Diffuse non-thermal emission in (high) and low thermal gas density environments

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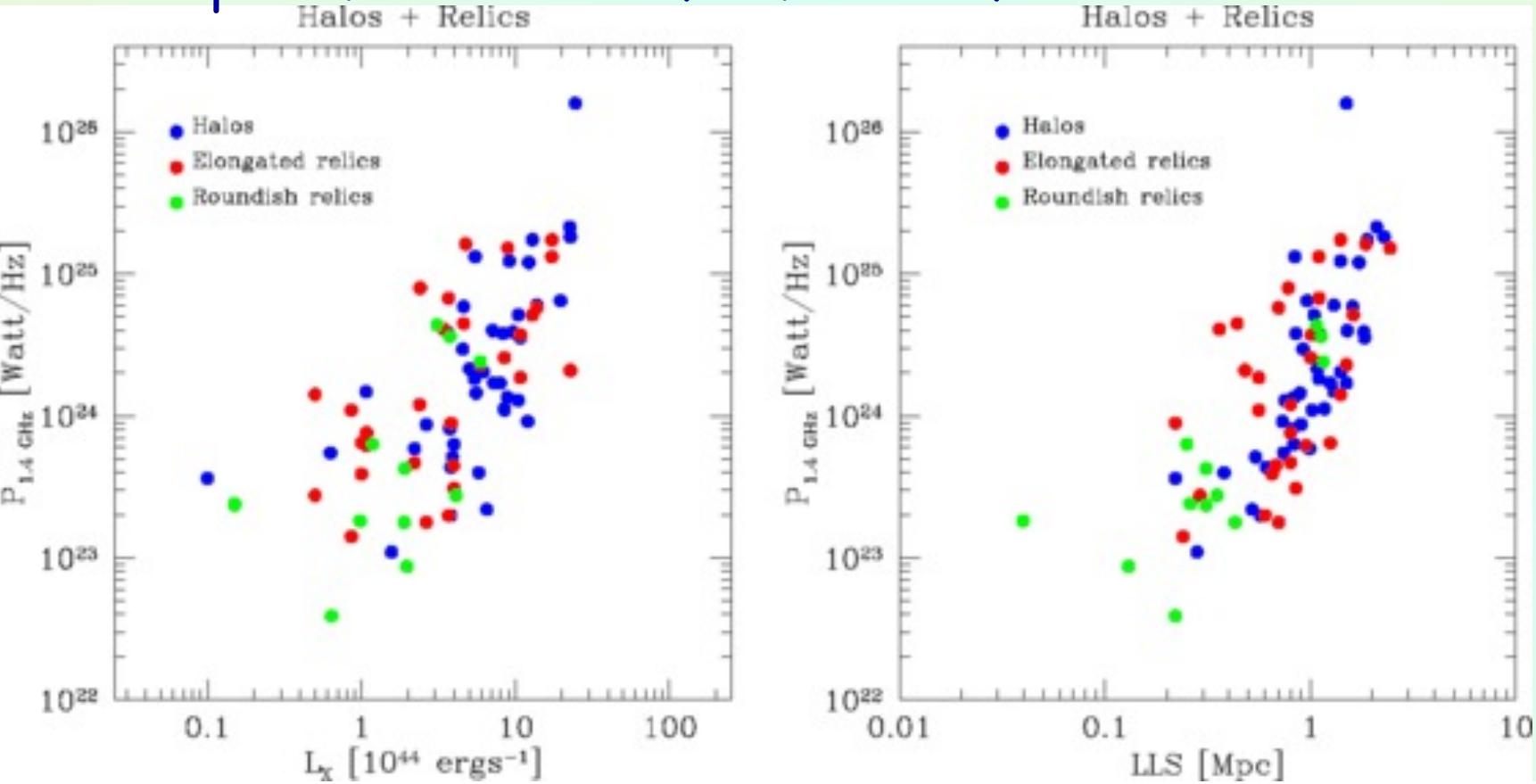
Halos and relics has been detected in several clusters (Feretti + 2012 for a recent review).

A strong correlation is present between the halo and relic radio power and the X-ray luminosity.
Since cluster X-Ray luminosity and mass are related, the correlation could derive from a physical dependence of the radio power on the cluster mass, therefore the cluster mass could be a crucial parameter in the formation of these sources.



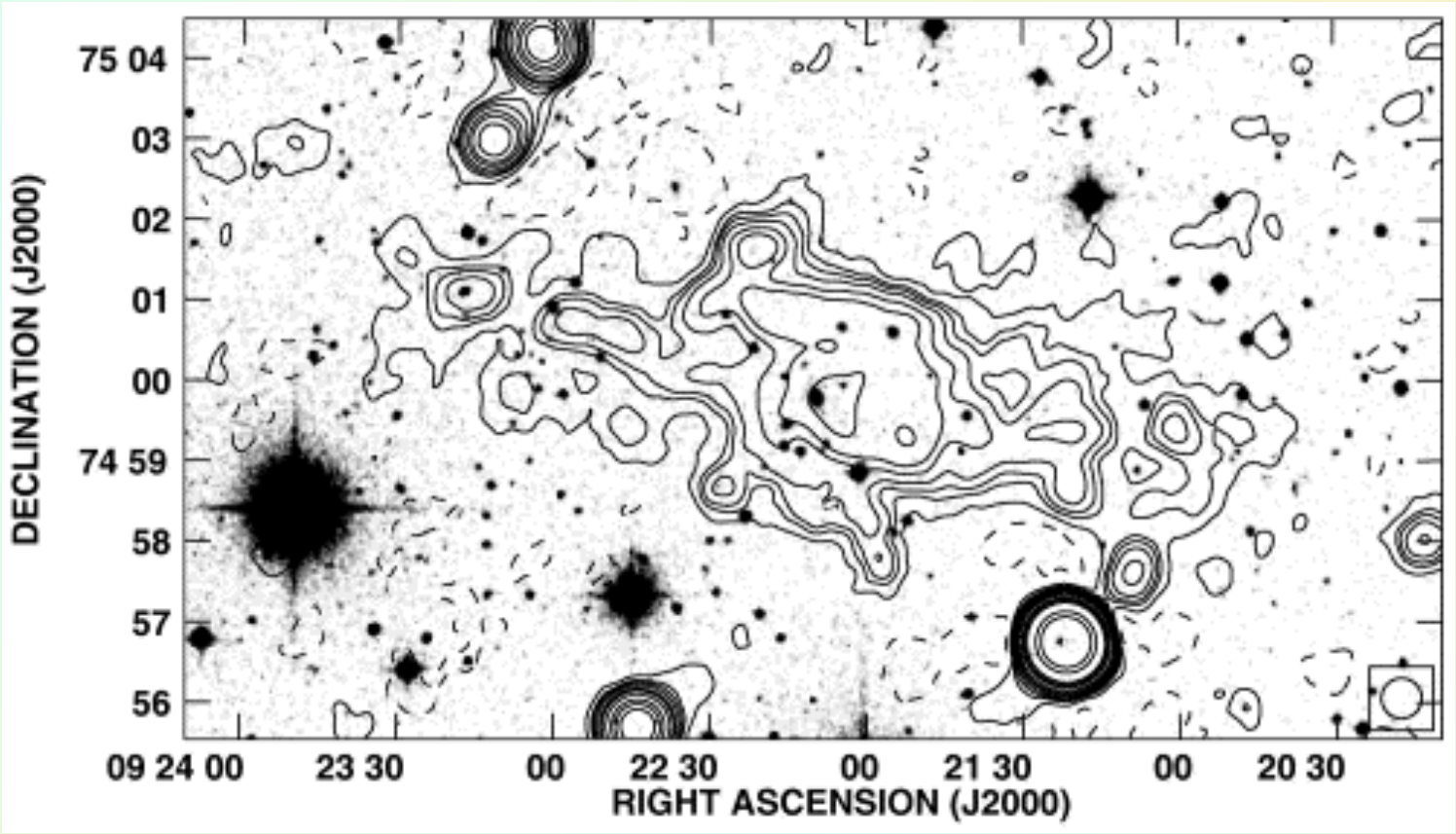
I would like to present observational evidences of diffuse, non-thermal emission in lower density environments with respect to galaxy clusters:

galaxy filaments connecting rich clusters (and X-ray underluminous galaxy clusters)

1) 0917+75

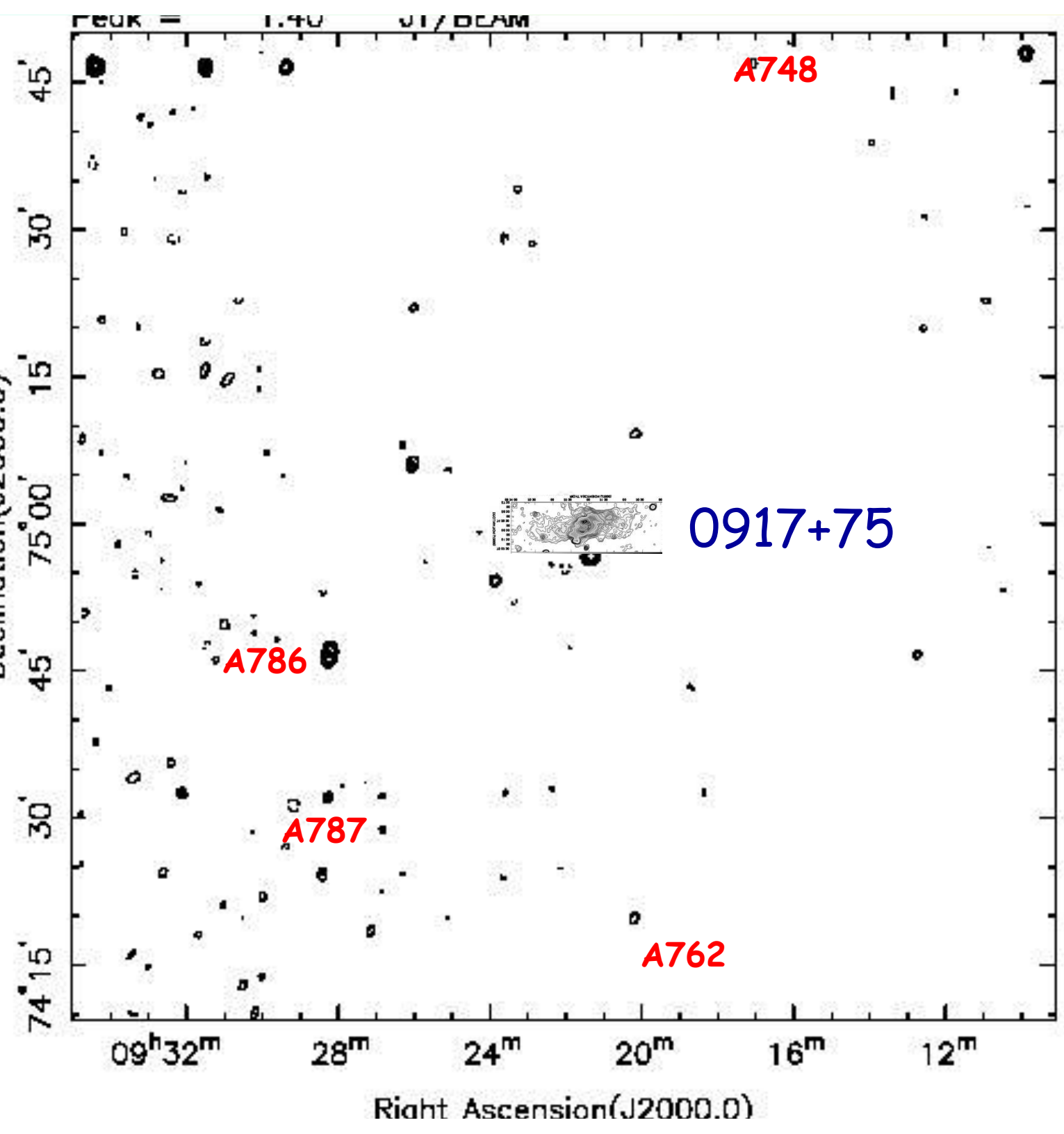
2) A523

3) MACS J0600-2008



Filament of galaxies. z is 0.138 (Girardi pc).
This filament connect A786 and A748 nearby clusters at the same distance (Girardi et al., in progress).

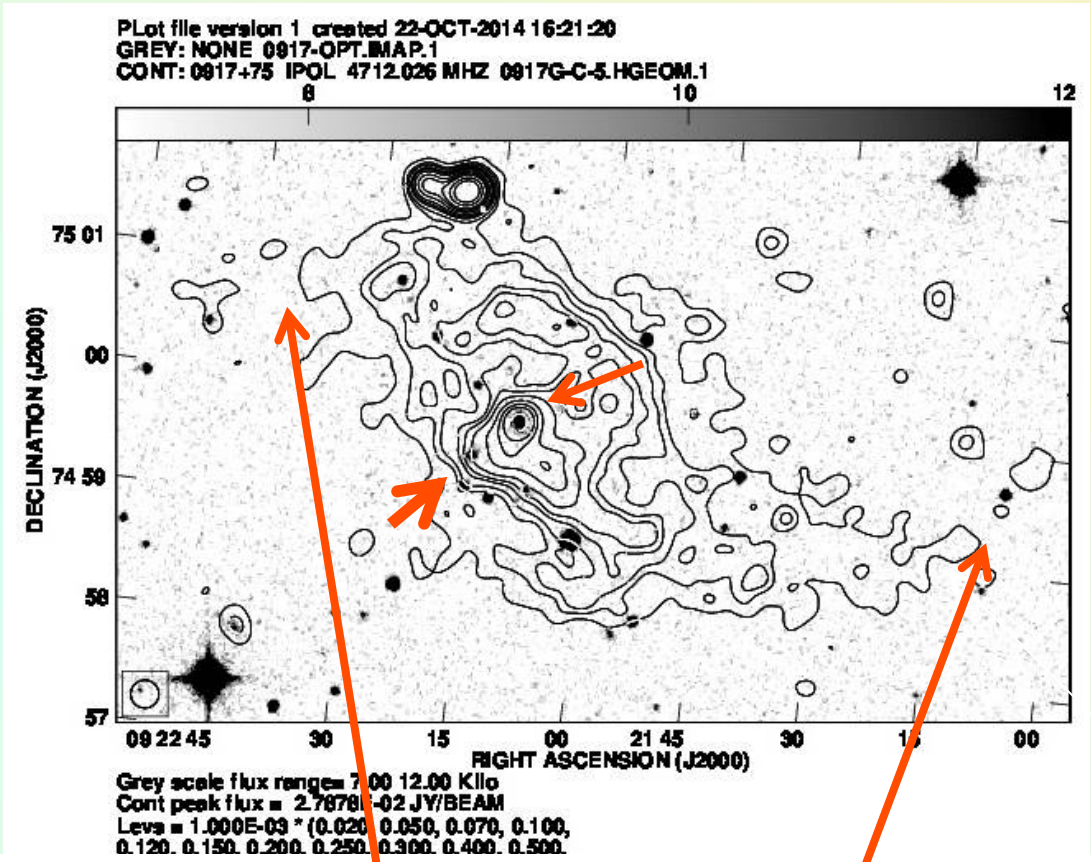
Studied in detail by: Dewdney et al. 1991 (radio halo)
Harris et al. 1993 (Relic: shape + polarization)
Giovannini & Feretti 2000 (very peculiar) very far (>4Mpc) from the nearest cluster

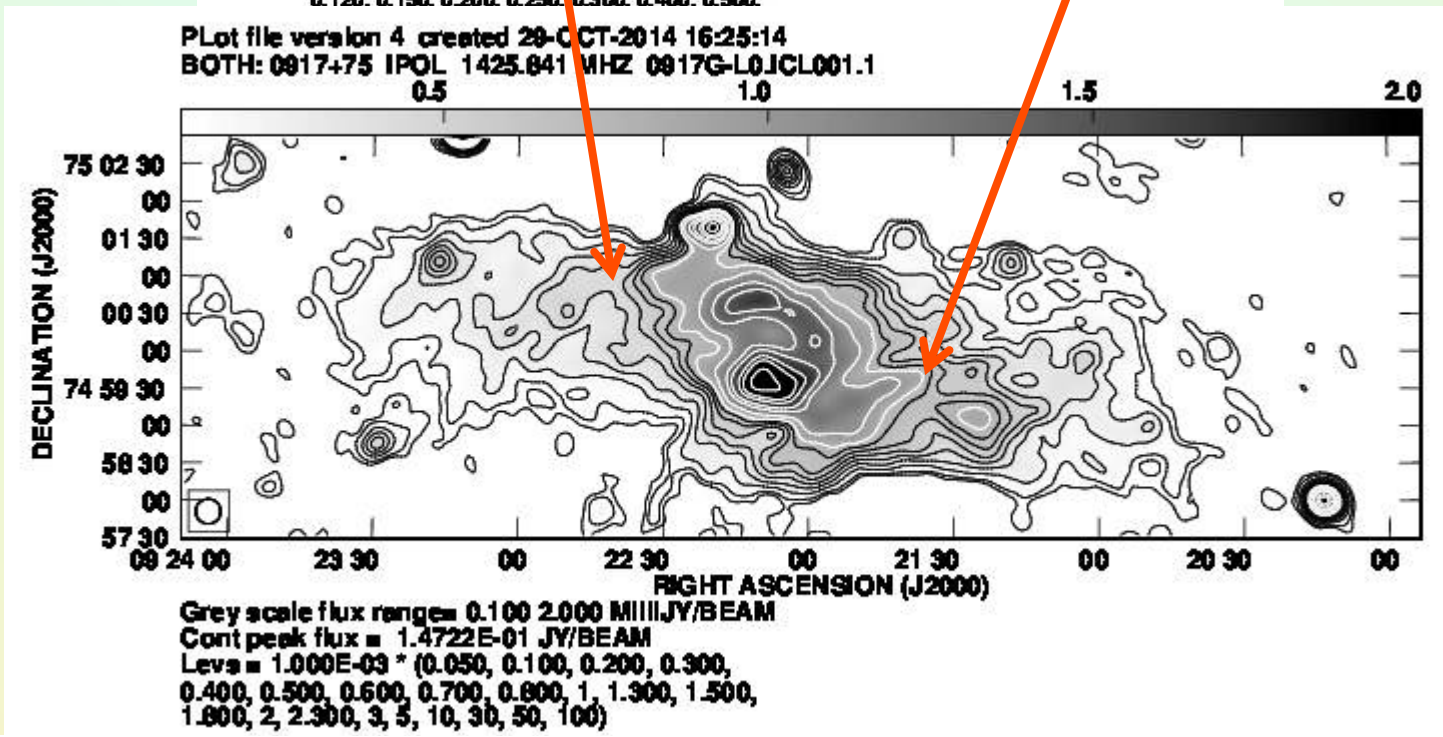


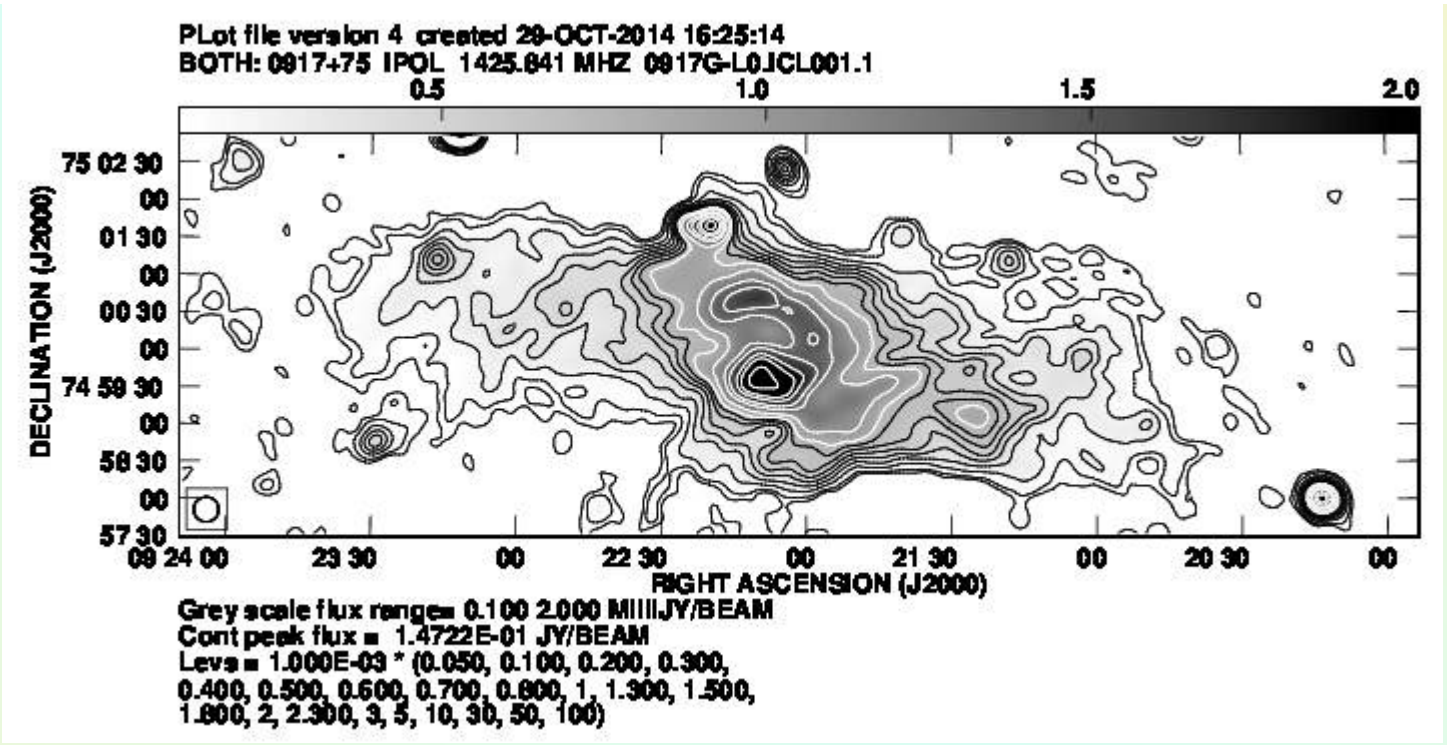
From VLSSr
74MHz

Diffuse emission 0917+75

Two galaxies at z=0.125







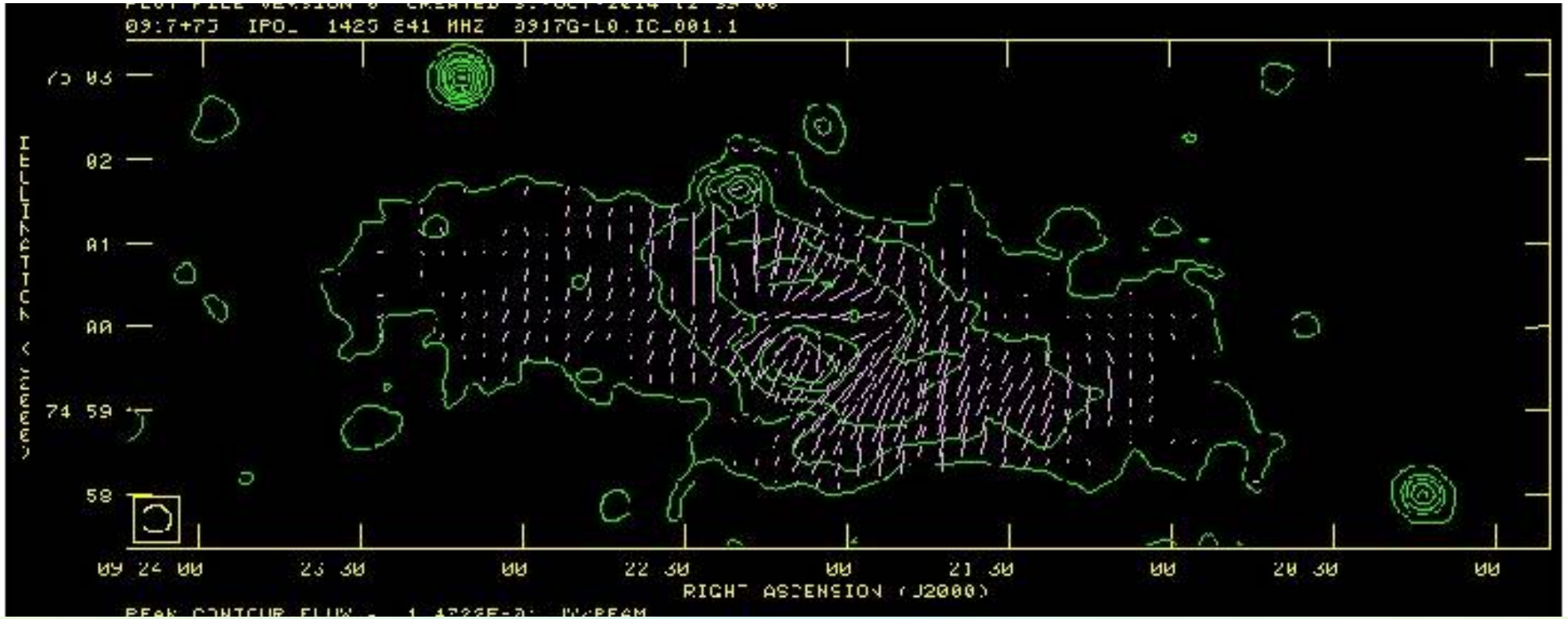
Flux density: (1.4 GHz) 110.22 mJy (5 GHz) 10.9 mJy

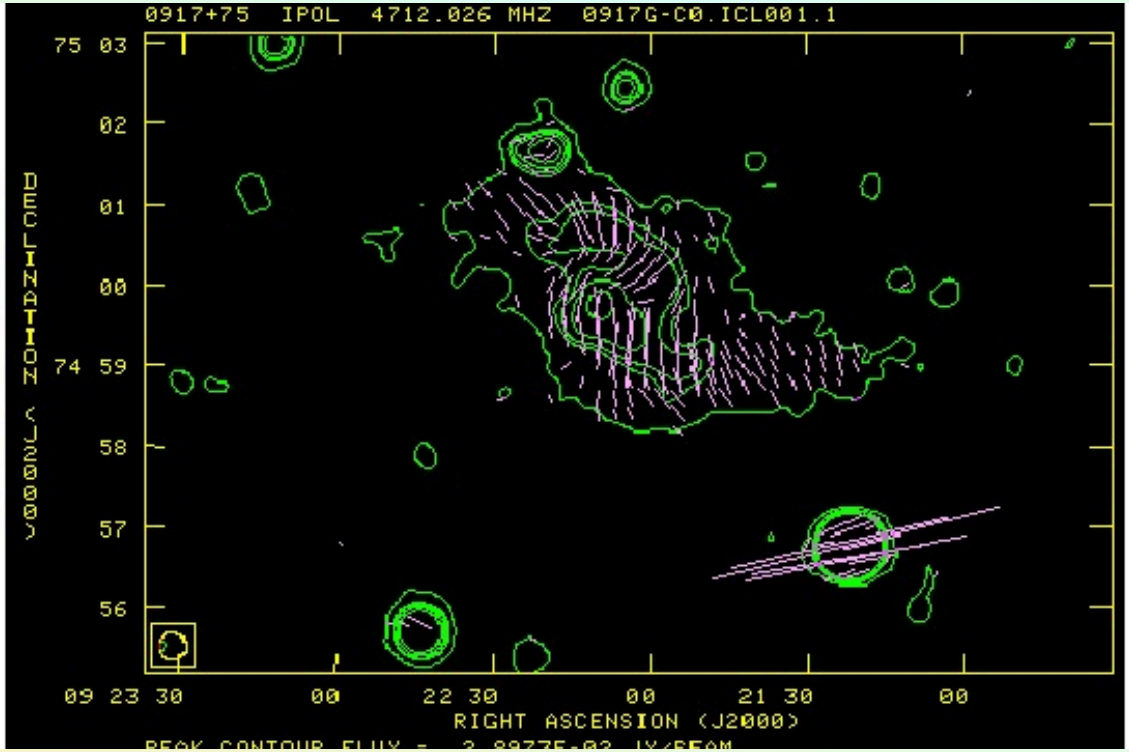
Radio power: 4.59×10^{24} W/Hz 4.54×10^{23} W/Hz

LAS: 1.7 Mpc Spectral index (total): 1.93

Harris et al. 1993: 1.2 Jy at 151 MHz (alpha = 1.07 between 151 – 1415)

Not detected by ROSAT and XMM ➔ $H > 0.81\ 10^{-6}$ G
at 3 sigma level (Chen et al. 2008)



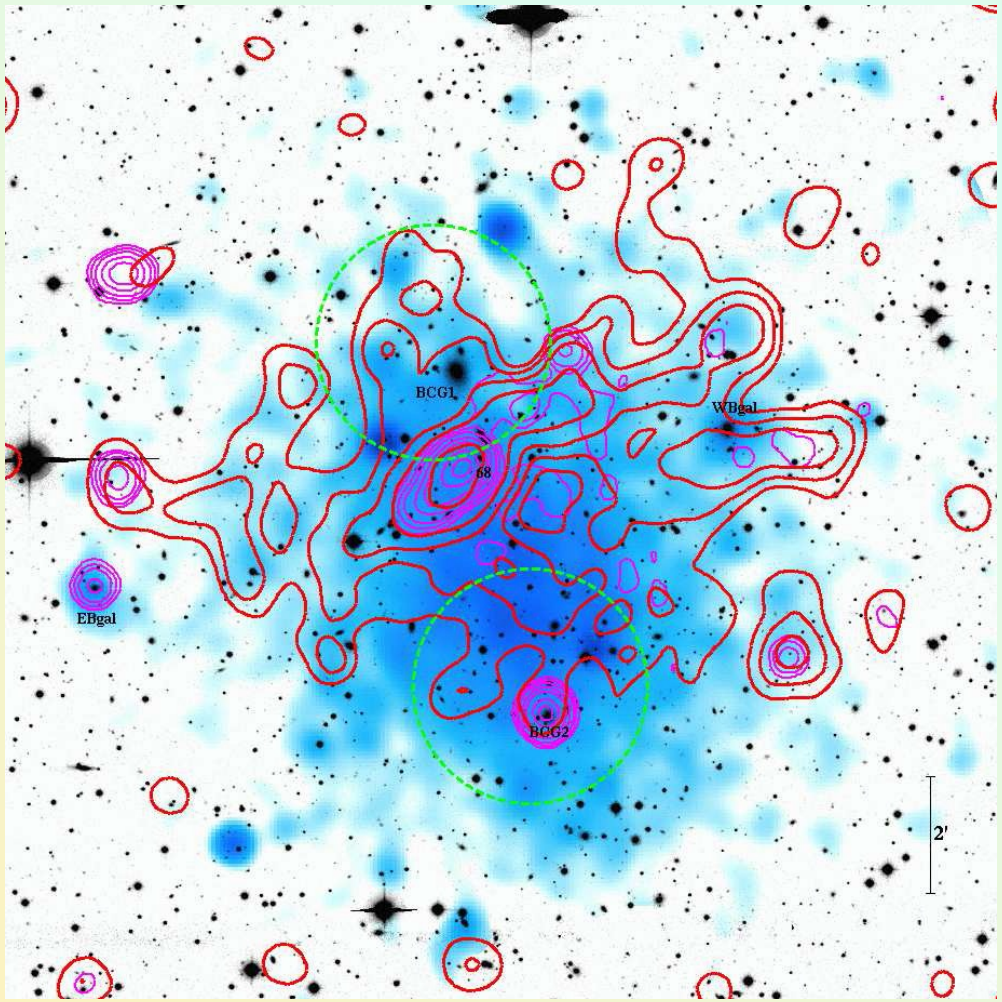


Pol average:

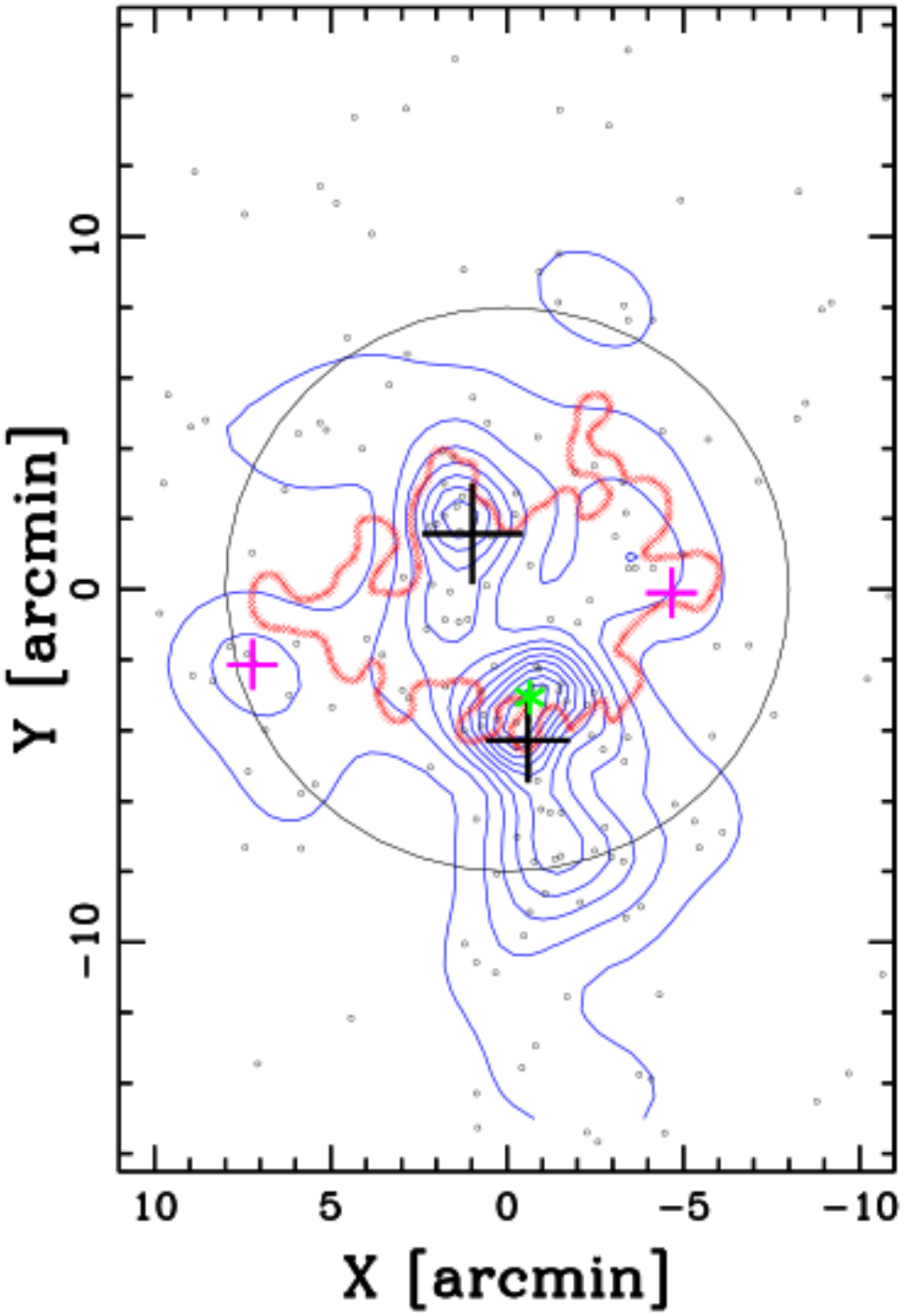
31% at 1.4
29% at 5.0

A523 hosts an extended and powerful diffuse emission with maximum linear size ~ $1.3\ h^{-1}_{70}$ Mpc and total radio power $P_{1.4\ GHz} \sim 1.5\ 10^{24}$ W/Hz strongly elongated along the ESE-WNW direction (Giovannini et al. 2011)

The A523 radio halo is far from the typical one



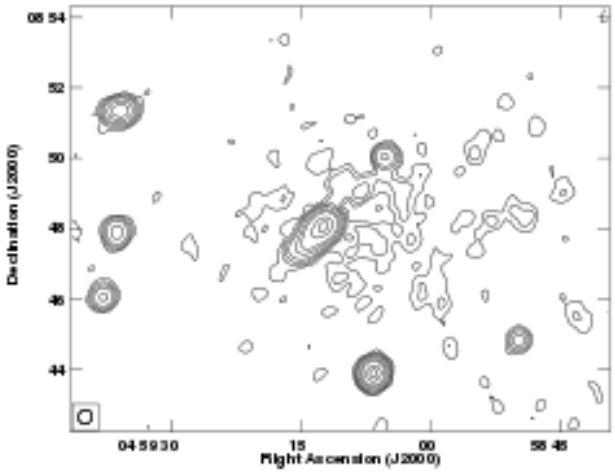
smoothed *Chandra* blue color,
thin magenta contours VLA radio at high–resolution
thick red contours VLA low–resolution image (with discrete sources subtracted
Green dashed circles highlight
the centres of the the two merging clusters.

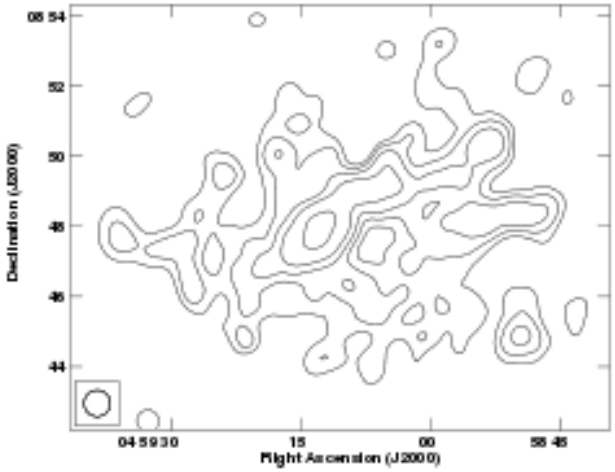


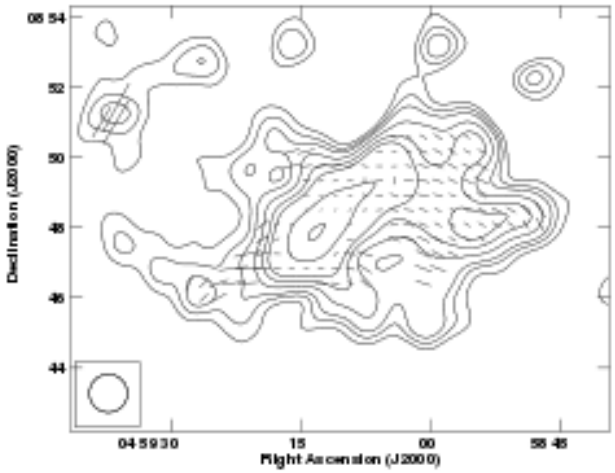
Spatial distribution on the sky of photometric cluster members
The two black crosses indicate the position of BCG1 and BCG2 and the two magenta crosses indicate EBgal and WBgal, the dominant galaxies in the background structure .

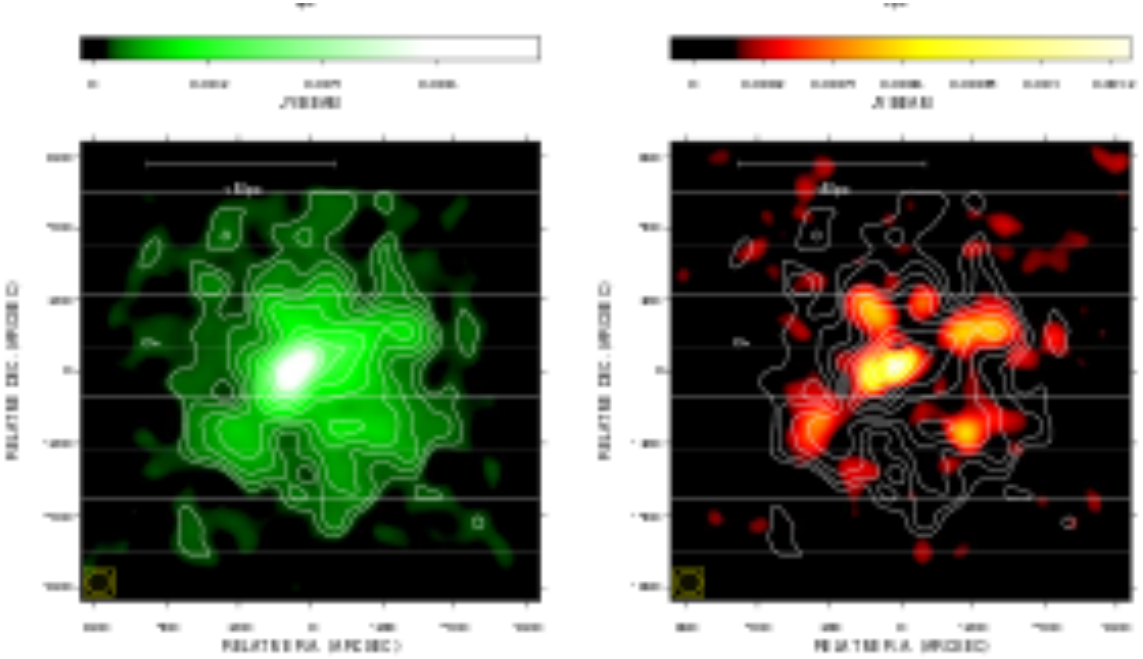
The green asterisk indicates the peak of the X-ray surface brightness

optical and radio data show some evidence in favor of a complex merger suggesting a scenario where A523 is forming at the cross of two filaments



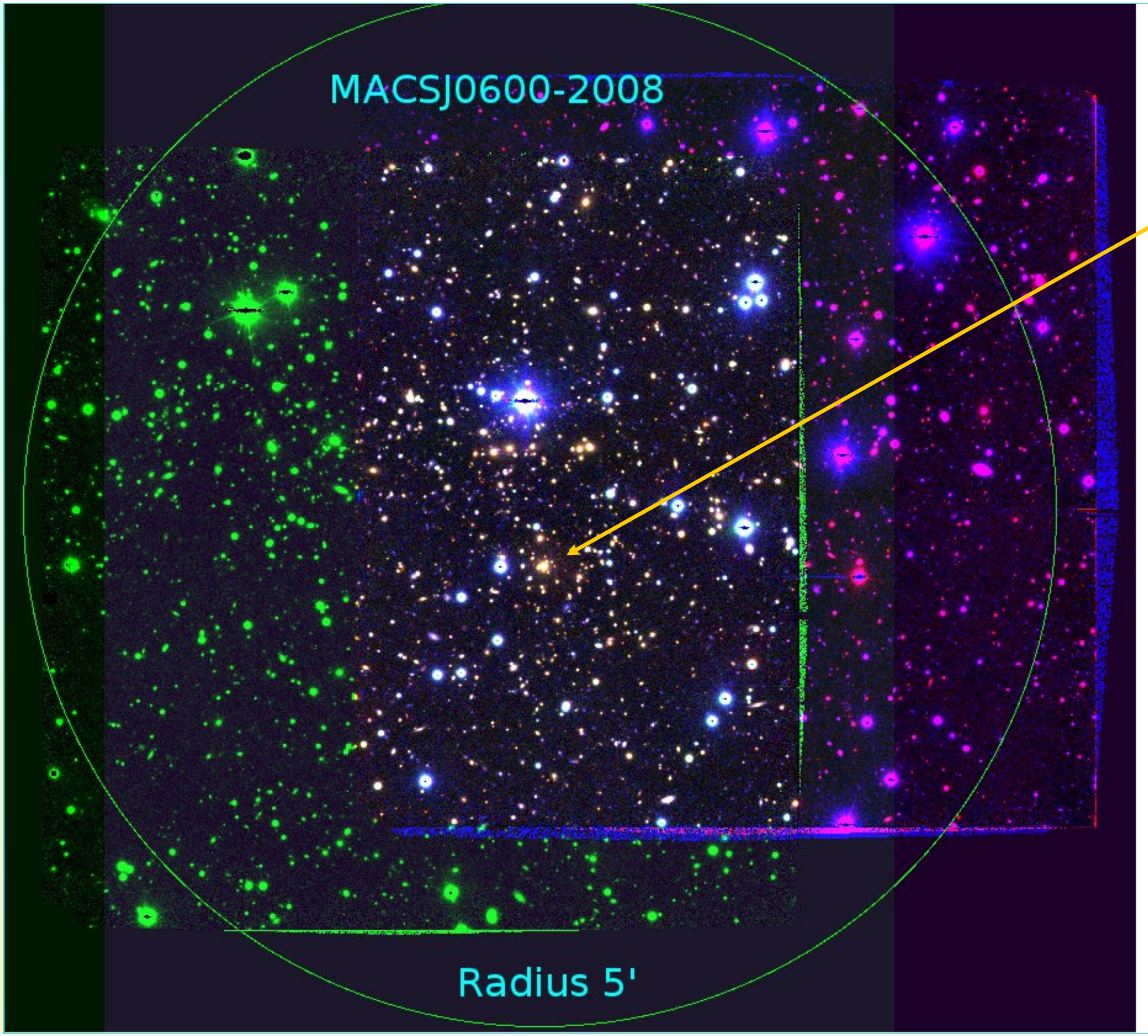


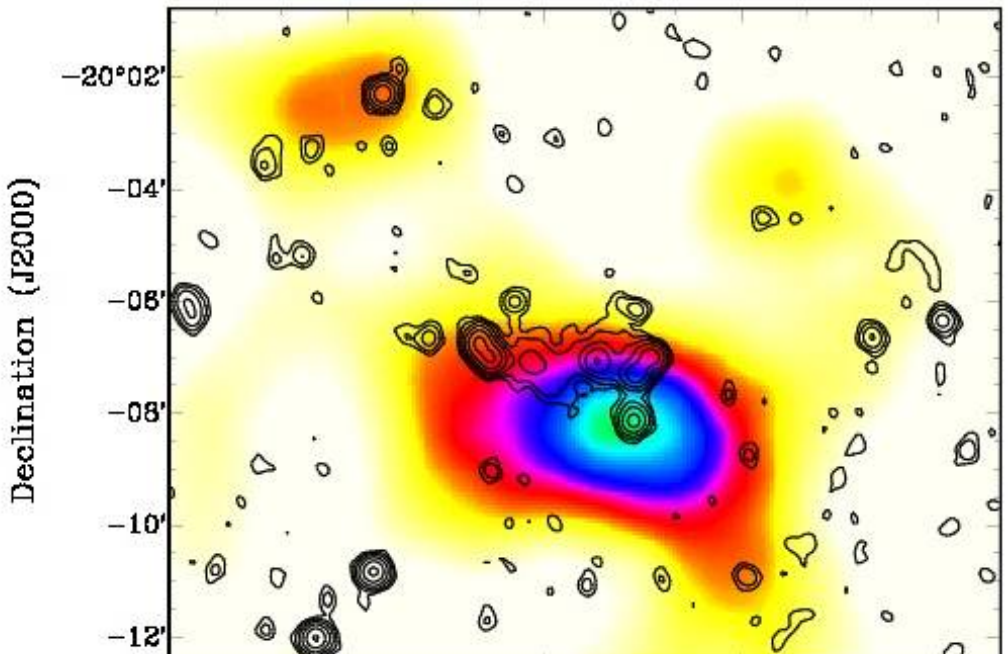




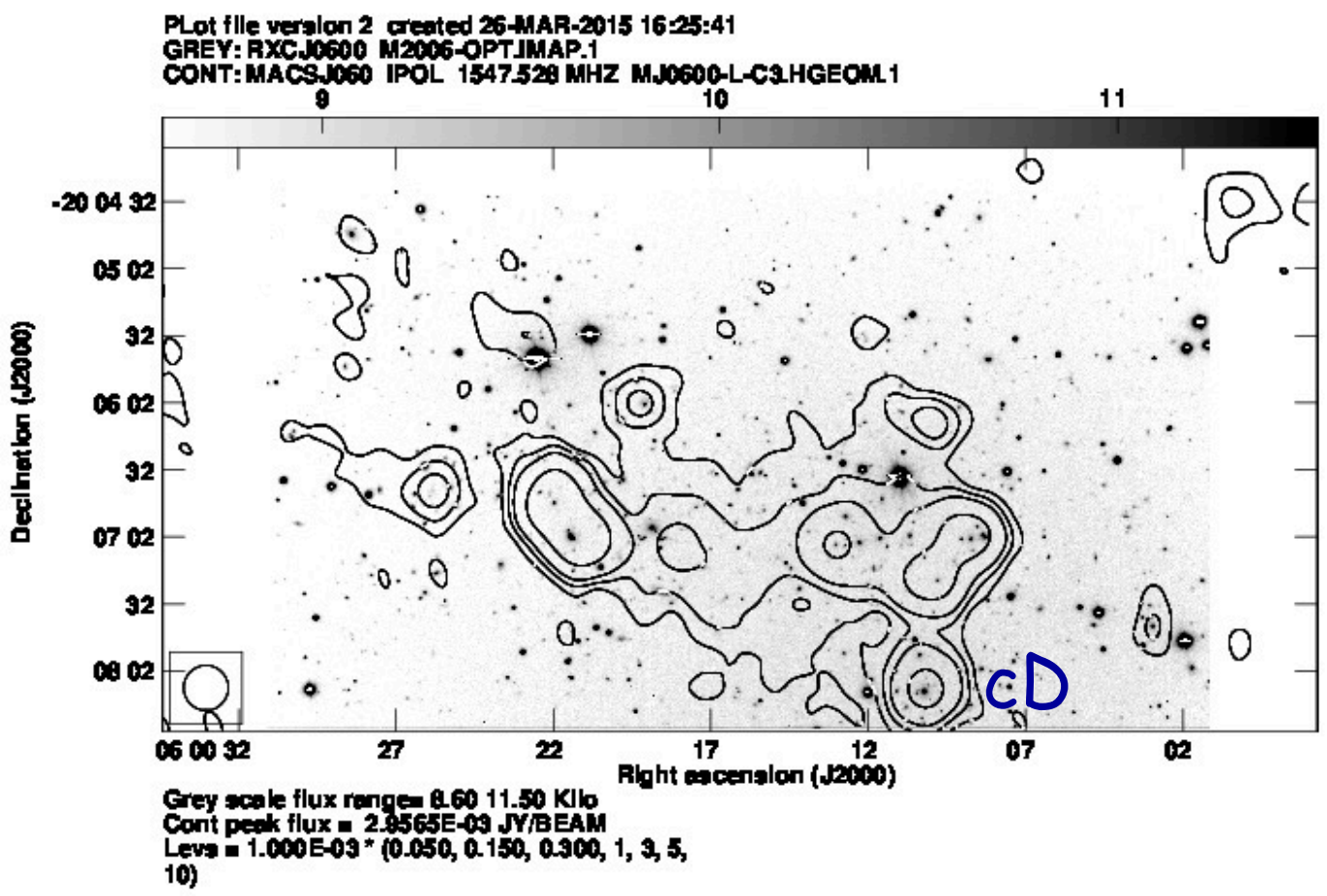
a magnetic field model with a central strength $B_0 \simeq 0.5\mu G$ which fluctuates over a large spatial scale is able to explain the presence of a polarized radio halo at a level of 15-20% characterized by a distorted radio morphology with a significant displacement from the X-ray gas distribution.

More in Girardi et al. MNRAS in press


MACSJ0600-2008
cD
z=
0.46
Radius 5'

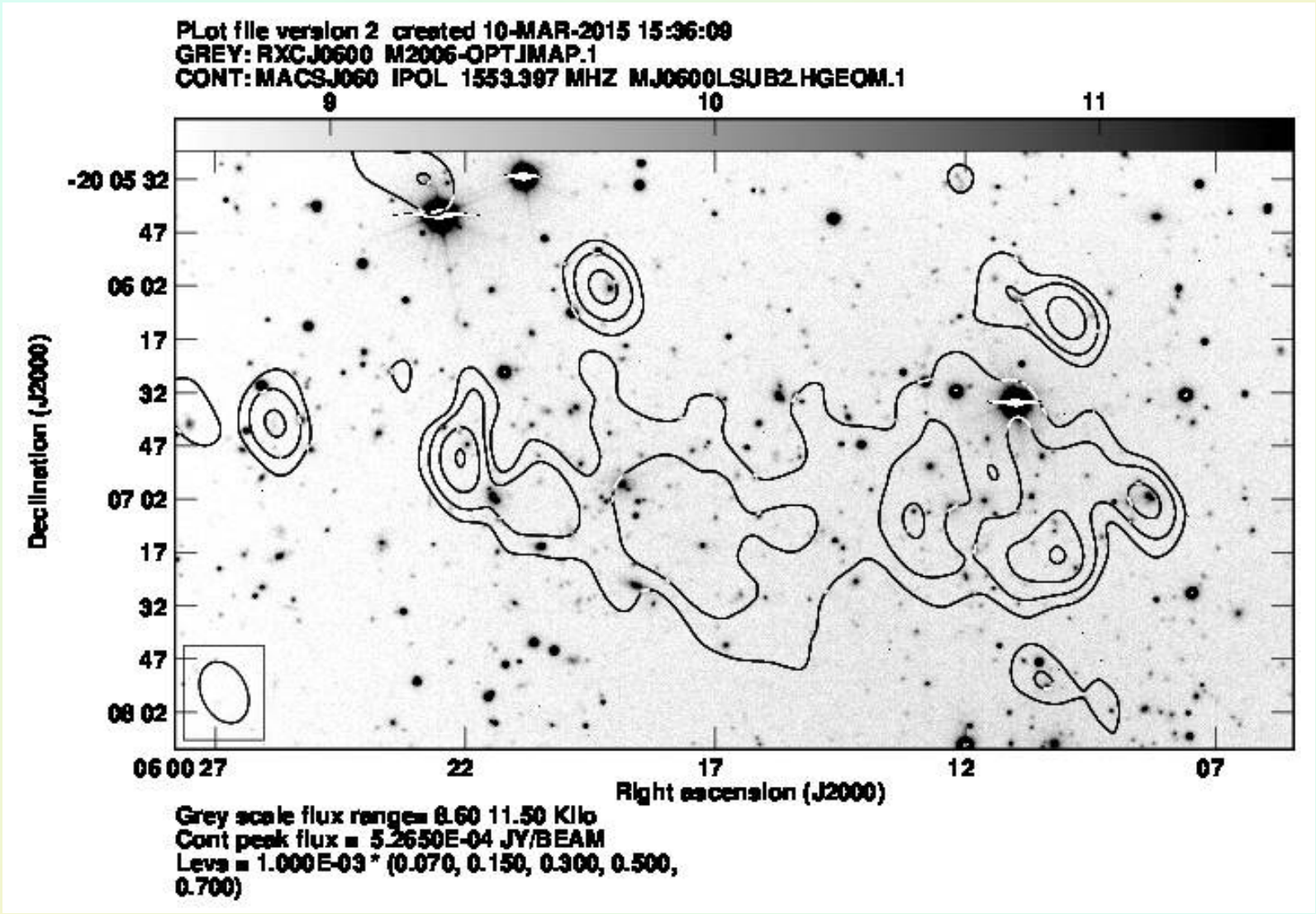


X-Ray ROSAT + radio

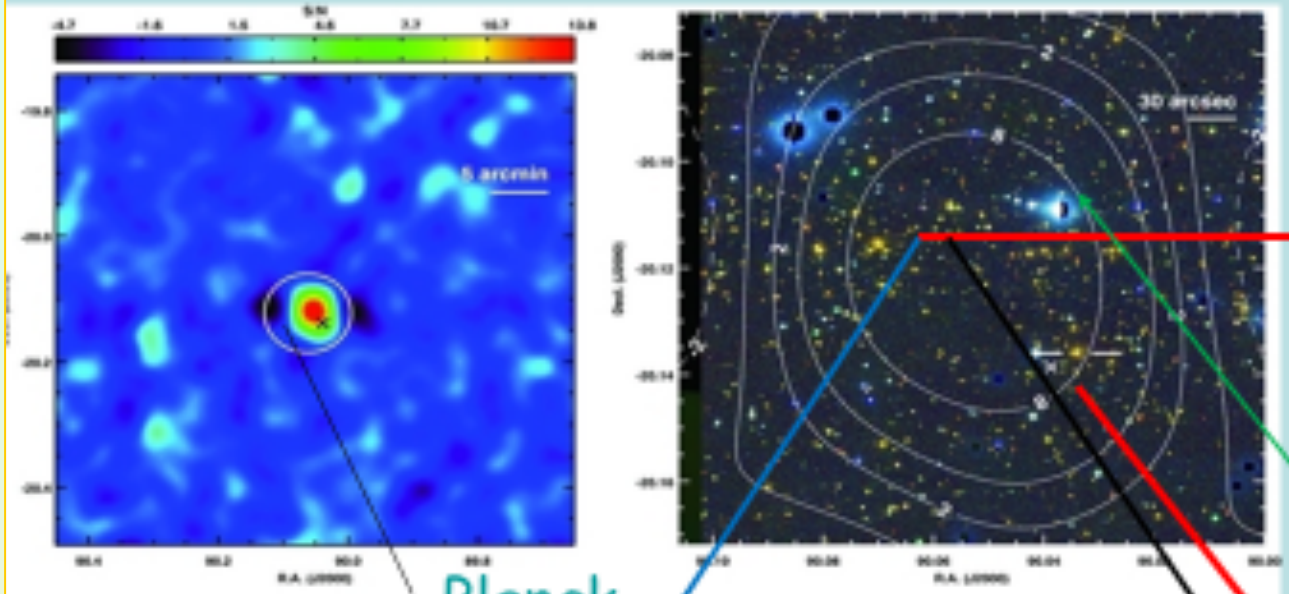


Radio + optical

Radio – optical discrete sources have been subtracted

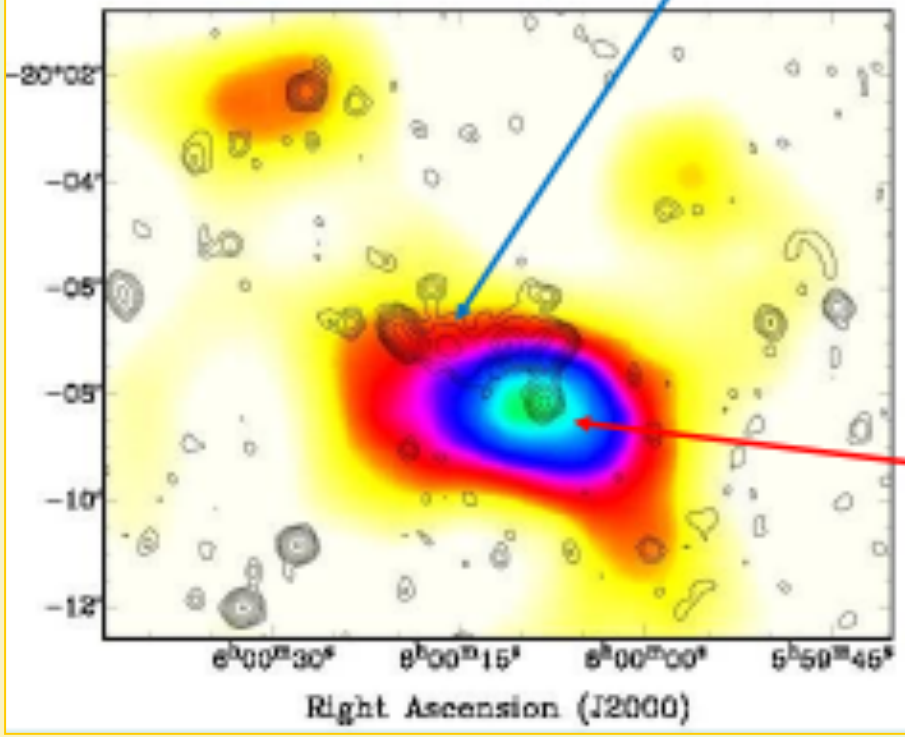


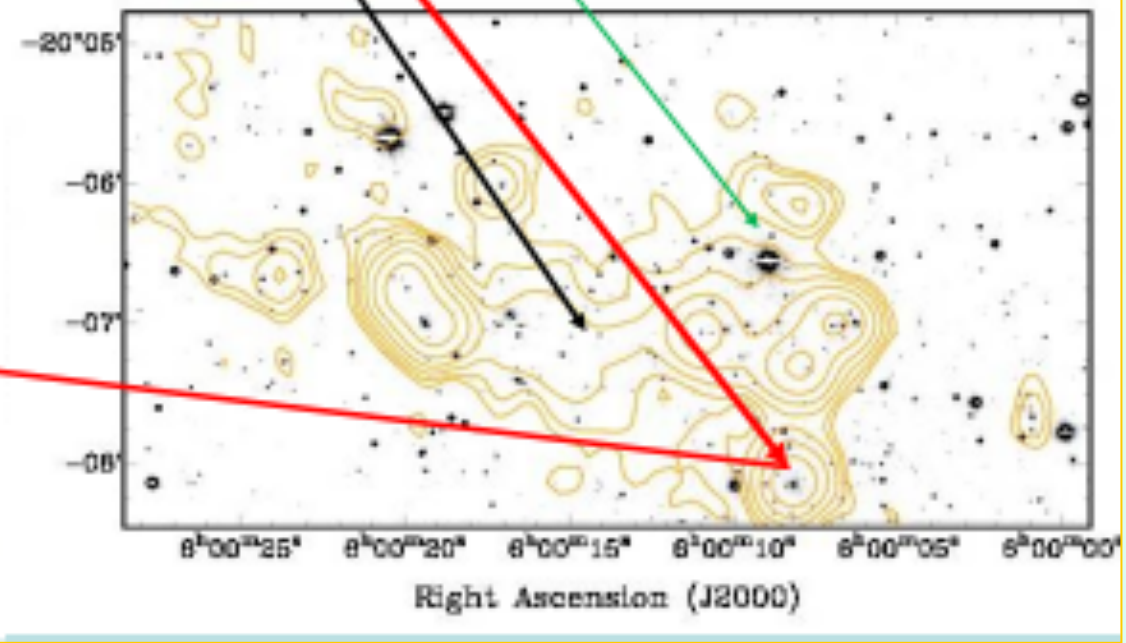
MACSJ0600
z=0.46



Optical filament

Planck





Conclusions

Diffuse extended non-thermal emission is present at larger scales with respect to classical halos:

Diffuse Halos (Coma, A2319) – Bridges (Coma, A2255) – emission outside rich clusters along merging filaments (A3411, ZwCl)

The origin of these sources can be related to peculiar conditions in filamentary merging structures with turbulence and shocks able to produce the non-thermal emission

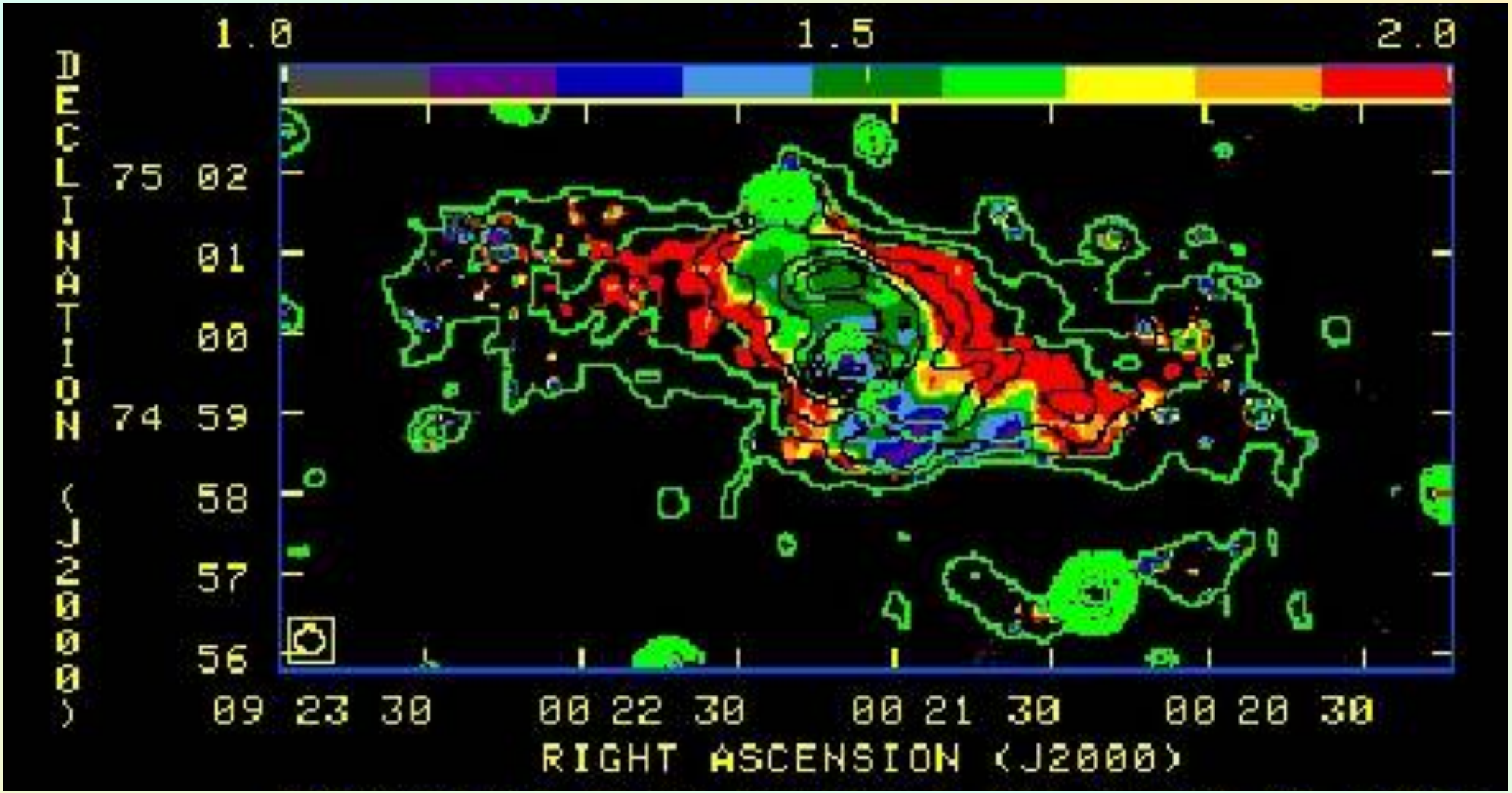
0917+75 a peculiar not yet understood source.
If it is the old emission of a radio galaxy, it could be the origin of relativistic electrons and magnetic fields in a filamentary structure (LAS as large as 2 Mpc).

A523 is a diffuse emission in between two merging clusters belonging to a large scale filament

MACSJ0600-2008 diffuse emission identified with a massive filament offset with respect to the X-Ray emission and the central cD galaxy

We need more sources…… low frequency high sensitive observations + good angular resolution


Thank



Spectral index of the radio peak coincident with the galaxy at the center: 1.1

1.3 in the surrounding region (S)

1.5 (N)

Relic radio source?

Morphology - no evidence of shocks – no Xray – central bright

missing merging clusters - polarized emission but not from a shock

Radio halo?

Elongated morhology – polarization – no Xray – central bright +

spectral index trend as in Coma C

Radio emission from a galaxy filament?

missing X-ray emission – central brighter emission –

origin relativistic particles? – high magnetic field - Cold gas?

Old diffuse emission from a dead radio galaxy?

too extended – still visible the core, but no jets – spiral structure?

morphology? Central brighter region

Electrons + magnetic fields in the filament weather

Optical inspection shows the presence of a filament of galaxies with colours in agreement with a redshift of 0.12 -- 0.13.

This filament connect nearby clusters at the same distance (Girardi et al., in progress).

A786 (z=0.124) 4Mpc	09 28 50	74 47 55
A787 (z=0.135) 5.6Mpc	09 27 22	74 26 25
A762(z=0.135) 6.3 Mpc	09 19 04	74 17 22
A748(z=0.136) 7.7 Mpc	09 16 24	75 46 31
A765(0.133) 9.9Mpc	09 20 22	73 50 12

Diffuse emission at 09 22 00 75 00 00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