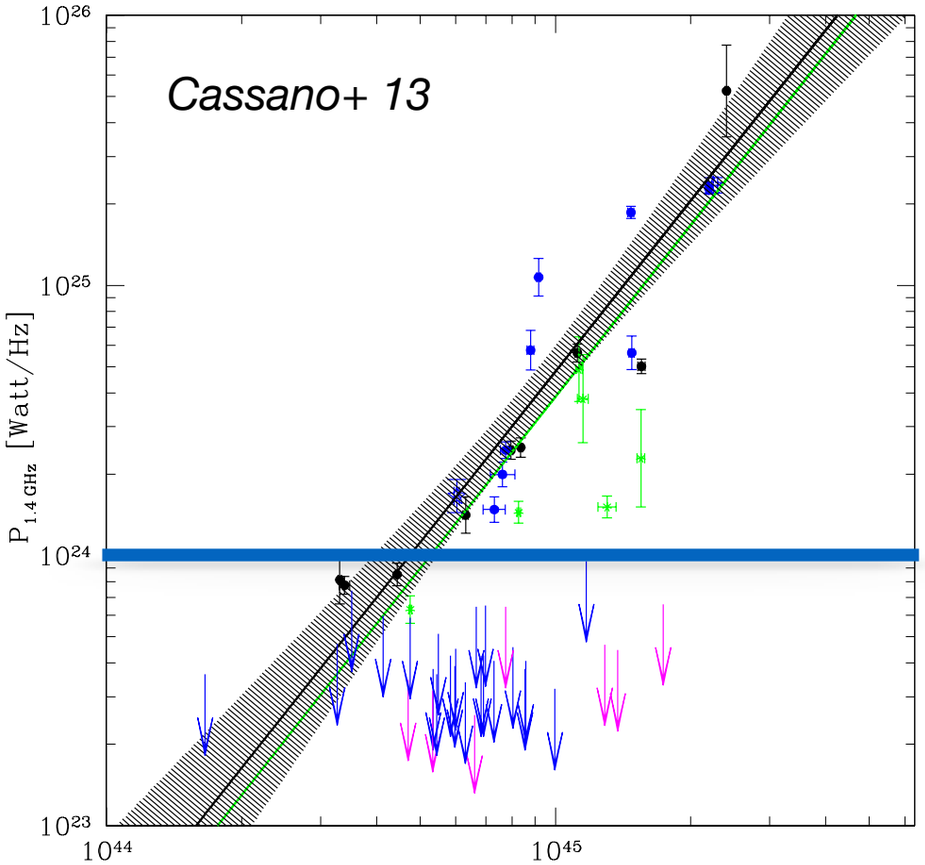
What is the origin of relativistic particles ?

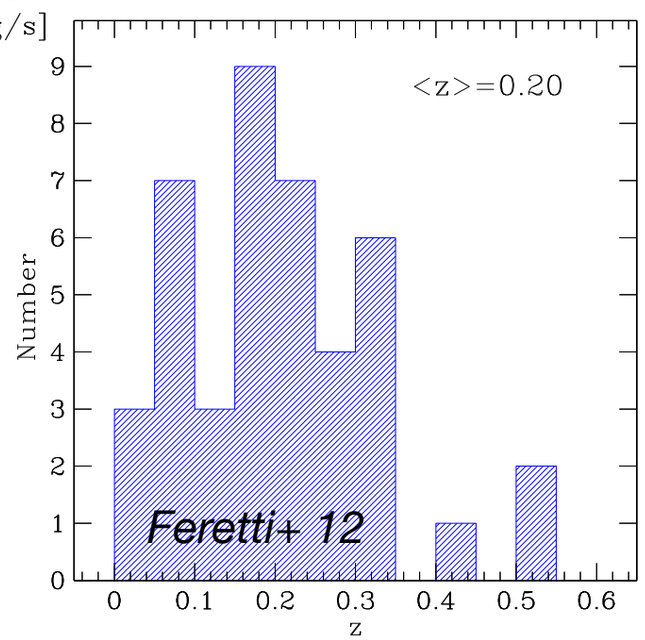
Radio galaxies +

Radio halo ($P_{1.4\ GHz} \sim 1 \times 10^{24}$ W/Hz)

@ $z \geq 0.5$





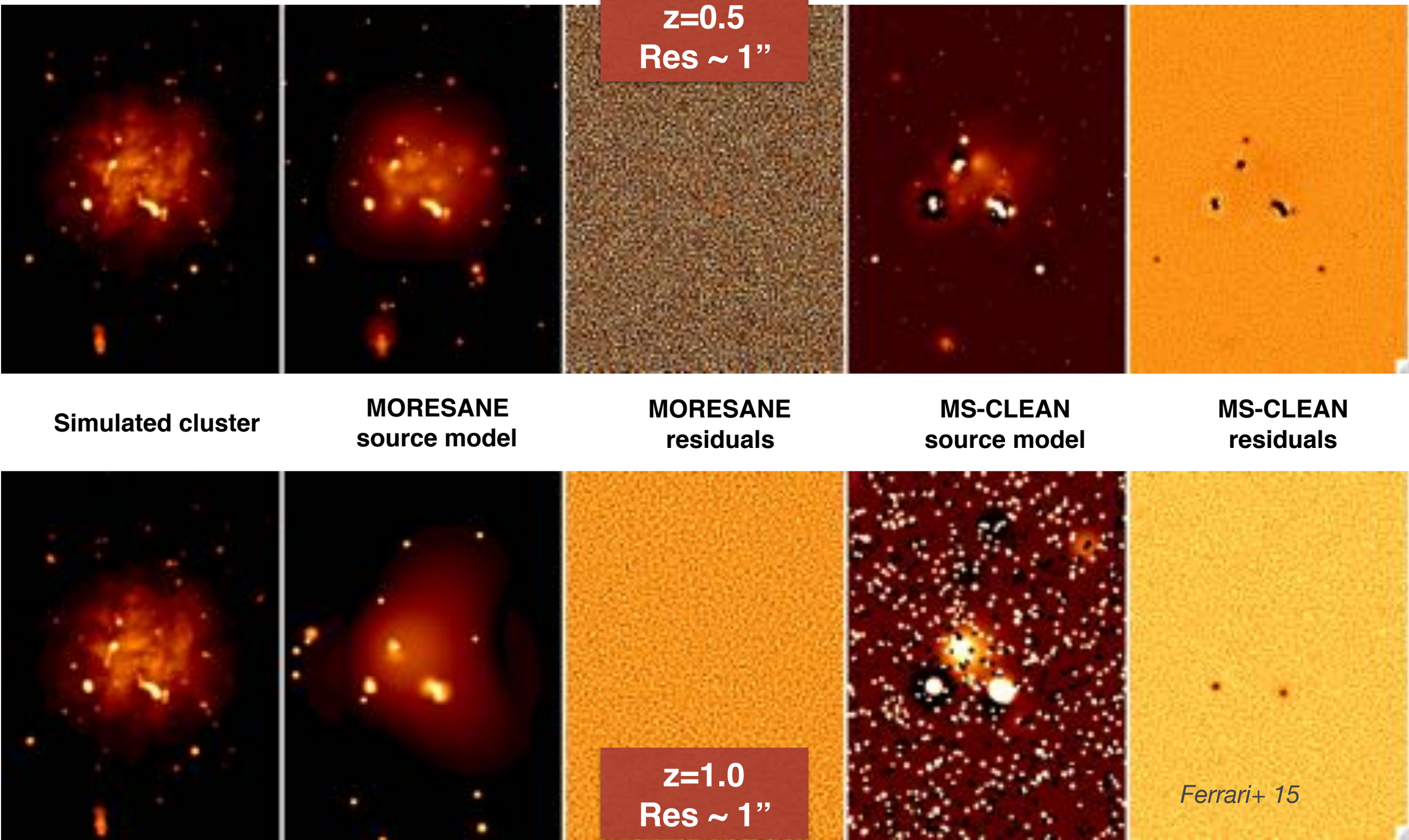


Relativistic electron population

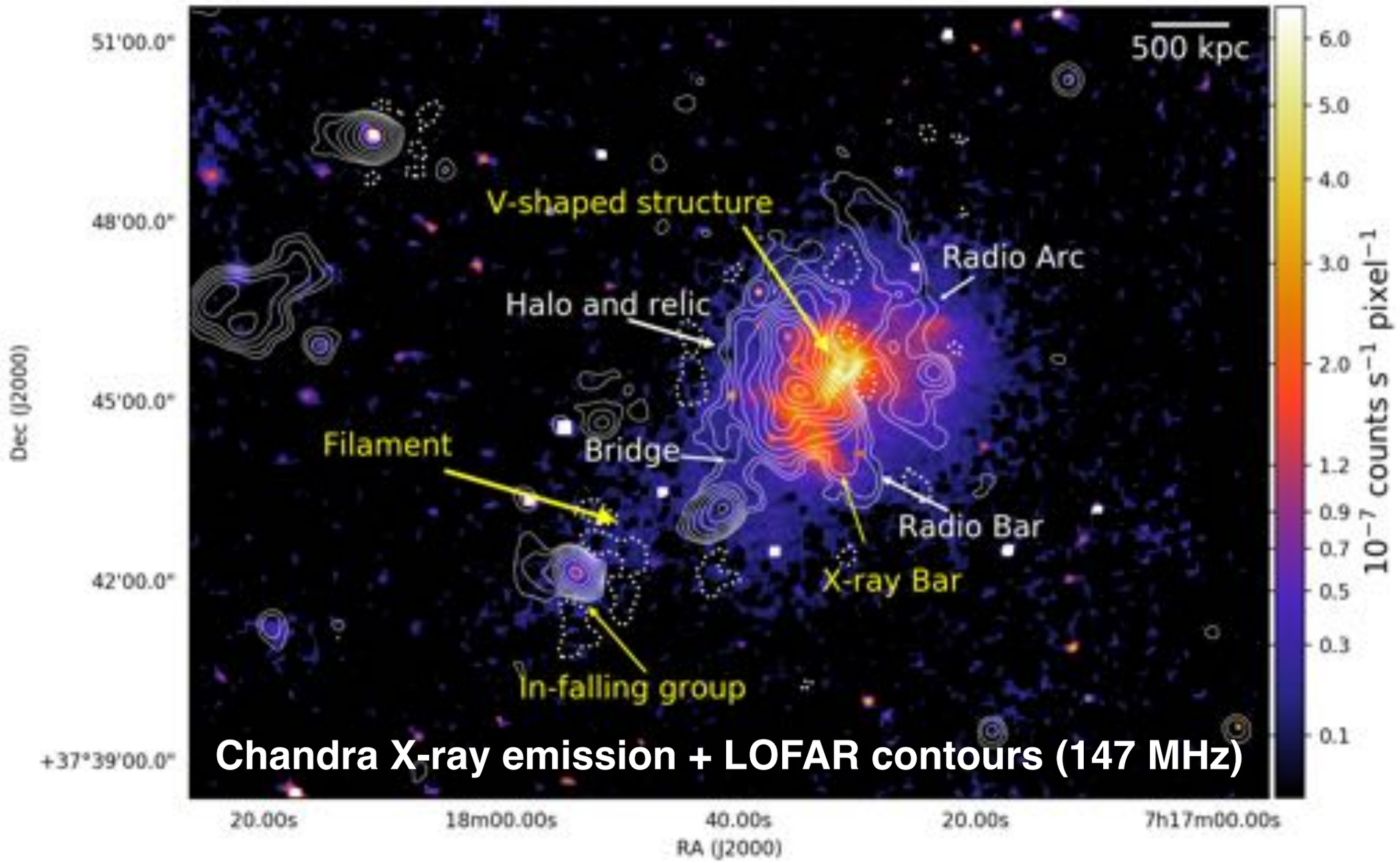
+ Magnetic field model

Faraday tool *(Murgia+ 04)*

Up to which redshift can we detect clusters with SKA1-MID ?

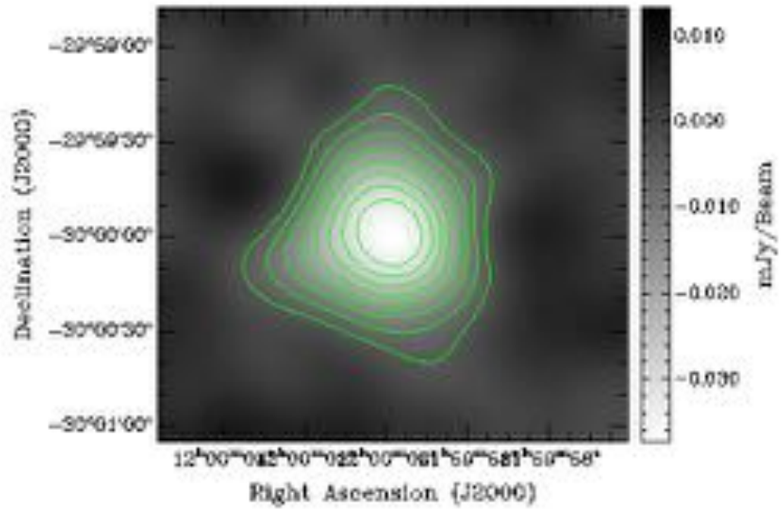


The non-thermal ICM



Bonafede+ 18

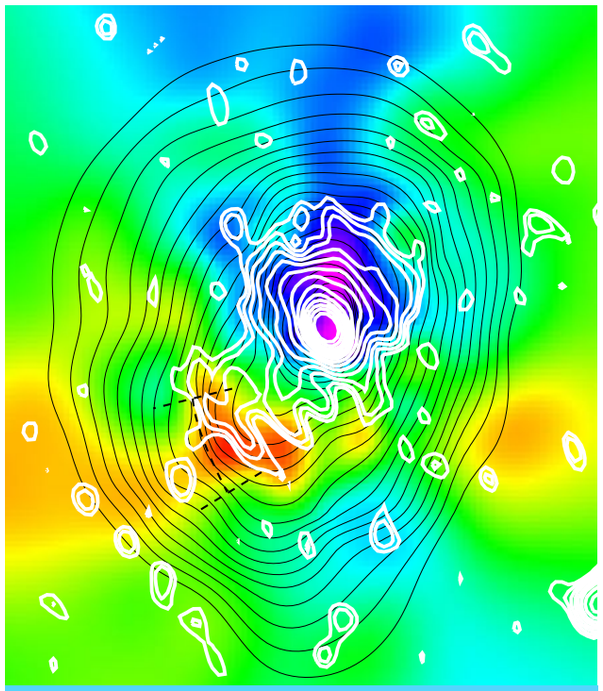
Synchrotron vs. SZ signal from galaxy clusters



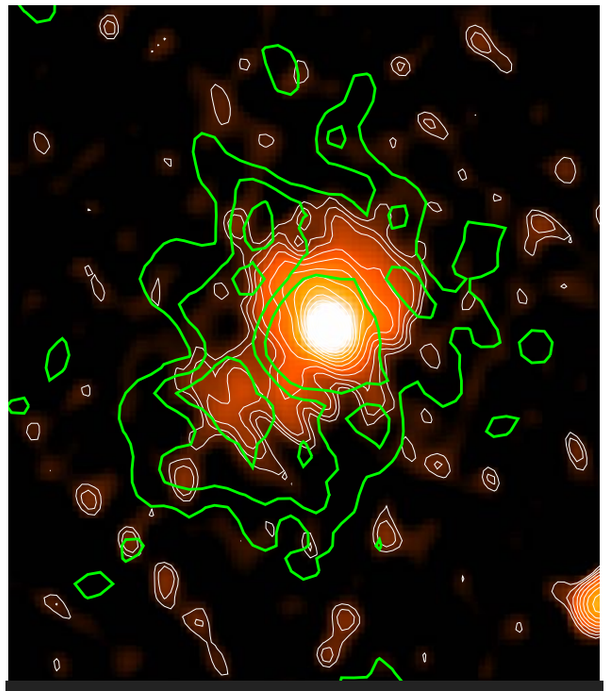
Simulated SZ observations:
1-hour with SKA1-MID
$M_{200} = 4 \times 10^{14} M_{Sun}$ @ z = 1.83

Ferrari et al. 11

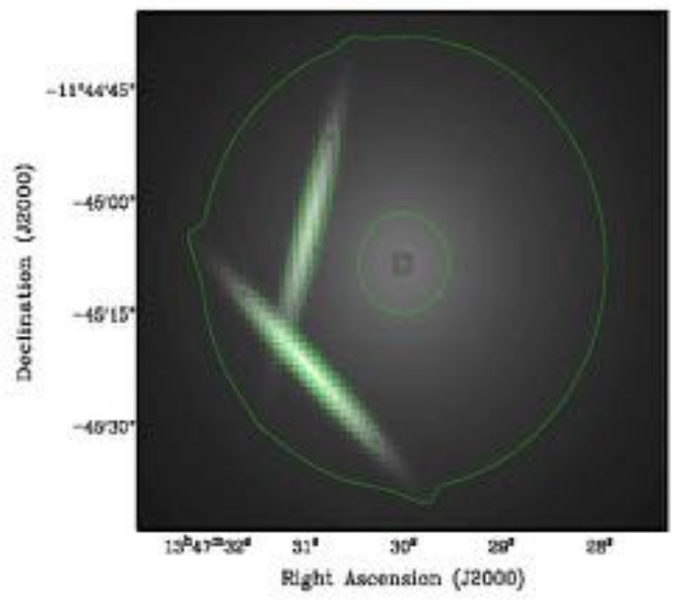
Grainge et al. 15

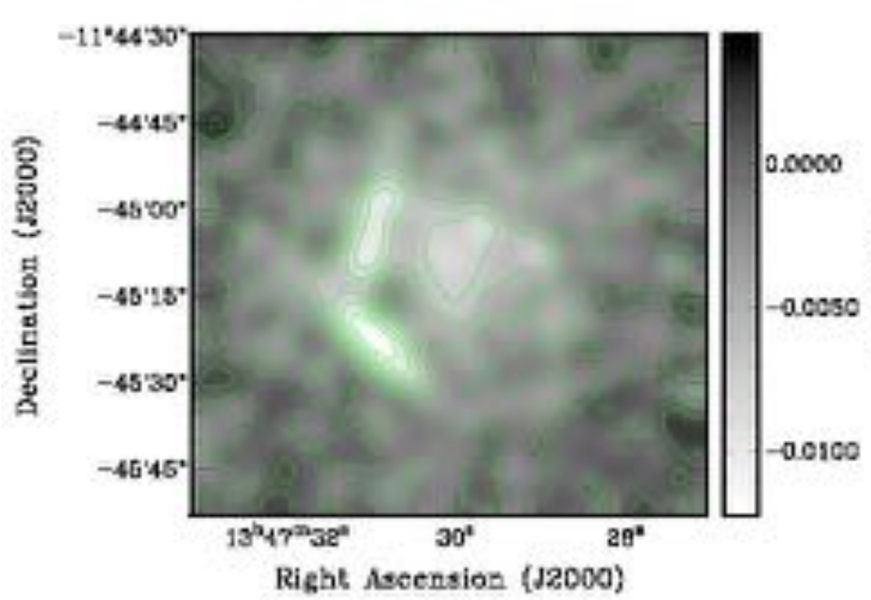


Temperature map
Radio contours
X-ray contours

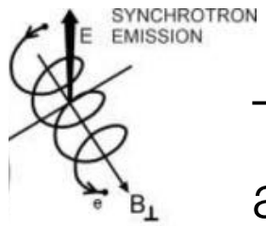


Radio map & contours
SZE contours

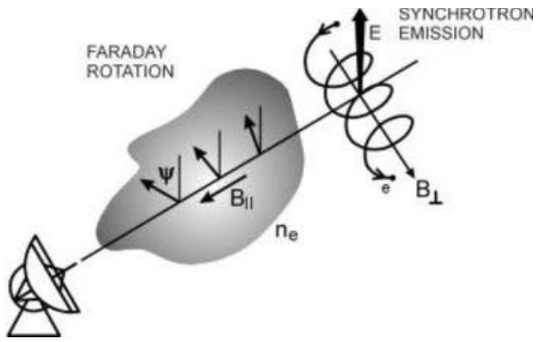




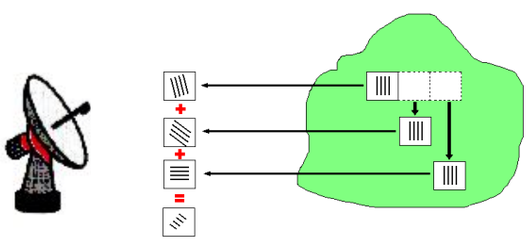
What is the intensity & structure of magnetic fields ?



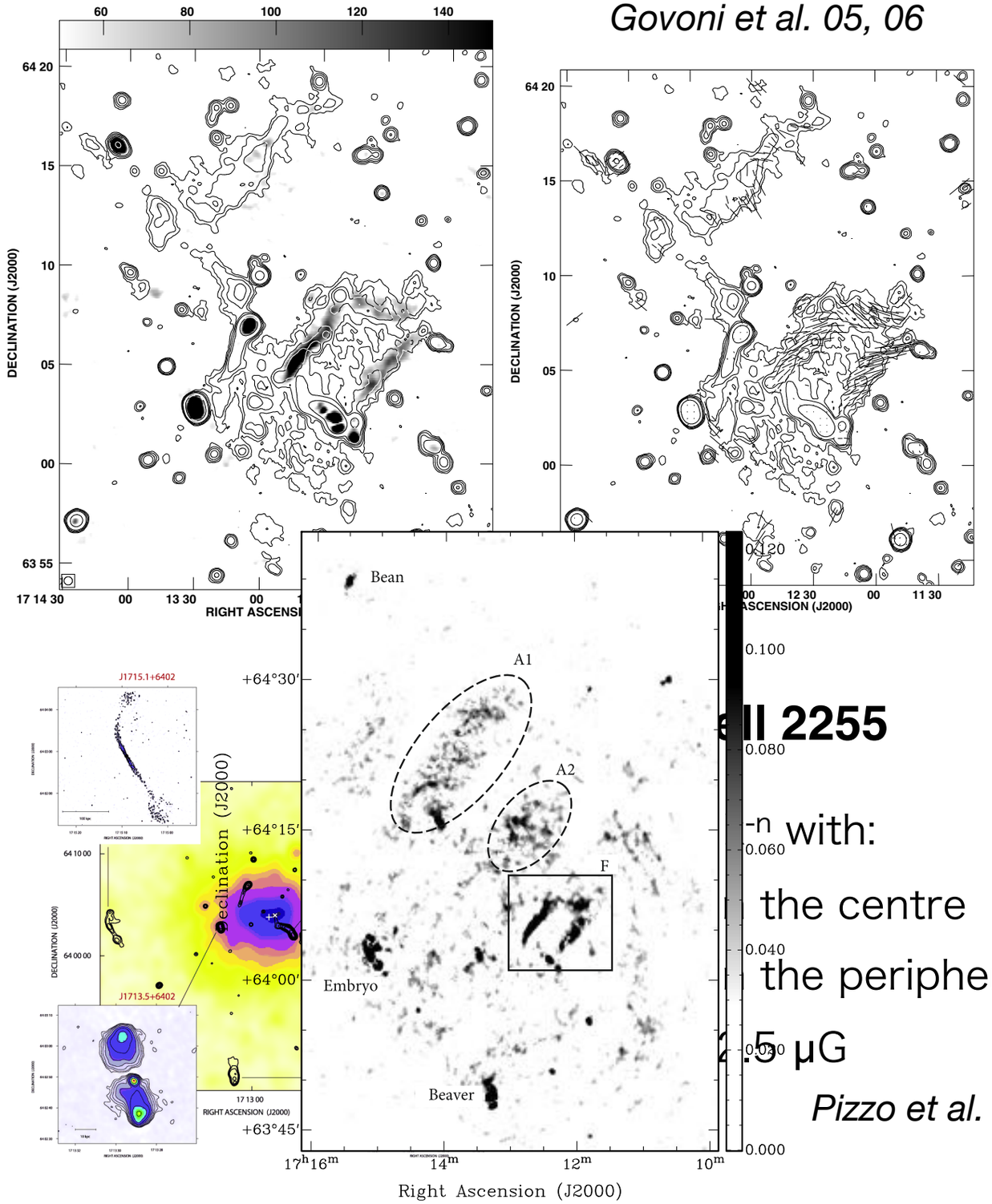
Total intensity and polarisation of synchrotron radiation



Faraday Rotation



Faraday Tomography



Govoni et al. 05, 06

ll 2255

-n with:

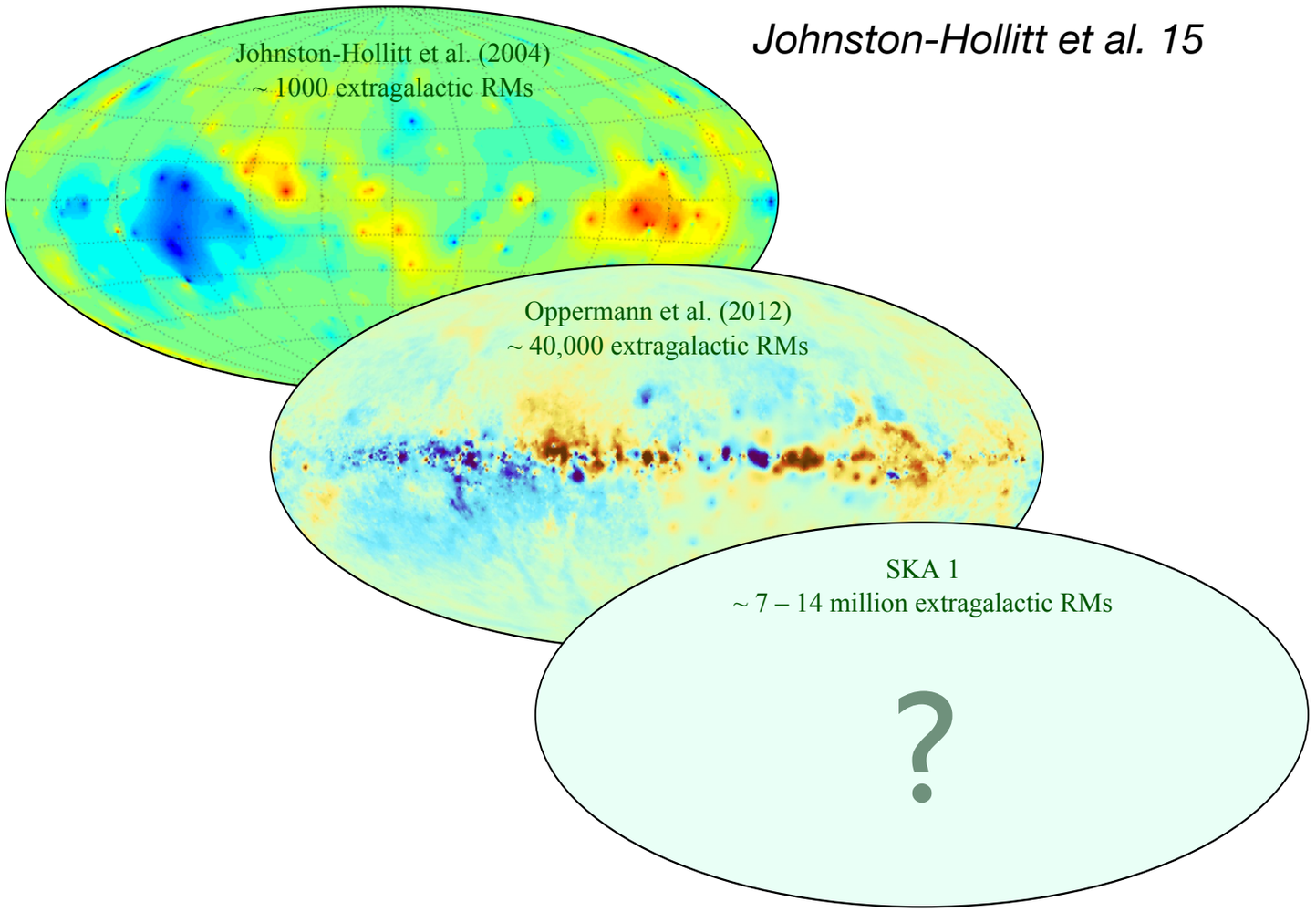
the centre

the periphery

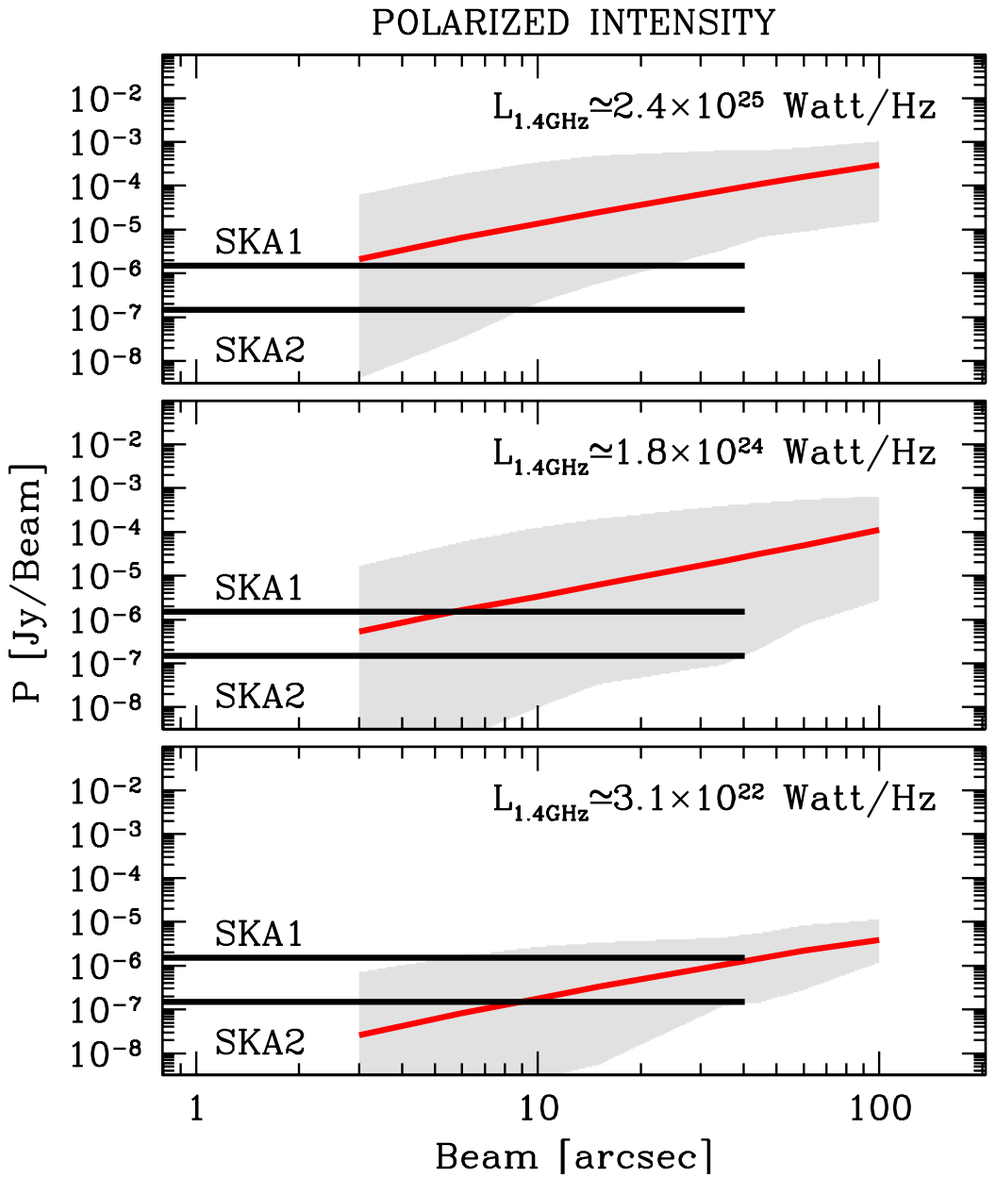
.5 μG

Pizzo et al. 11

What is the intensity & structure of magnetic fields ?

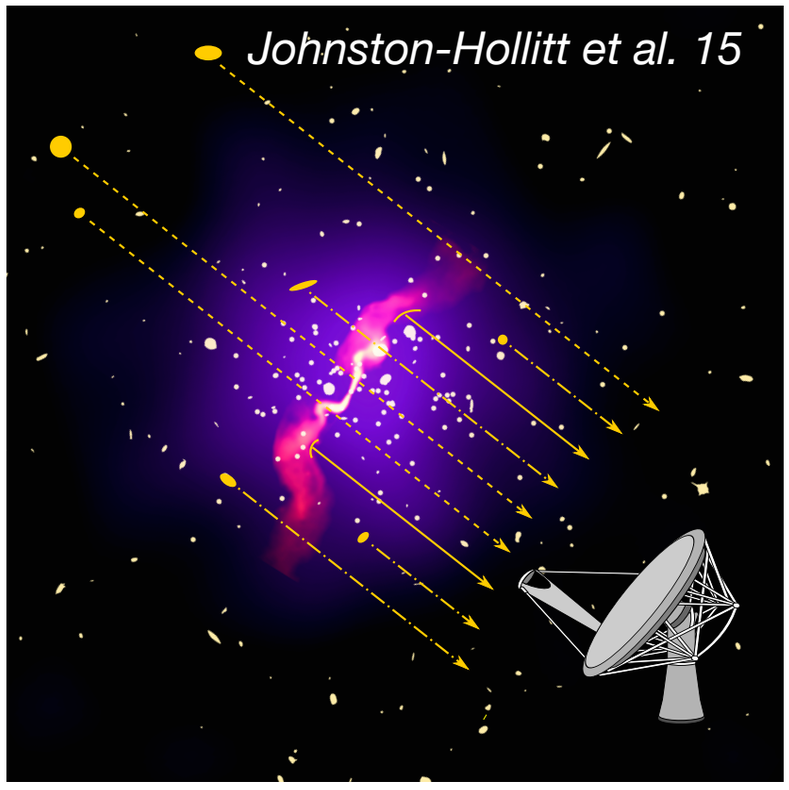


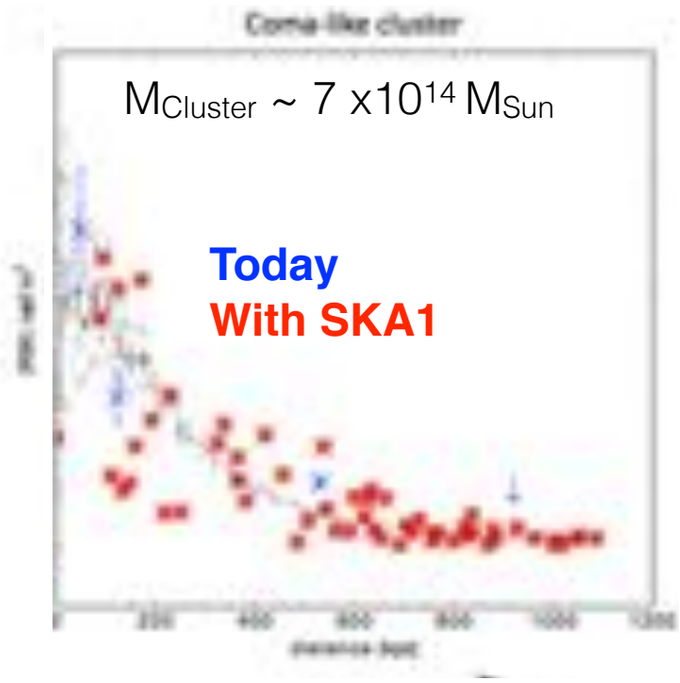
Johnston-Hollitt et al. 15



Govoni et al. 13, 15

What is the intensity & structure of magnetic fields ?

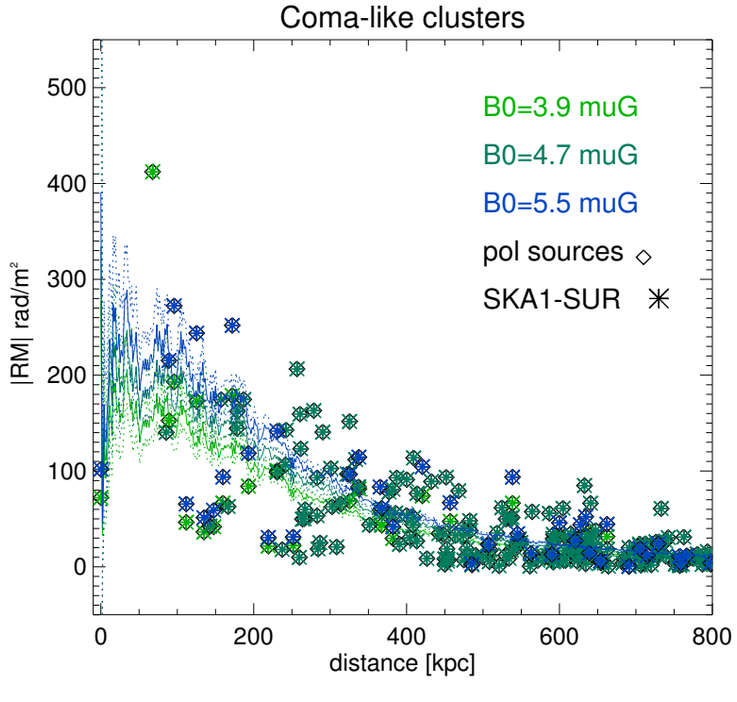


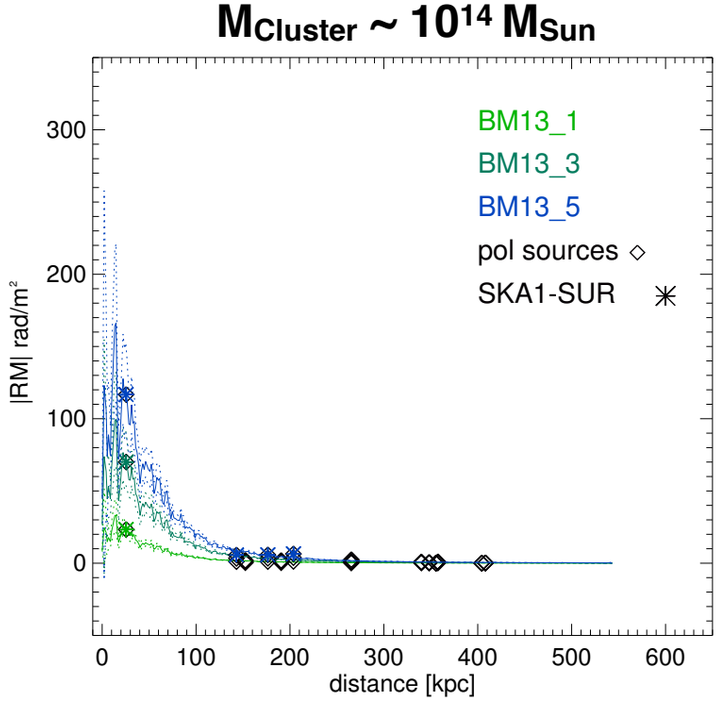


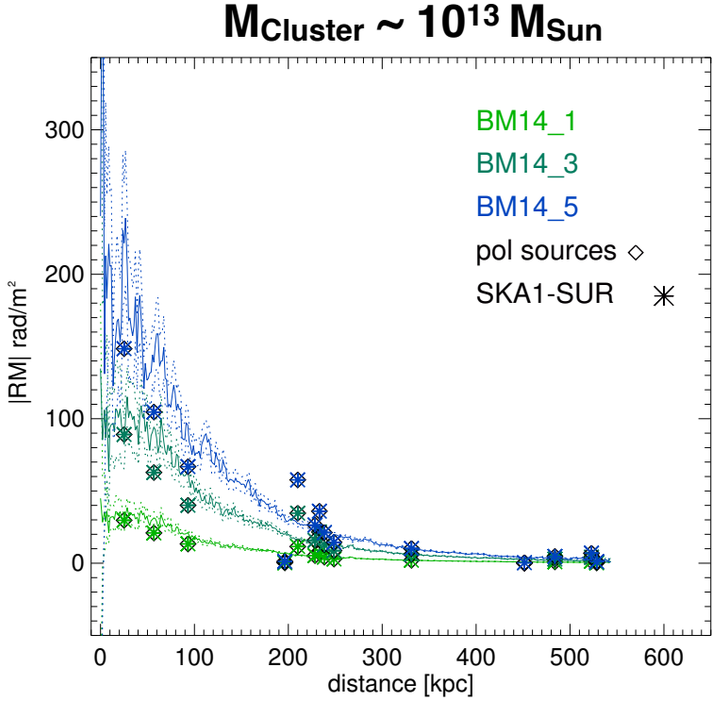
Bonafede et al. 15

Mock RM observations by modelling:

- strength & structure of magnetic fields
- gas density (ß-model)







Conclusions

- The SKA will change dramatically our view of the radio sky, including galaxy clusters

- We will be able to assess the presence of a non-thermal component in thousands of clusters, up to $z > 1$

- Major signal processing developments are particularly crucial for the detection of cluster diffuse radio sources

- A wide scientific community is expected to collaborate in the development of the SKA project