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THE COMA RELIC @ 2.3GHz From Combination of SINGLE DISH AND INTERFEROMETER OBSERVATIONS

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> NON THERMAL PHENOMENA IN GC: RADIO HALOS & RELICS

- > THE COMA CLUSTER
- > THE COMA RELIC 1253+275
- COMBINATION OF INTERFEROMETER & SINGLE DISH DATA: WHY & HOW
- > FIRST RESULTS
- **FUTURE STEPS**



RADIO HALOS & RADIO RELICS

- Extended (\geq 1 Mpc) diffuse synchrotron emission
- Low surface brightness (~ μ Jy/arcsec2 at 1.4 GHz)
 - Steep spectrum $\alpha = 1.2 1.4$ (USSRH up to 2)

- Located at the centre of galaxy
 Located at the cluster periphery clusters
- Fairly regular morphology (in good spatial coincidence with the hot X-ray emitting gas)
- Radio emission unpolarized

- Variety of morphologies (elongated and arc-shaped are most common)
- High fractional polarization



RADIO HALOS & RELICS







PROPOSED MODELS FOR RELICS

• _PRIMARY / RE-ACCELERATION MODELS:

electrons accelerated by SHOCKS produced during cluster mergers via Fermi I processes (Ensslin et al 1998; Hoeft& Brueggen 2007) via adiabatic compression (Ensslin & Gopal-Krishna 2001)



CIZA J2242.8+5301

Van Weeren et al. 2010



COMA CLUSTER

First cluster where a radio halo and a relic were detected (Large 1959, Willson 1970, Ballarati et al. 1981)



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DYNAMICAL STATE OF THE COMA CLUSTER





327 MHz WSRT

Giovannini et al. 1991



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608 MHz GMRT

Giovannini et al. 1985,1991







OPEN QUESTIONS

- > What's going on there??! Is this source really the prototype of a radio relic?
- If it's a shock, what is causing it??! Is it a merger, infall or accretion shock?
- If it's a shock, which is the upstream and which is the downstream region??!
- What is getting accelerated...ICM or fossil plasma? Is NGC4789 playing a role ?







COMBINATION OF INTERFEROMETER AND SINGLE DISH DATA : <u>HOW</u>?

THERE ARE TWO BASIC WAYS TO COMBINE DATA:

> IN THE FOURIER DOMAIN

You can combine in the uv plane and then image the two data set together (COMBINE THEN DECONVOLVE) You can image the two data set separately but combine them in the uv space (DECONVOLVE THEN COMBINE)

> IN THE IMAGE DOMAIN

You can image the two data set separately and then combine them in the image plane



S. Stanimirović 1999, PhD Thesis

DECONVOLVE THEN COMBINE

CALIBRATION FACTOR

Method:

Make a single dish and interferometer map separately Fourier transform both images Weight & add them according to

 $V_{\text{comb}}(k) = w'(k)V_{\text{int}}(k) + fw''(k)V_{\text{sd}}'(k)$ TAPERING FUNCTION $\Rightarrow w'(k) + w''(k) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{\theta_{\text{int}}^2 k^2}{4\ln 2}\right)$

Fourier transform back to the image plane

The resolution of the combined image should be the same as the interferometer image and the total flux should be the same as the total flux in the single dish image



INTERFEROMETER OBSERVATIONS: WSRT @ 2.3 GHz



SINGLE DISH OBSERVATIONS: EFFELSBERG @ 2.7 GHz

COMA A 2639 MHz Total Intensity





Trasatti et al. in prep.

RESULT OF COMBINATION



WSRT

COMBINED

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RESULT OF COMBINATION

With TVSTAT == flux in each pixel

	EFFELSBERG	WSRT	COMBINED
RELIC AREA	0.2368 Jy	0.1397 Jy	0.2372 Jy
5C4.24A		0.0231Jy	0.0232 Jy
5C4.24B		0.00333 Jy	0.00376 Jy
FS1A		0.00486 Jy	0.00509 Jy
FS1B		0.00785 Jy	0.0081 Jy
5C4.31A		0.0145 Jy	0.0147 Jy
5C4.31B		0.002143 Jy	0.002143 Jy







ONGOING & NEXT STEPS

> ONGOING :

Brightness profile of the relic Polarization map of the relic Total intensity map of the halo (9 pointings...)

> NEXT STEPS :

Spectral index study across the relic

2.3 GHz : COMBINED WSRT+EFFELSBERG 1.4 GHz : VLA (C&D conf) from Giovannini et al. 1.4 GHz : EFFELSBERG from Fuerst et al or GBT from Brown & Rudnick 350 MHz : WSRT from Brown & Rudnick Do the same for the halo

CONCLUSIONS

Although the coma relic is known since decades, we still don't know the origin;

Through multiwavelenght observations of such sources we can constrain the spectrum of the emitting particles and so put different models to the test;

Combination of interferometric data with single dish data provide both the high resolution of the interferometer and the short-spacing information of the single-dish observations.

THANKS

