LOFAR Observation of the Merging Galaxy Cluster ABELL 1914

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R. van Weeren, C. Ferrari, G. Brunetti, H. Rottgering and many others

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Motivation

* Ultra Steep Spectrum sources have been seen sporadicly in clusters in the past (examples: Slee et al. 2001, van Weeren et al. 2009/2011, de Gasperin et al. 2015)

* With improved sensitivity at the lowest radio frequencies, we start to see many more; may be very common in clusters

* Morphologically diverse group, so not easy to categorize

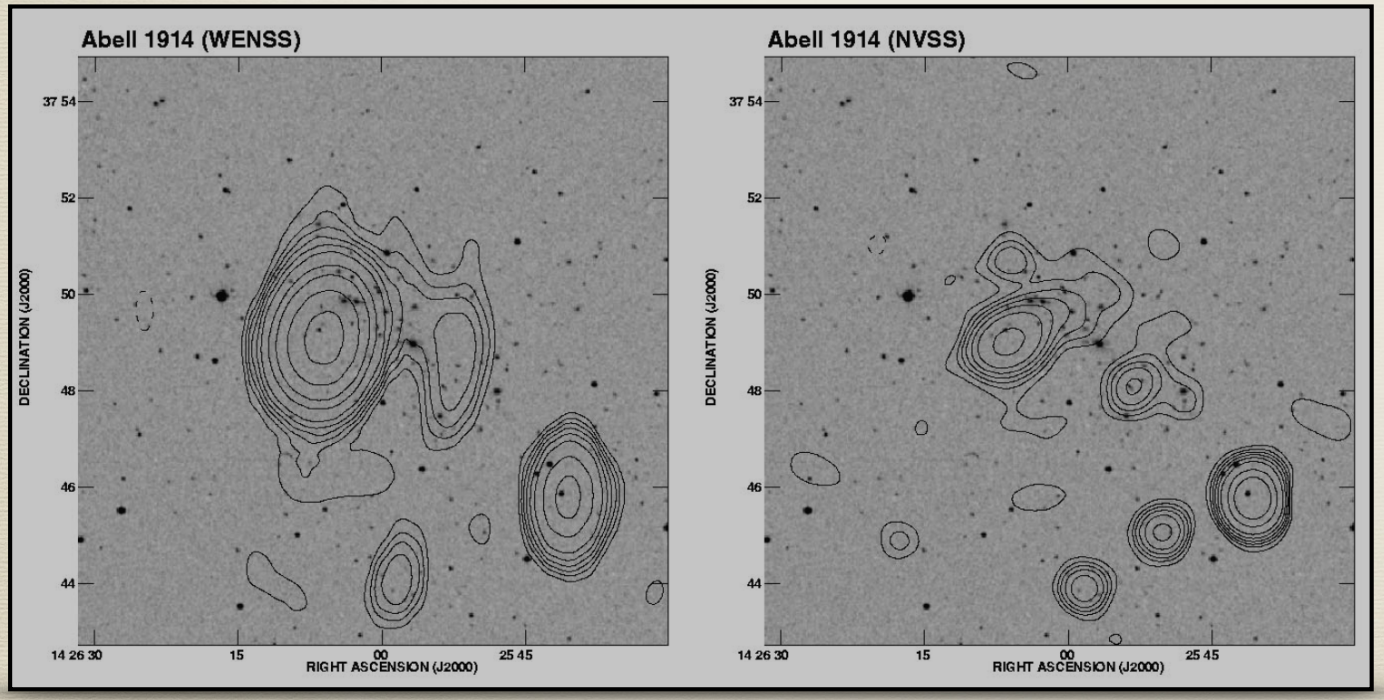
* Most likely explanation is shock compression of aged plasma

* Need to grow known sample & study in more detail to get a better handle on their general properties and test old plasma compression theory

Detailed observation of ABELL 1914

* Presence of Radio Halo was suggested (from NVSS (1.4 GHz) search; Giovannini et al. 1999)

* Detected by Kempner & Sarazin (2001) from WENSS (300 MHz)



Redshift: 0.17

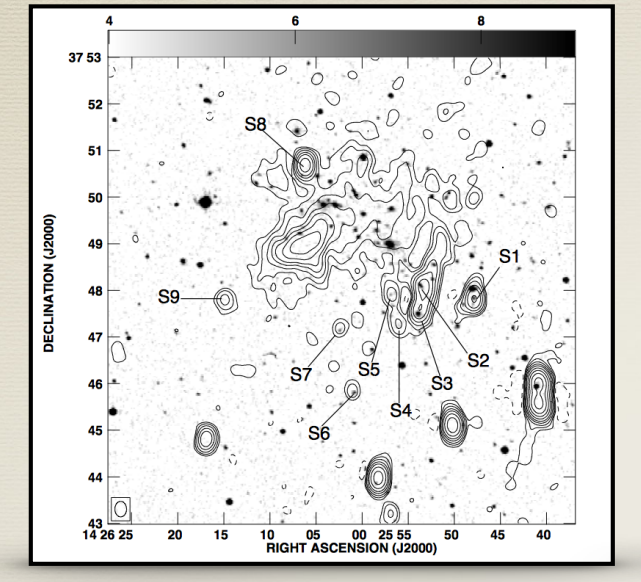
Total flux (WENSS): 114 +/- 29 mJy

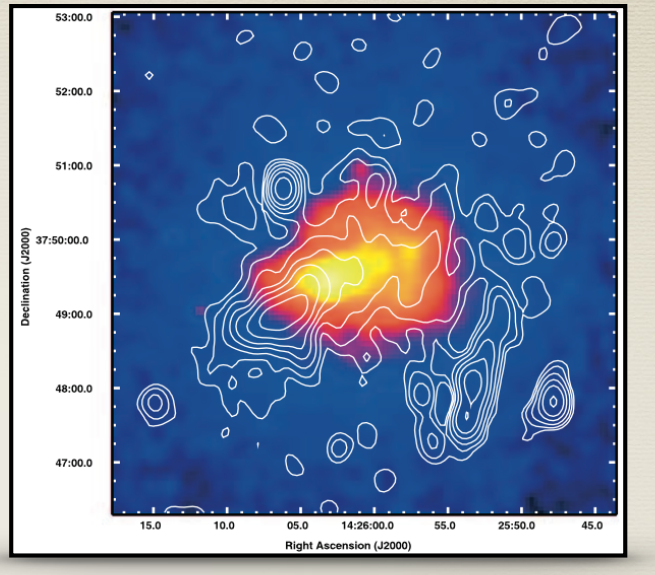
Total flux (NVSS): 20+/-3 mJy

ABELL 1914

Higher Resolution VLA Map (Bacchi et al. 2003, Govoni et al. 2004)

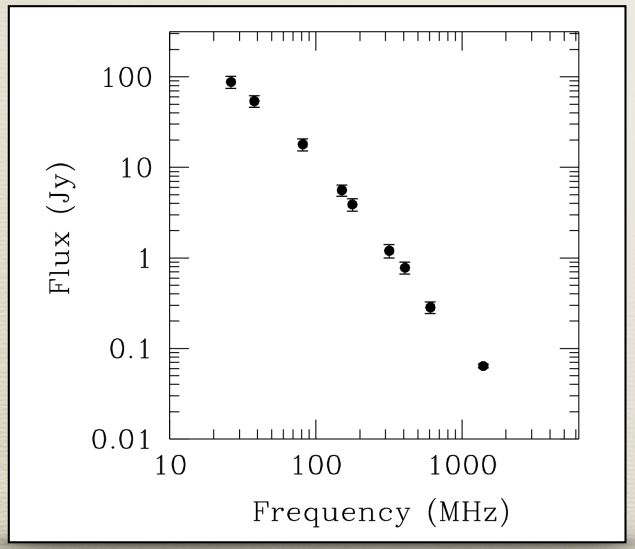
VLA Map
20”x15”

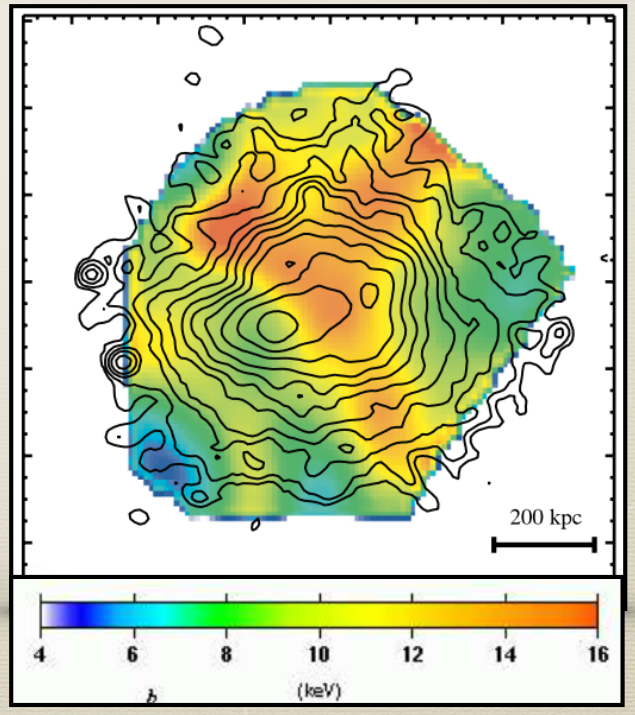




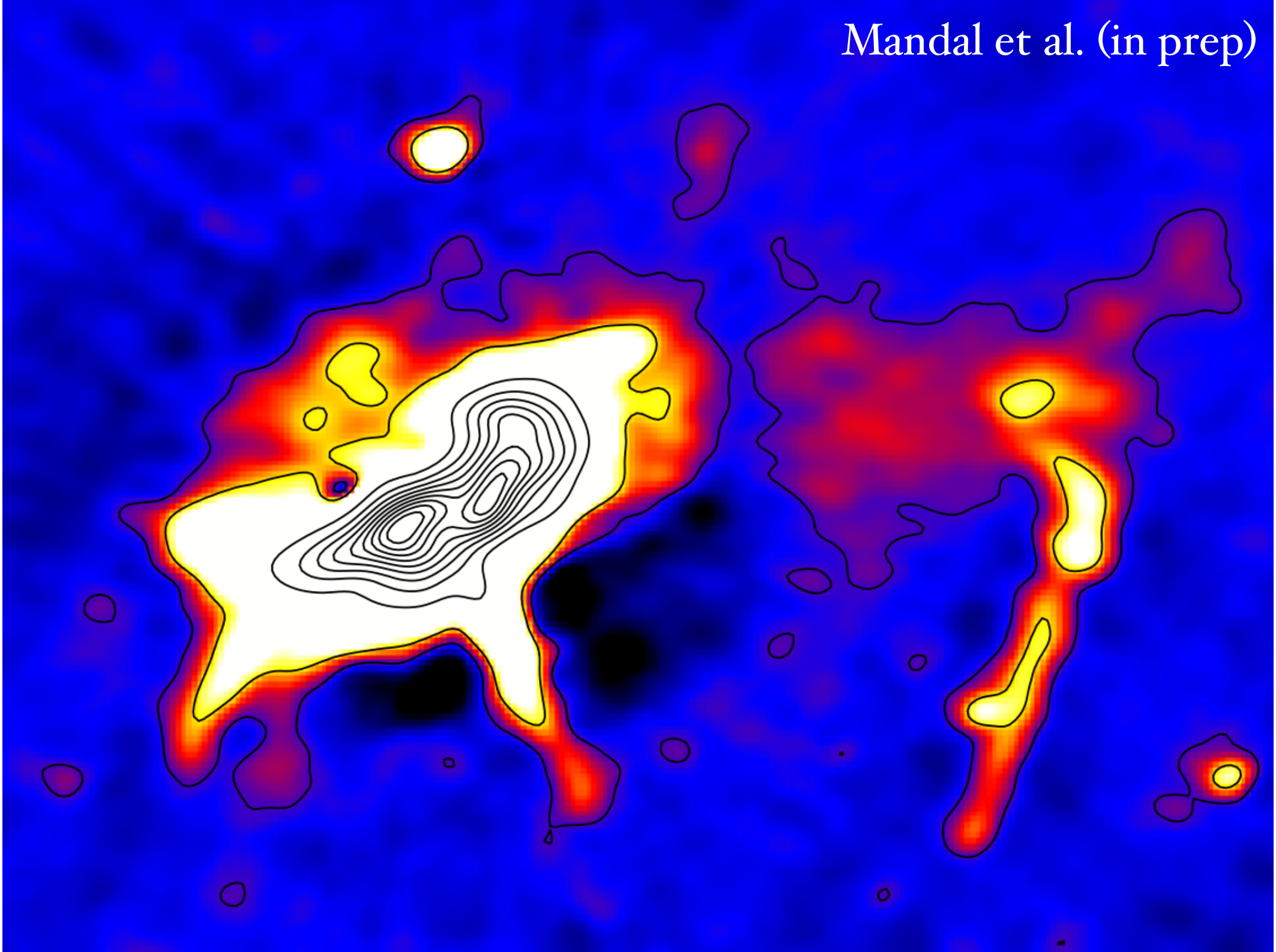
X-ray map overlaid with VLA @ 1.4 GHz

Integrated Spectrum



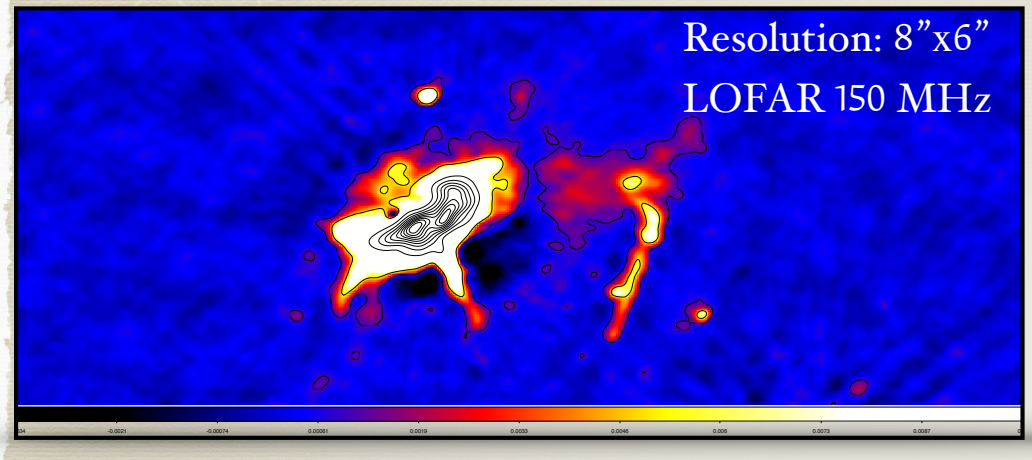


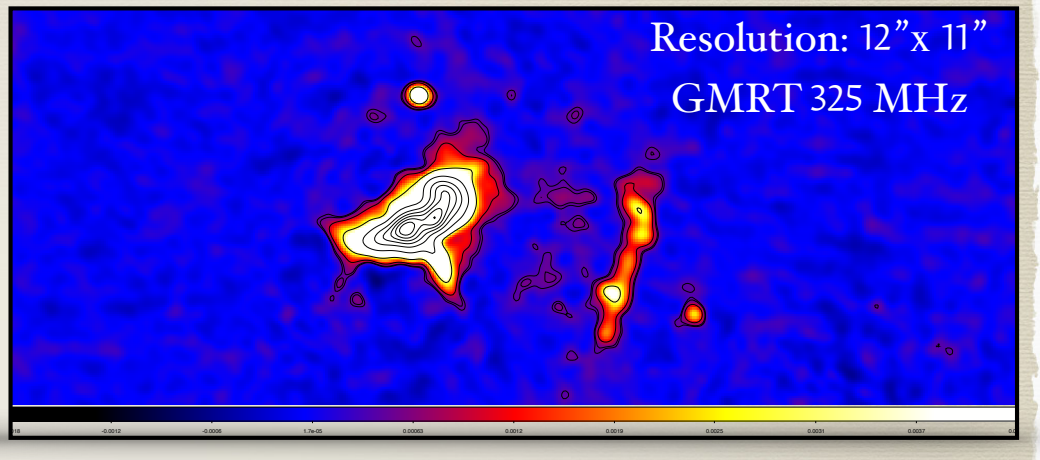
Temperature Map

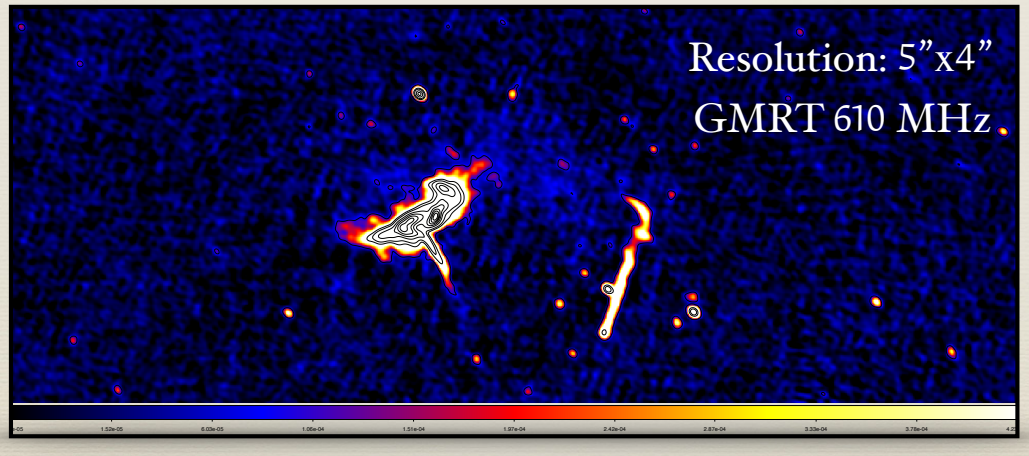

Mandal et al. (in prep)


Mandal et al. (in prep)

Abell 1914 Recent Observations







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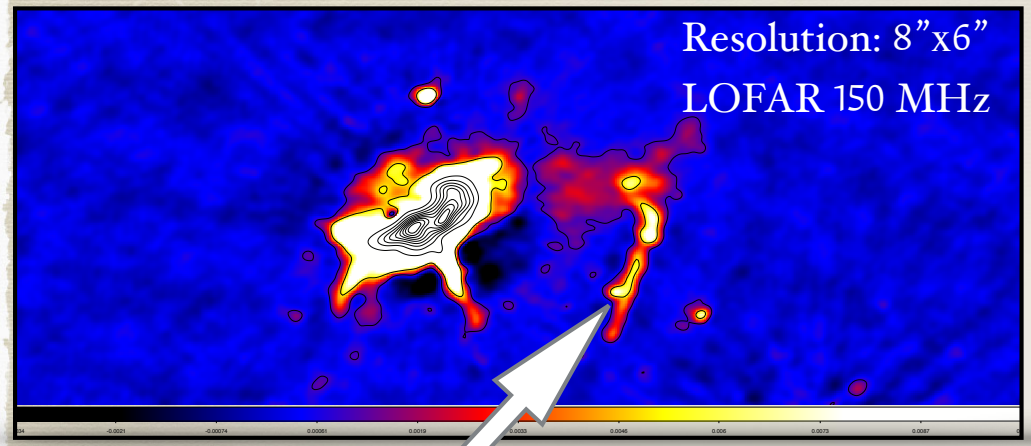
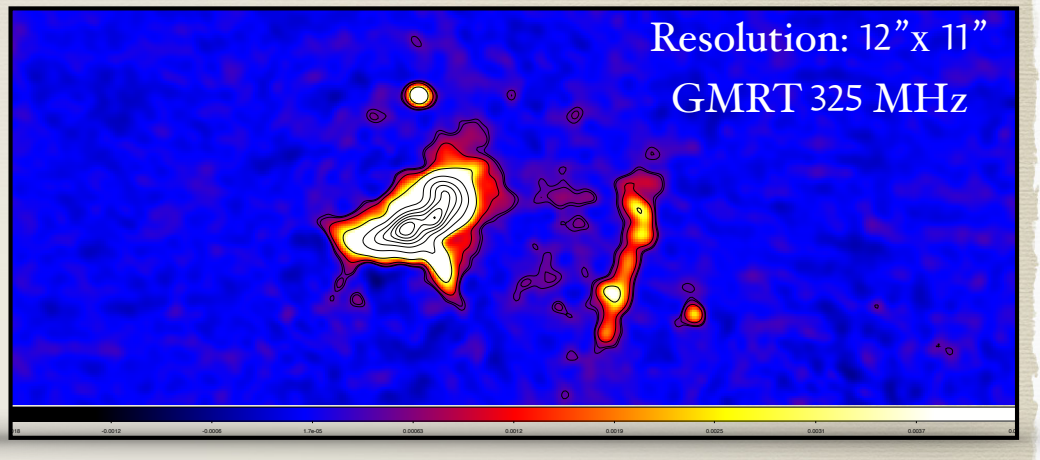
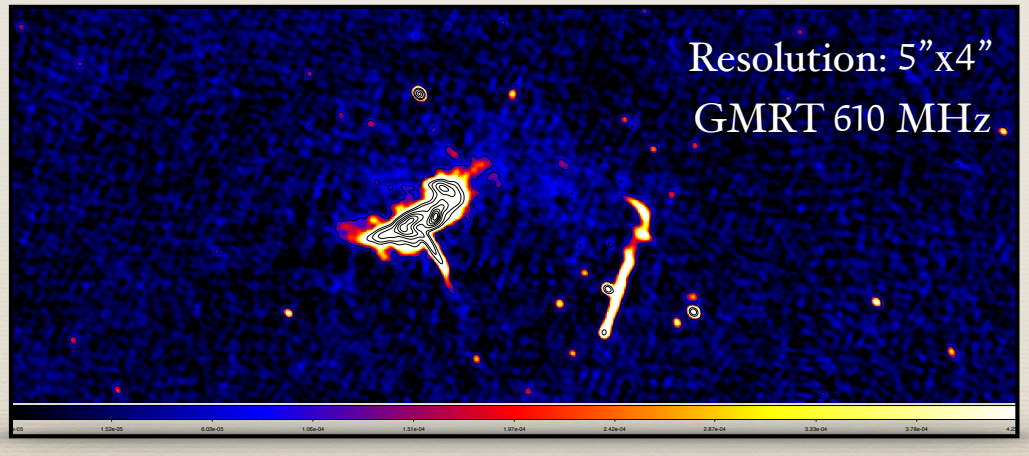
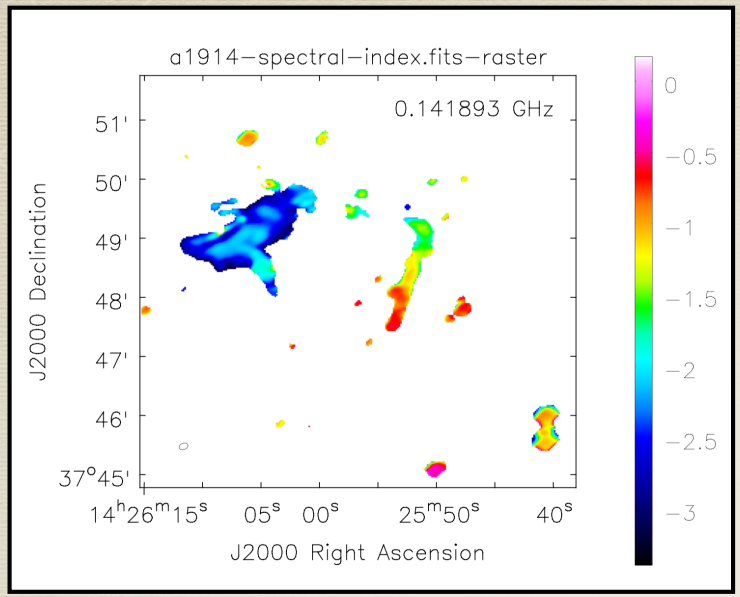




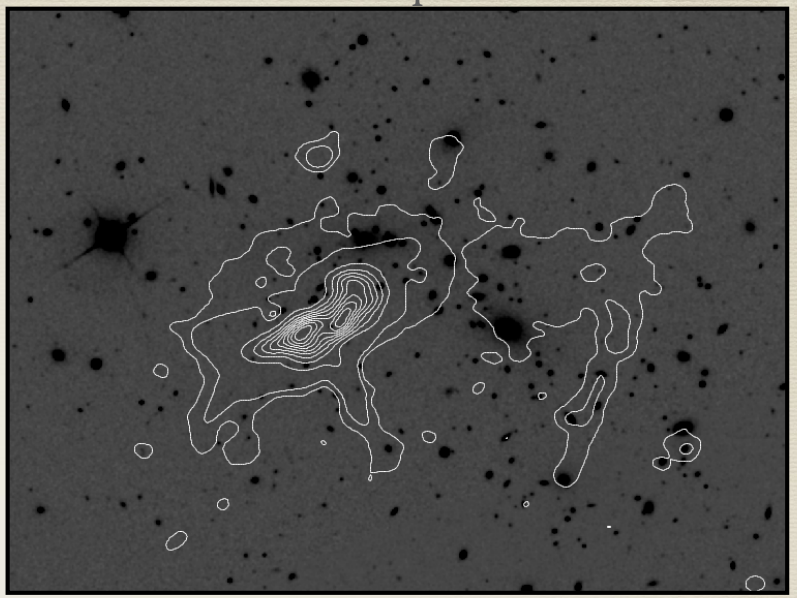


Head tail / Radio Relic?

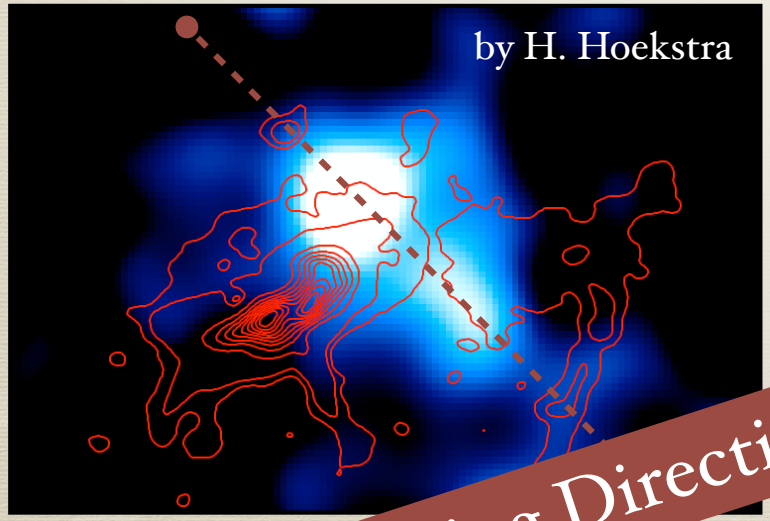
Spectral Index Map LOFAR 150 MHz and GMRT 610 MHz



LOFAR 150 MHz contours on SDSS (optical)

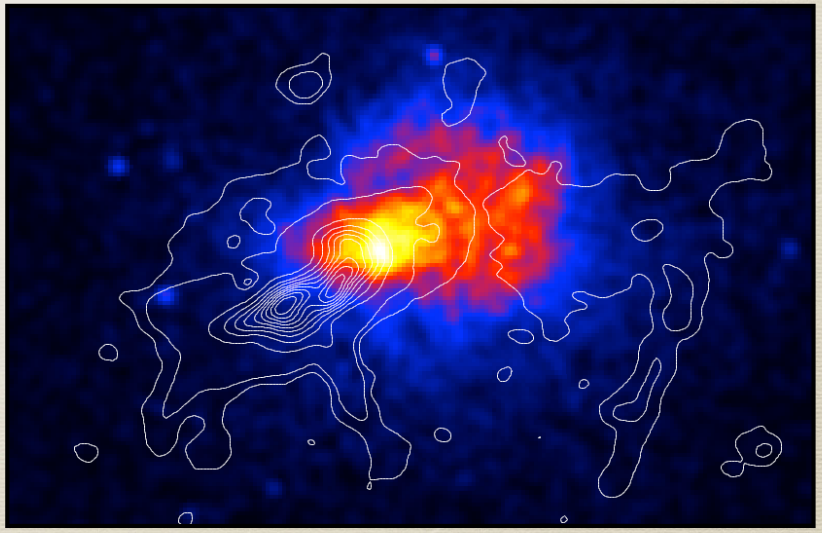


Weak Lensing Map with LOFAR 150 MHz contours



Merging Direction

Chandra Map with LOFAR 150 MHz contours



Chandra Analysis
25 kS observation

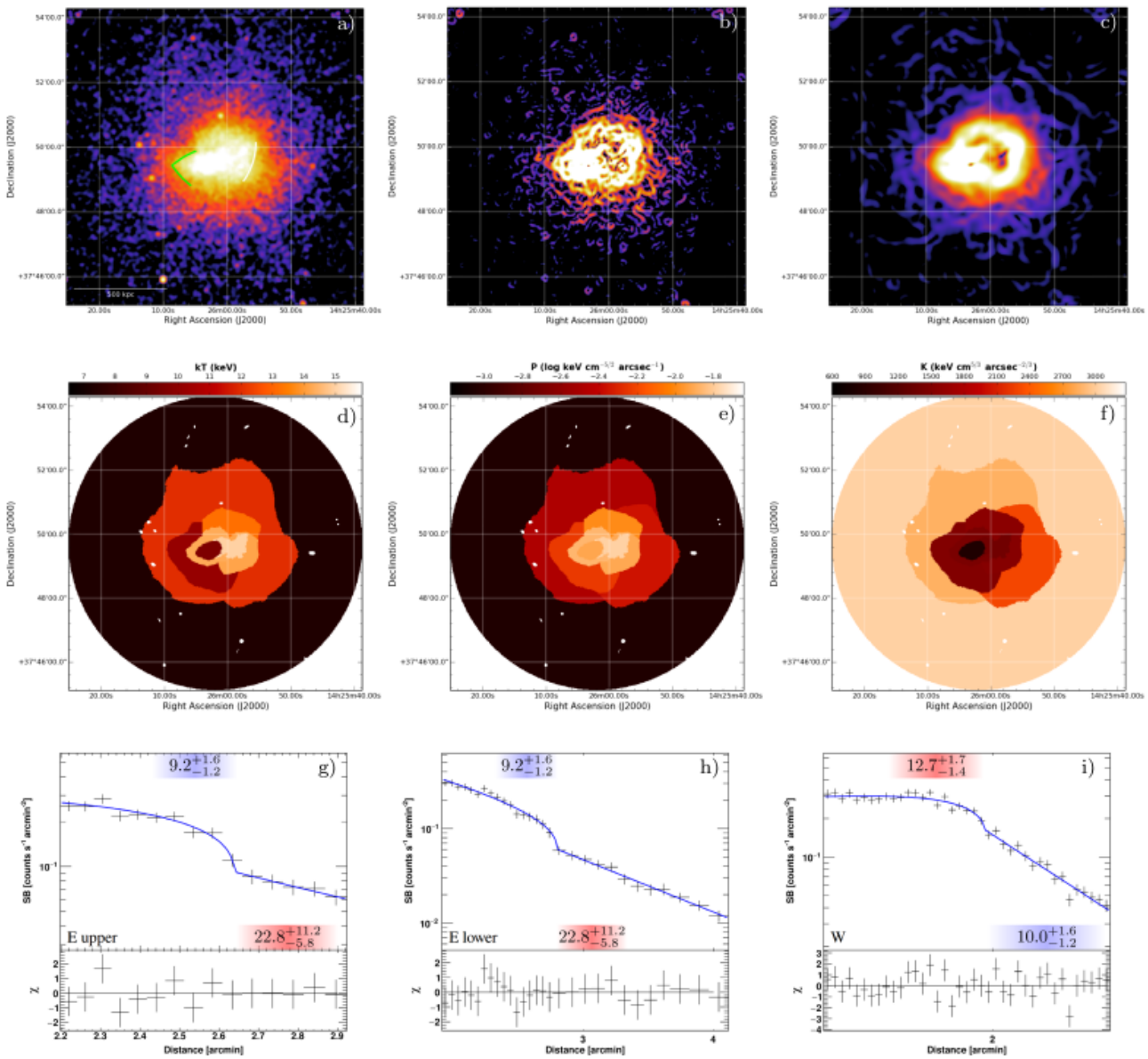


Figure 9. A1914. Same caption of Fig 3. The goodness of fits is reported in Fig. C7. The positions of the edges are marked in the *Chandra* image in green (cold front) and white (shock).

Mandal et al. in prep
Botteon et al. in prep

Green: Cold Front
White: Shock

Summary & Conclusion

- 4C38.39 Source has a total flux of 7 Jy at 150 MHz and has a spectral index of -3 in some regions!
- The extended part is a head tail galaxy (630 kpc); The gradient in spectral index map confirms that.
- Merger axes are contradictory from X-ray and weak lensing observations, probably it involves more than two system mergers.
- Sub-clusters probably have a non-zero impact parameter.
- Discontinuity in X-ray surface brightness profile gives indication of cold and shock front.
- The remnant is a compact core. So it may be a similar mass merger.
- Polarization studies give an upper limit of 3%.