LOFAR discovery of a double radio halo in Abell 1758

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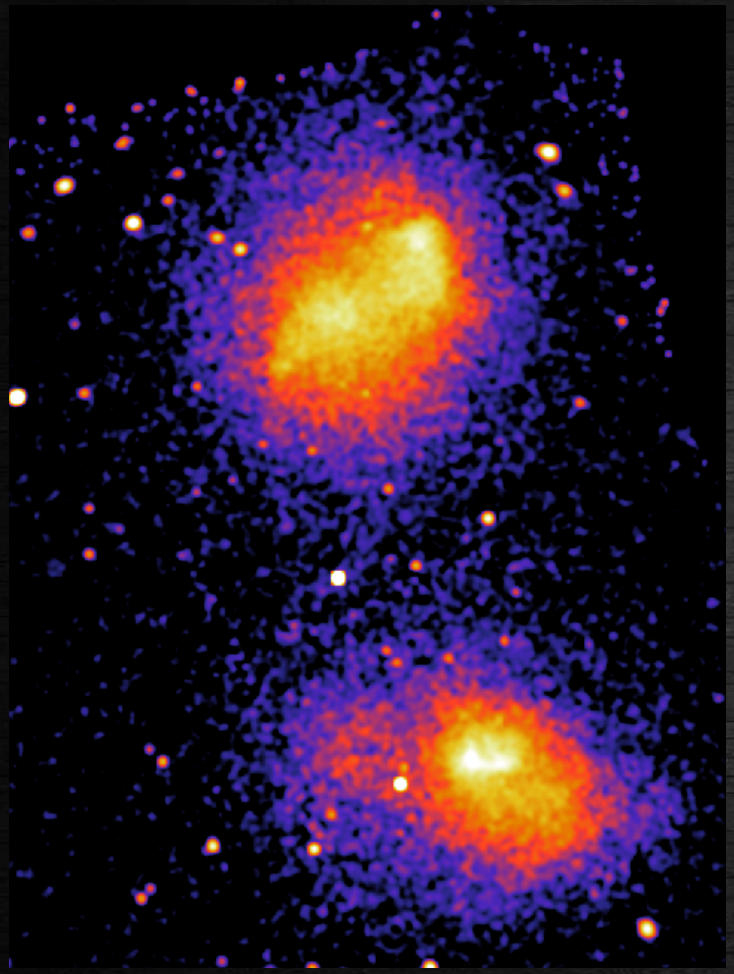
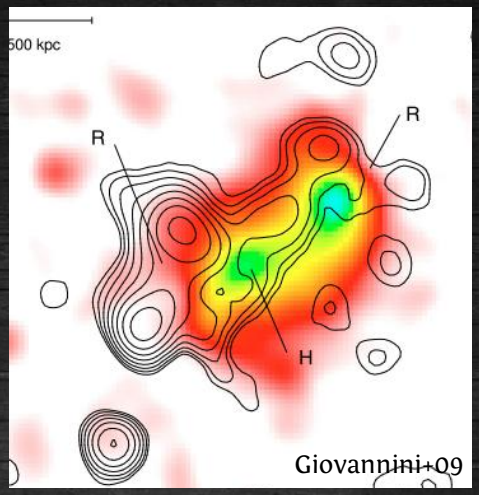
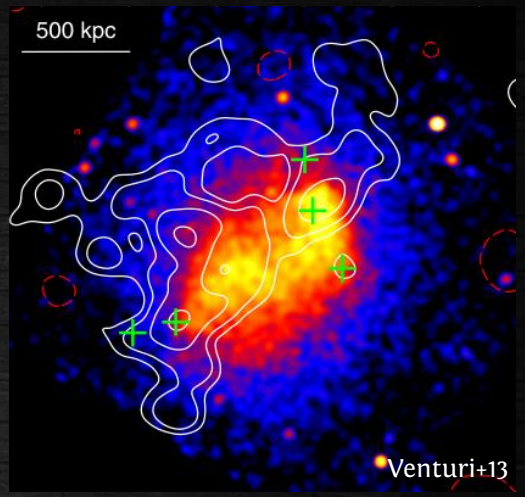
October 23, 2017 – Diffuse Synchrotron Emission in Clusters of Galaxies, Leiden

Abell 1758N & Abell 1758S





VLA @ 1.4 GHz
res. 45" x 45"
rms 70 μJy/beam



GMRT @ 325 MHz
res. 35" x 35"
rms 400 μJy/beam

Separated by 8' (about **2 Mpc** at *z=0.279*), apparently **no interaction** between the two components

A1758N:

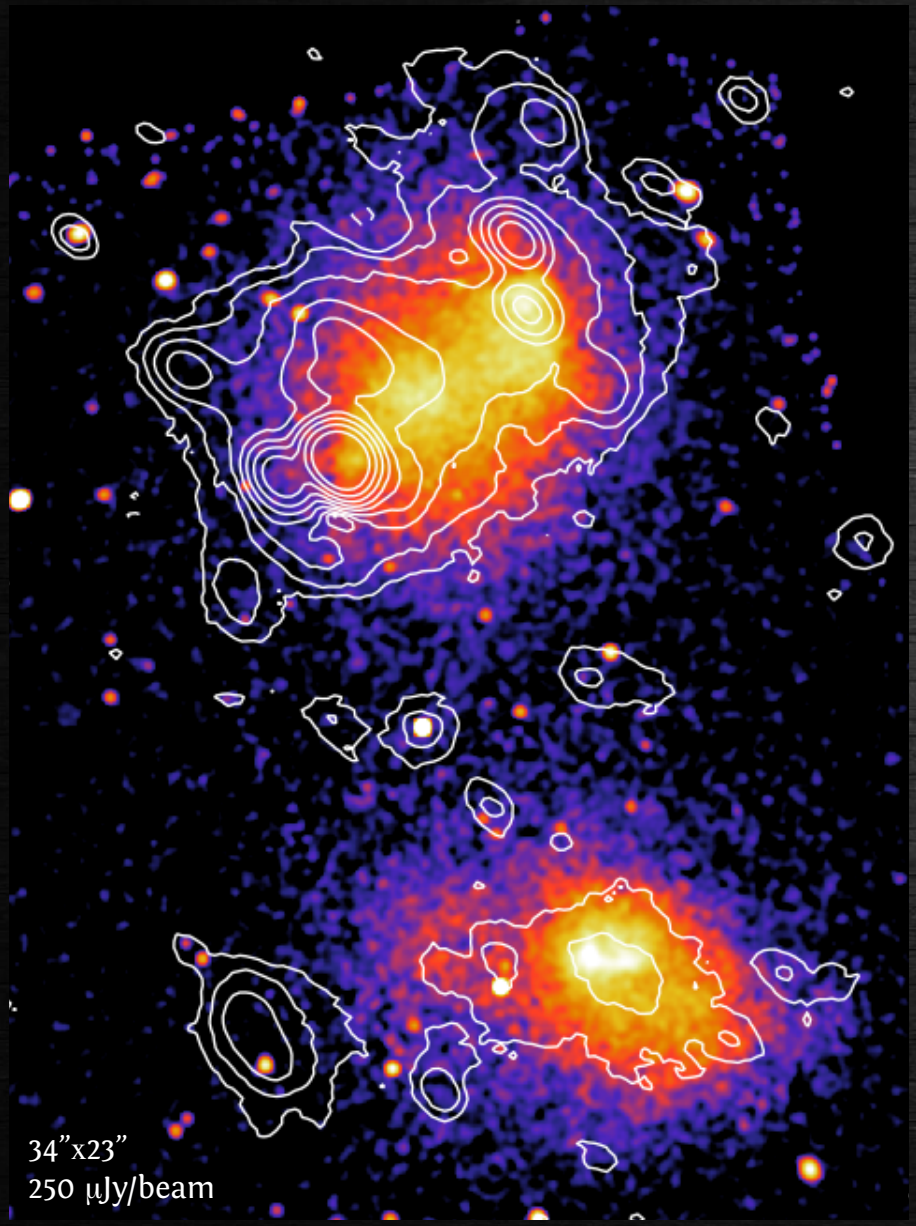
- 10^{15} $M_{\odot}$
- Late state merger
- Radio halo (α = 1.3-1.4)

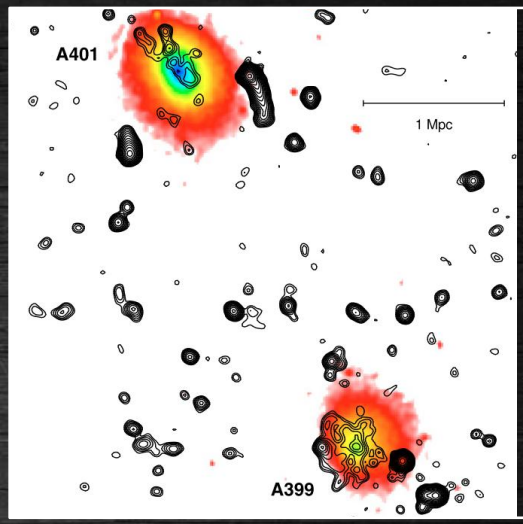
A1758S:

- Less massive (3-6 x 10^{14} $M_{\odot}$)
- Early state merger
- Radio "quiet" (GMRT+VLA)

Rizza+98, David+04, Haines+09, Durret+12, Boschin+12, Ragozzine+12, Machado+15, MonteiroOliveira+17

A double radio halo





The other *double RH system*:

A399+A401

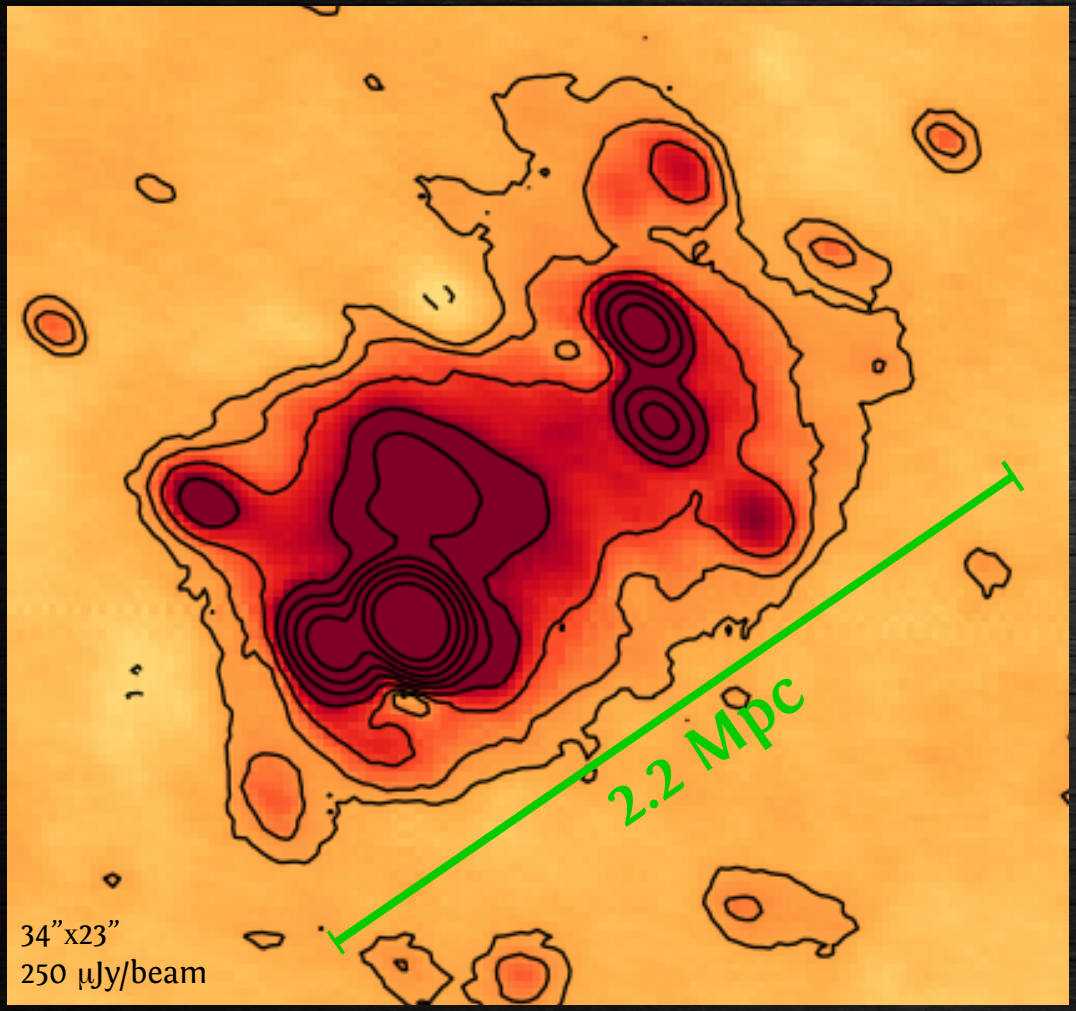
at *z=0.07*

(Murgia+10)

Comparison between the *mass* and/or the *dynamical state* of **A1758N** and **A1758S** to test the models of halo formation

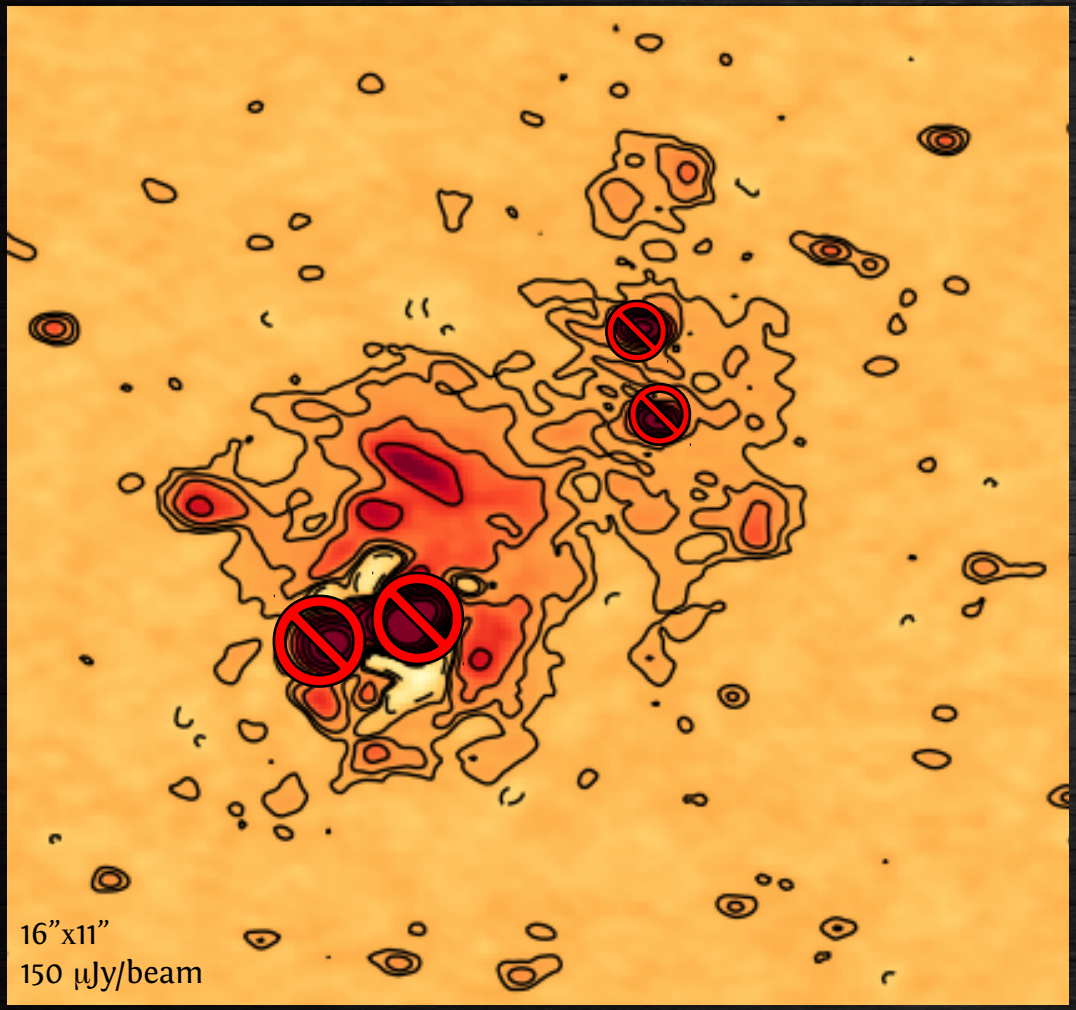
A1758S is one of the *less massive clusters* (3-6 x 10^{14} $M_{\odot}$) where a **giant radio halo** has been detected

A1758N



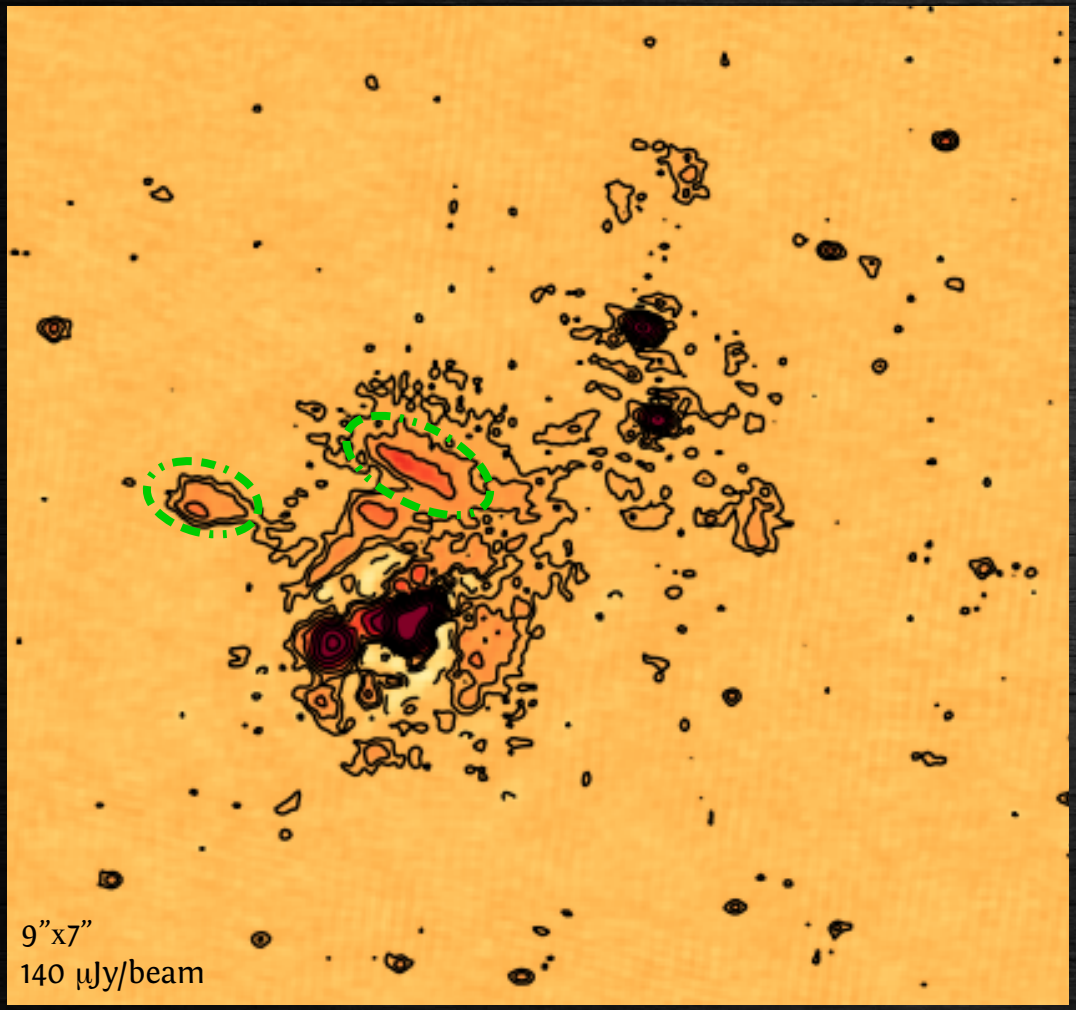
- LOFAR recovers more extended emission

A1758N



- LOFAR recovers more extended emission
- Diffuse flux: 450-520 mJy, consistent with α = 1.3-1.4

A1758N



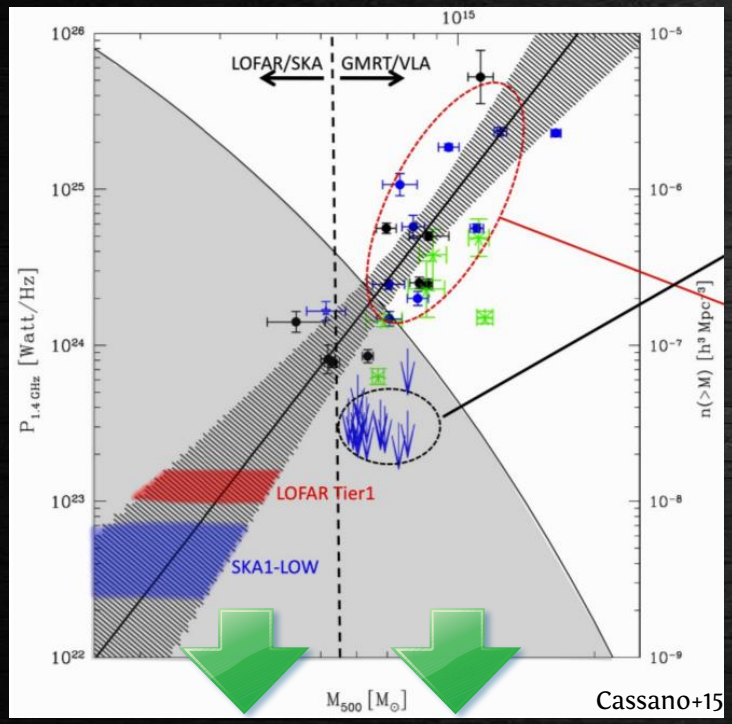
- **LOFAR** recovers more extended emission
- Diffuse flux: **450-520 mJy**, consistent with **α = 1.3-1.4**
- *Straight* and *bright* structures

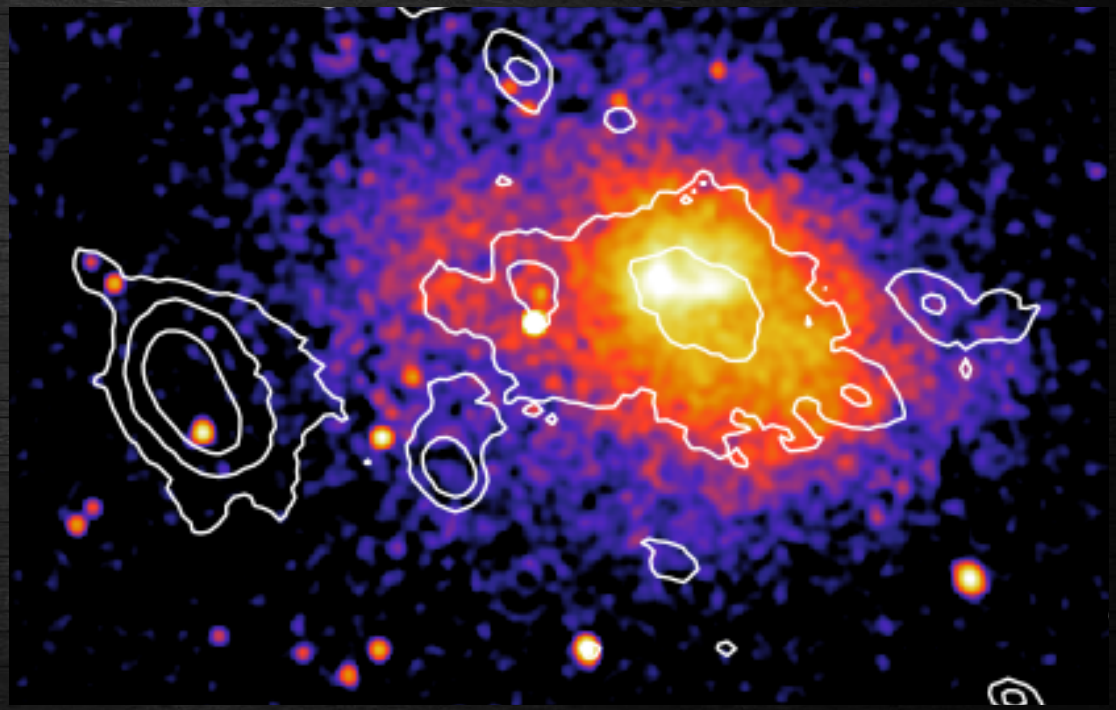
A1758S

A1758S is not detected by **GMRT** and **VLA** because its halo might be too:

1) Faint ⟶ LOFAR has the sensitivity to detect it

2) Steep ⟶ LOFAR operates at low frequency



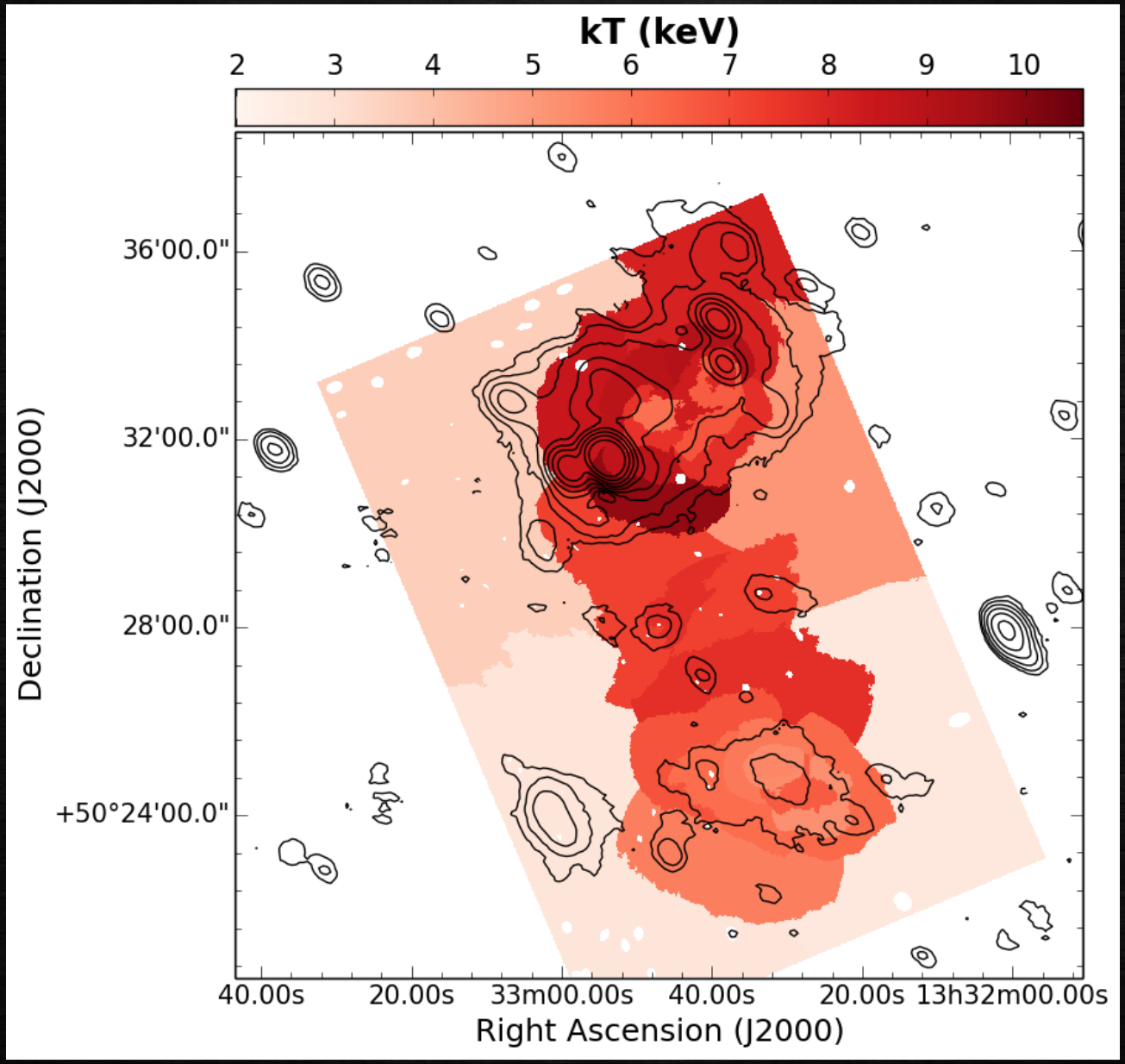


A1758S A1758N

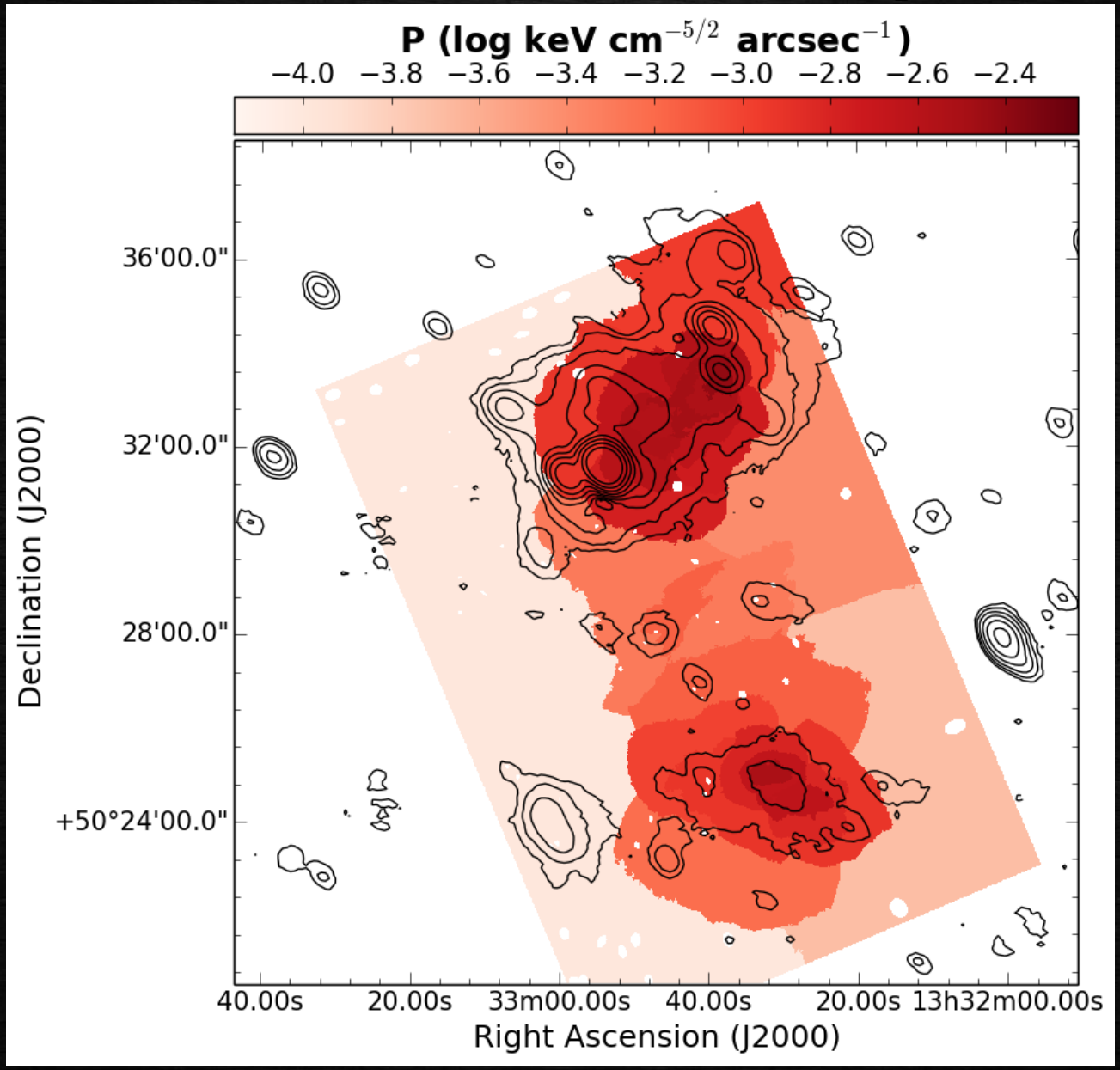
LOFAR fluxes:
Halo 50 mJy
Relic? 30 mJy

Exploring the *low mass* regime thanks to **LOFAR**

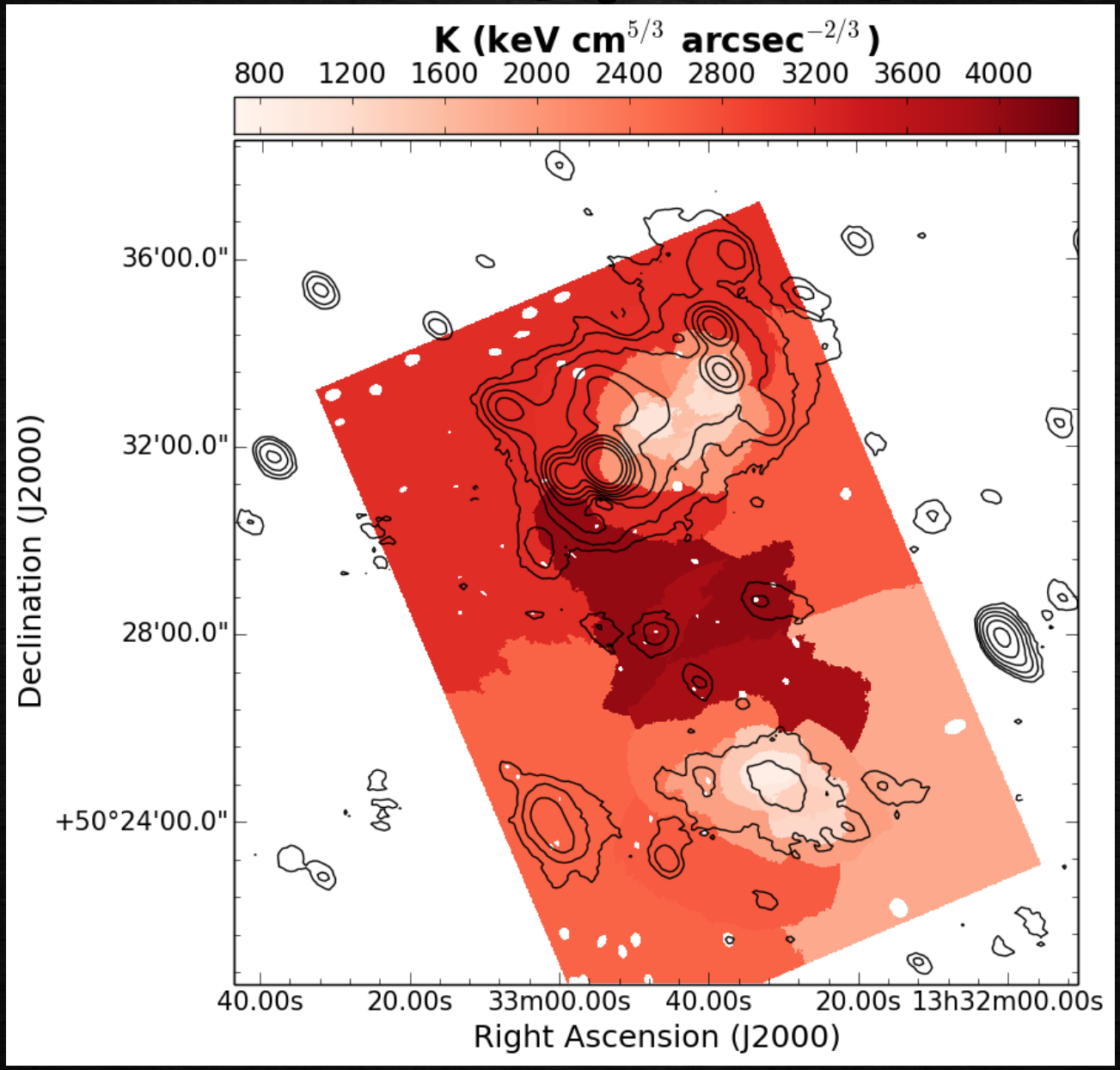
Temperature map



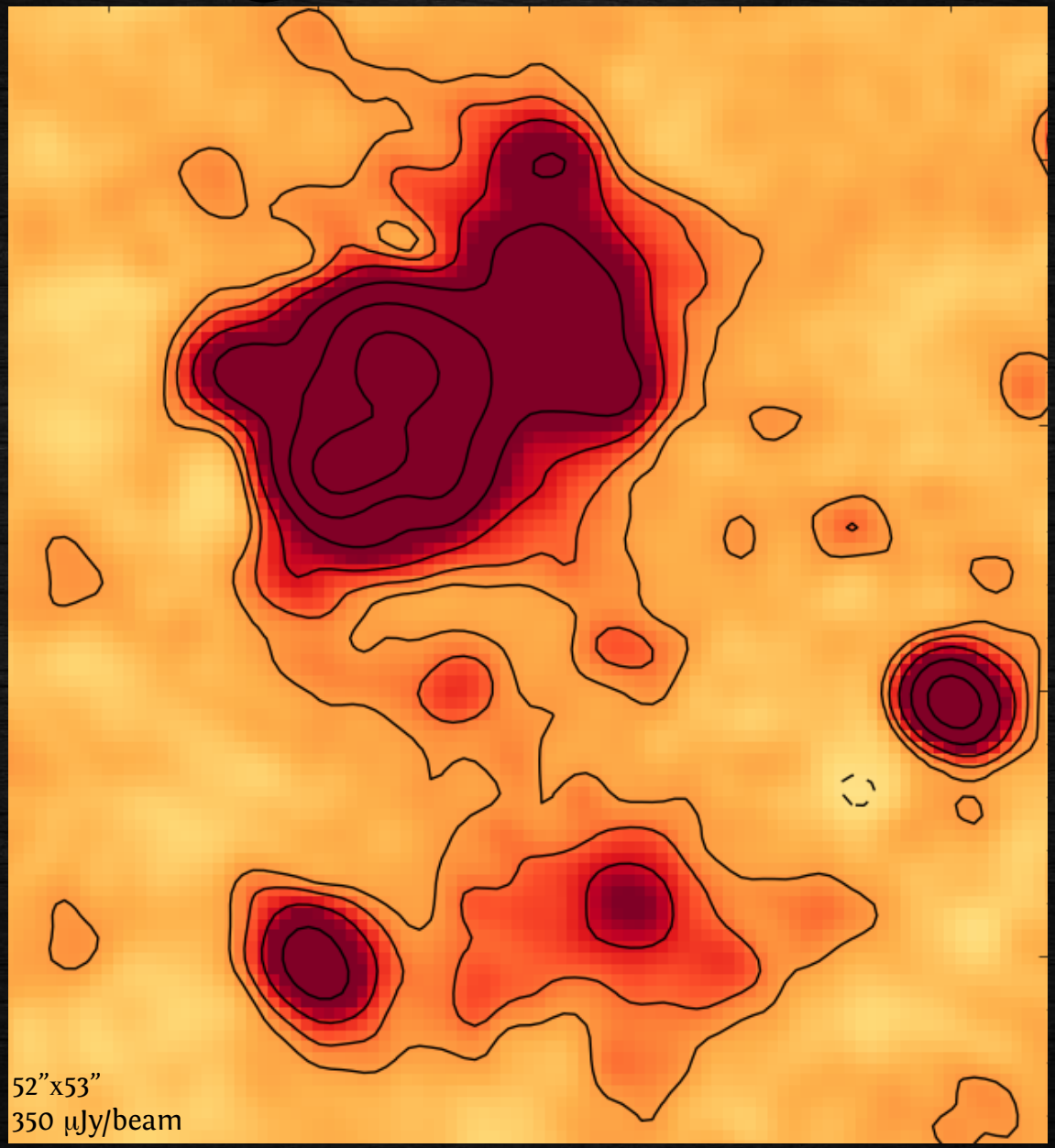
Pressure map



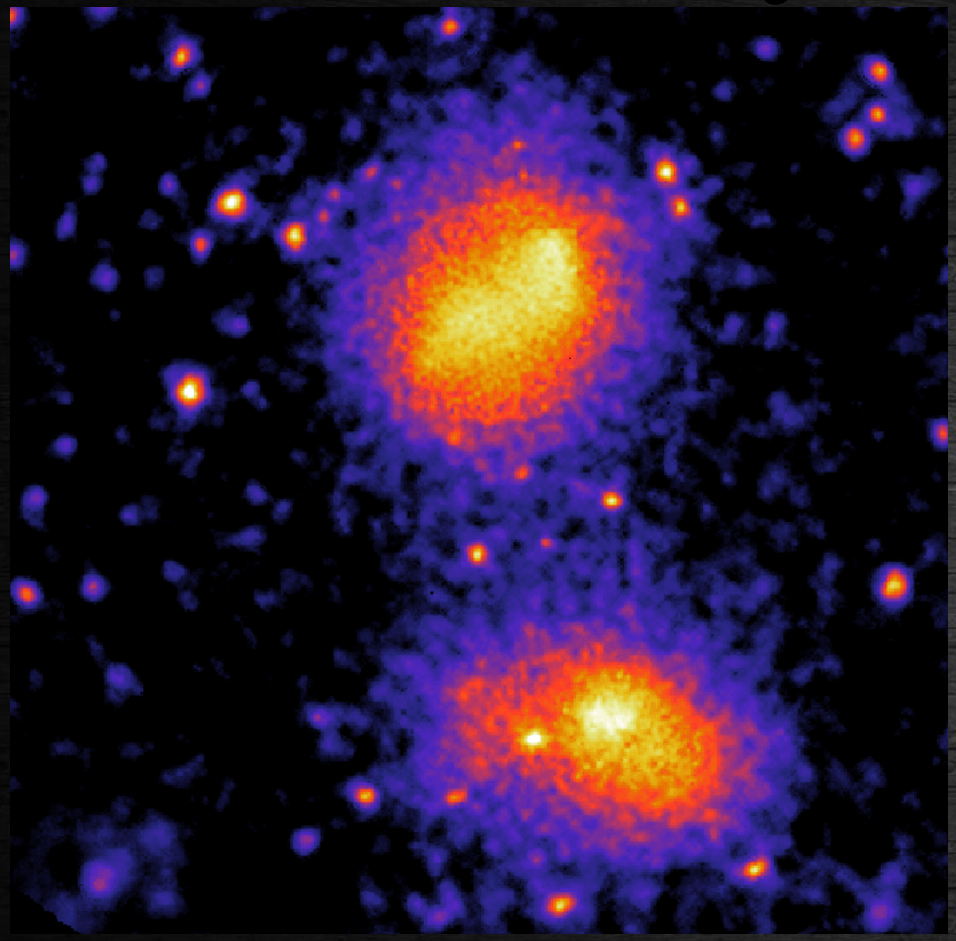
Entropy map


K (keV cm$^{5/3}$ arcsec$^{-2/3}$)
800 1200 1600 2000 2400 2800 3200 3600 4000
36'00.0"
32'00.0"
28'00.0"
+50°24'00.0"
Declination (J2000)
40.00s 20.00s 33m00.00s 40.00s 20.00s 13h32m00.00s
Right Ascension (J2000)

A bridge of emission?



X-ray channel



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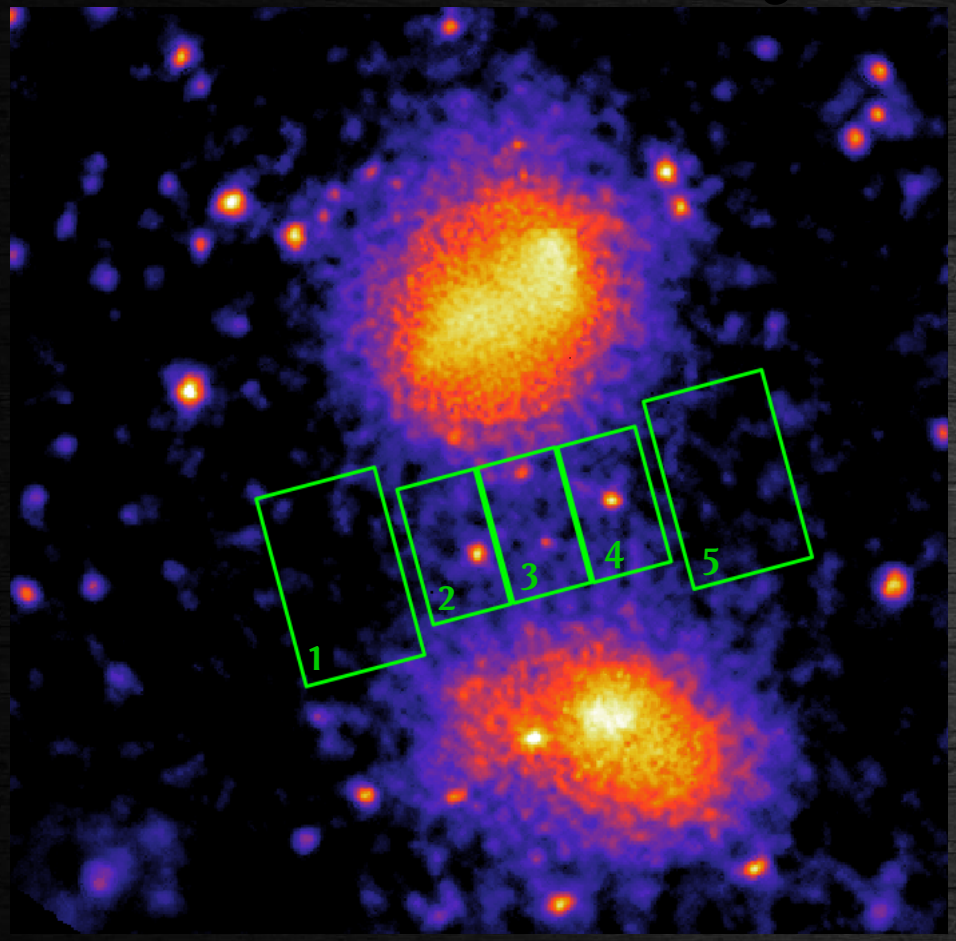
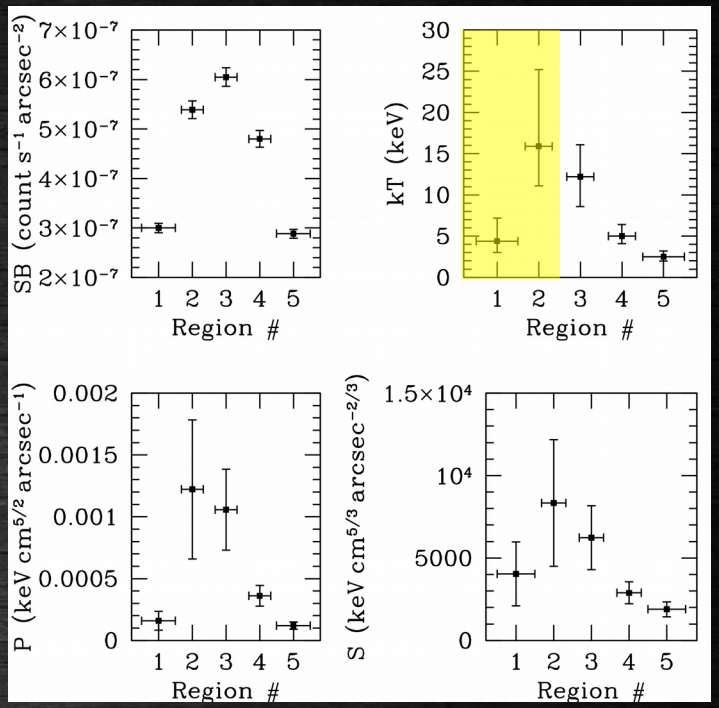
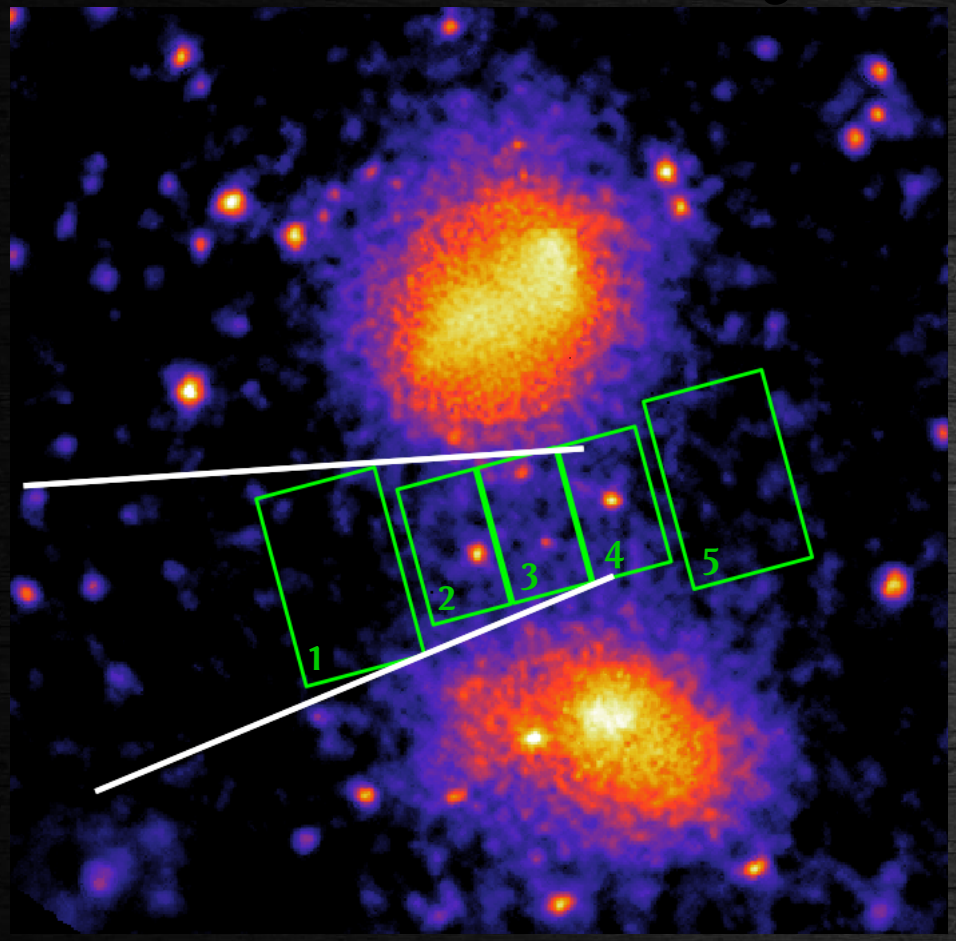


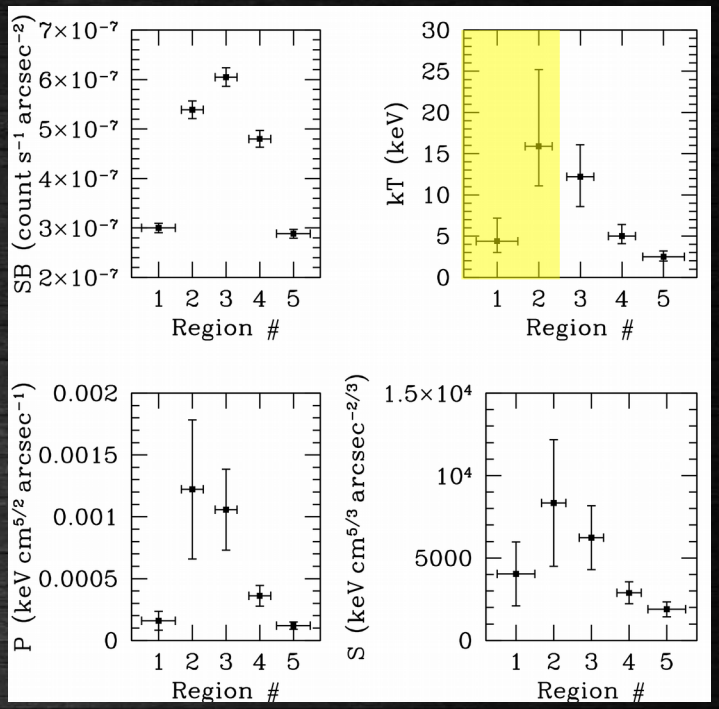


Chandra

$$\mathcal{M}_{\rm kT} = 3.0^{+1.4}_{-1.0}$$

X-ray channel



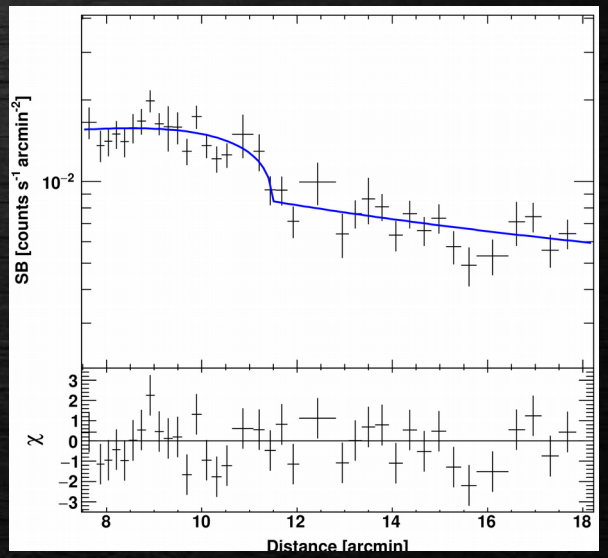


Chandra

$$\mathcal{M}_{\rm kT} = 3.0^{+1.4}_{-1.0}$$

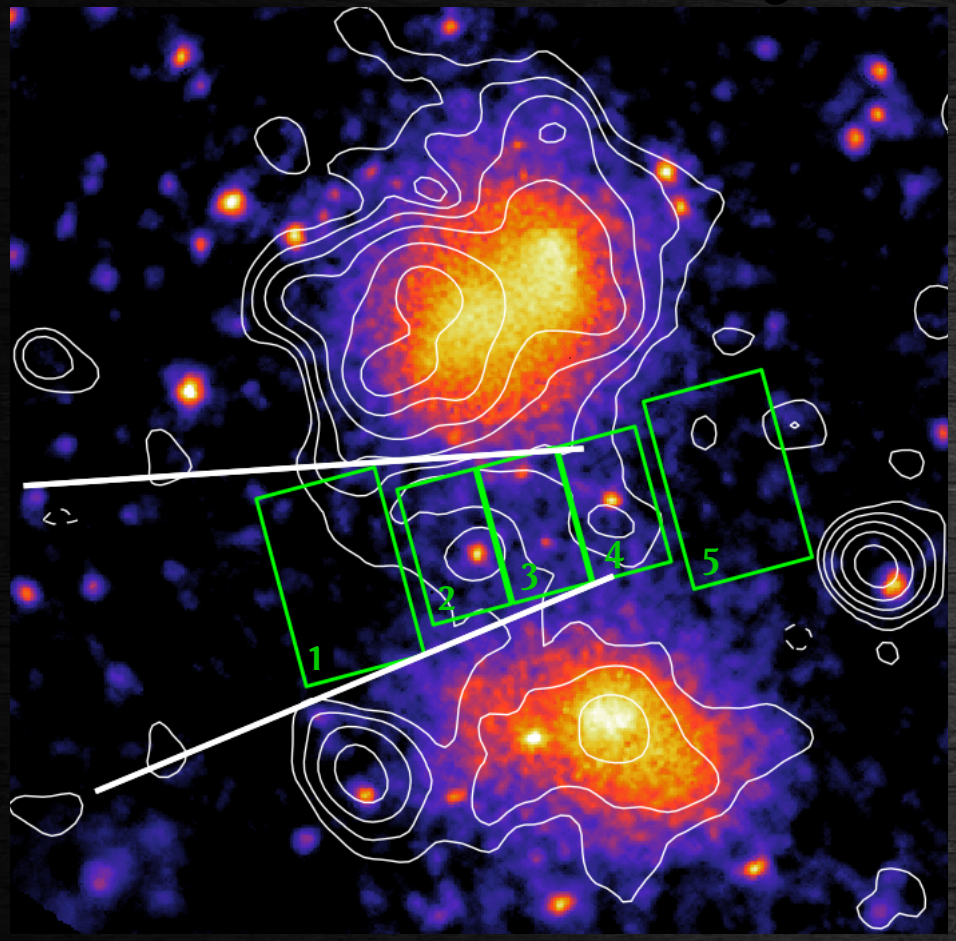
$$\mathcal{M}_{\rm SB} = 1.8^{+0.4}_{-0.2}$$

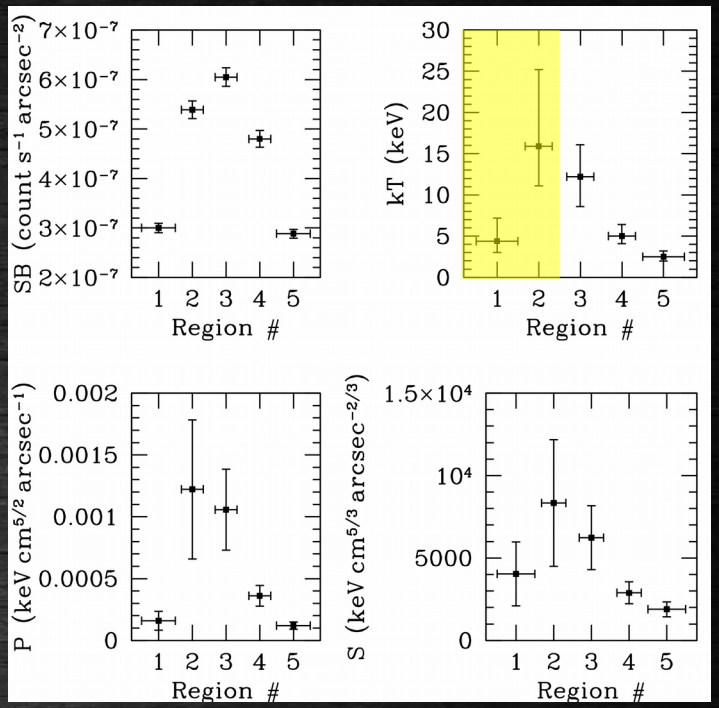
→ very affected by *projection effects*



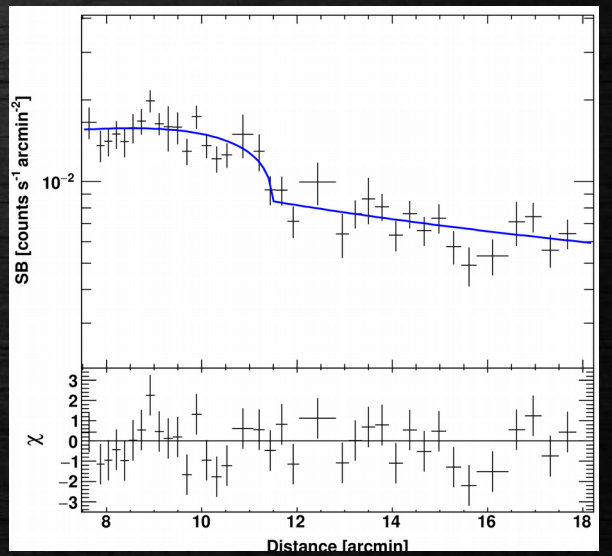
XMM

X-ray channel





Chandra



XMM

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$$\mathcal{M}_{\rm SB} = 1.8^{+0.4}_{-0.2}$$

→ very affected by *projection effects*

Summary

- *New* halo and relic(?) in **A1758S**
- *Double* radio halo
- Tentative *bridge* of emission

- Presence of a **transversal shock**?
- *Interection* between A1758 **N** & **S**

Summary

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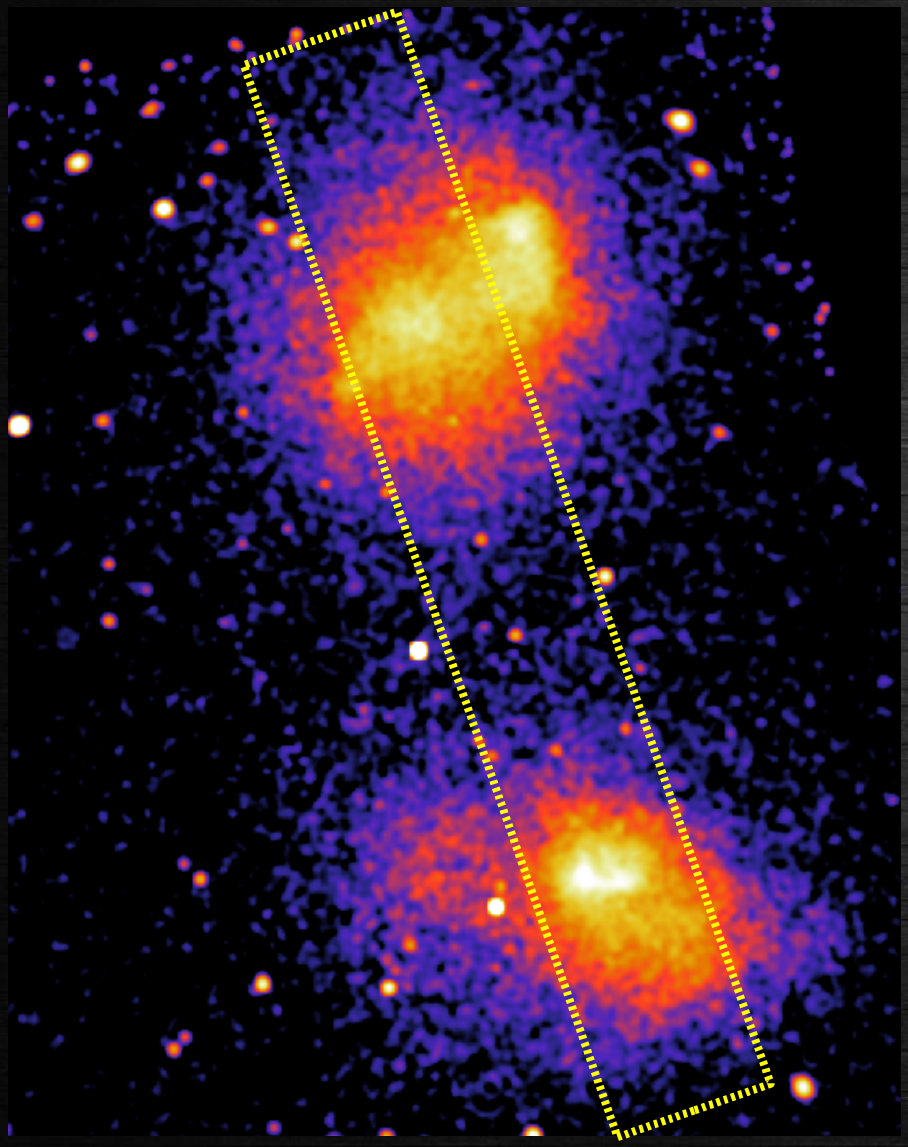
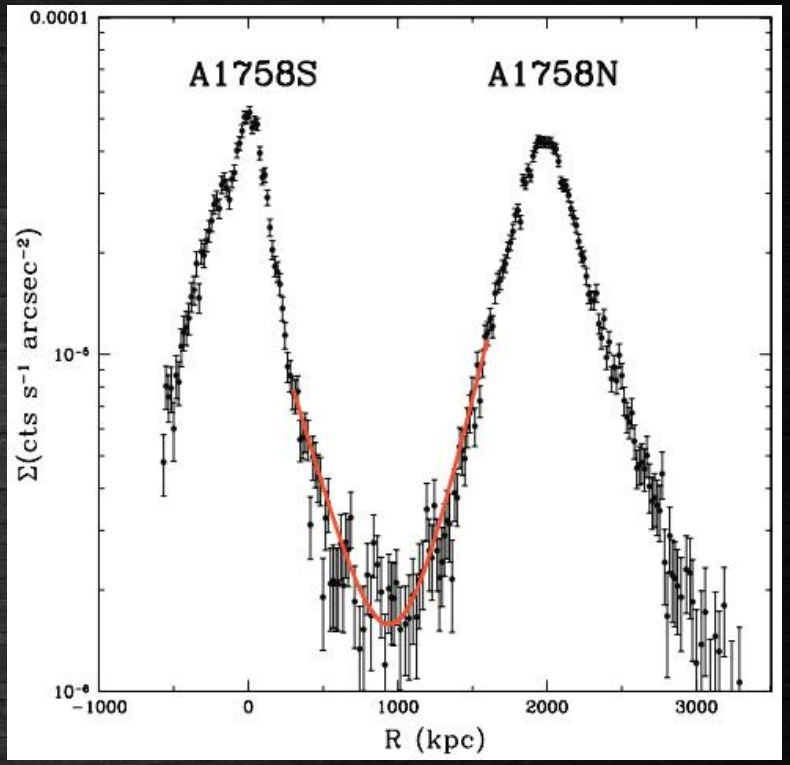
Thank you

Extra slides

Interaction?

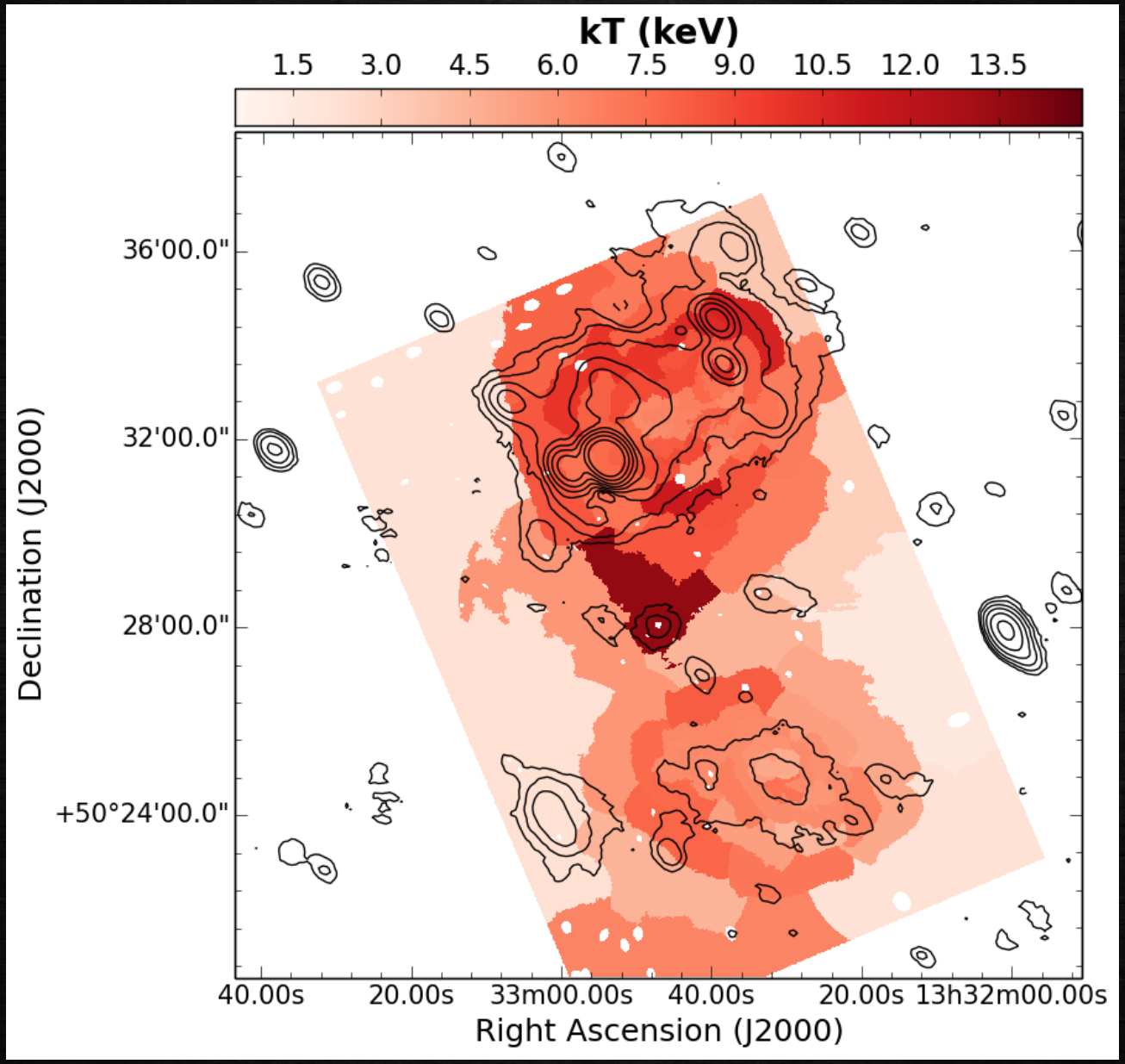




No X-ray excess above that expected from a *projection* of the two systems

(David+Kempner04)

Low S/N kT map


kT (keV)
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
36'00.0"
32'00.0"
28'00.0"
+50°24'00.0"
Declination (J2000)
40.00s
20.00s
33m00.00s
40.00s
20.00s
13h32m00.00s
Right Ascension (J2000)

A399+A401 shock