Durham University

Towards Understanding BCGs: HI Absorbers and Highly Inverted Radio Sources

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DEX VIII 12/01/12

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Outline

BCGs: Why do we care?

Highly Inverted Radio Sources: When the core gets active?

HI Absorbers: Attempting to trace the accreting material to the centre

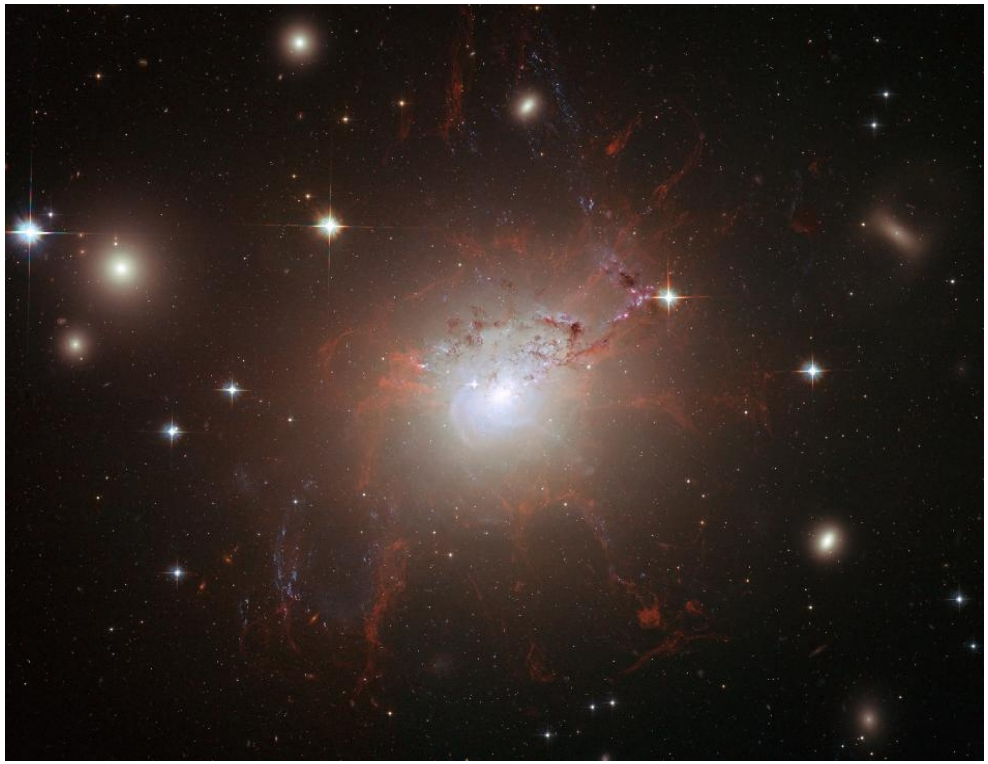
Brightest Cluster Galaxies: What's the Fuss?

AGN Feedback has been a hot topic over the last few years.

Feedback needed to offset cooling and explain the deficit of cold, molecular gas in cluster cores.

Growing acceptance that the AGN in the BCG within rapidly cooling cores is always 'on', just spends a lot of time at a 'quiescent' level too low to counteract cooling.

Want to know the power output of the BCGs across its duty cycle and across the spectrum to better constrain the energy available for heating cluster cores.



NGC1275: Nasa Image of the Day archive:
http://www.nasa.gov/multimedia/imagegallery/image_feature_1833.html

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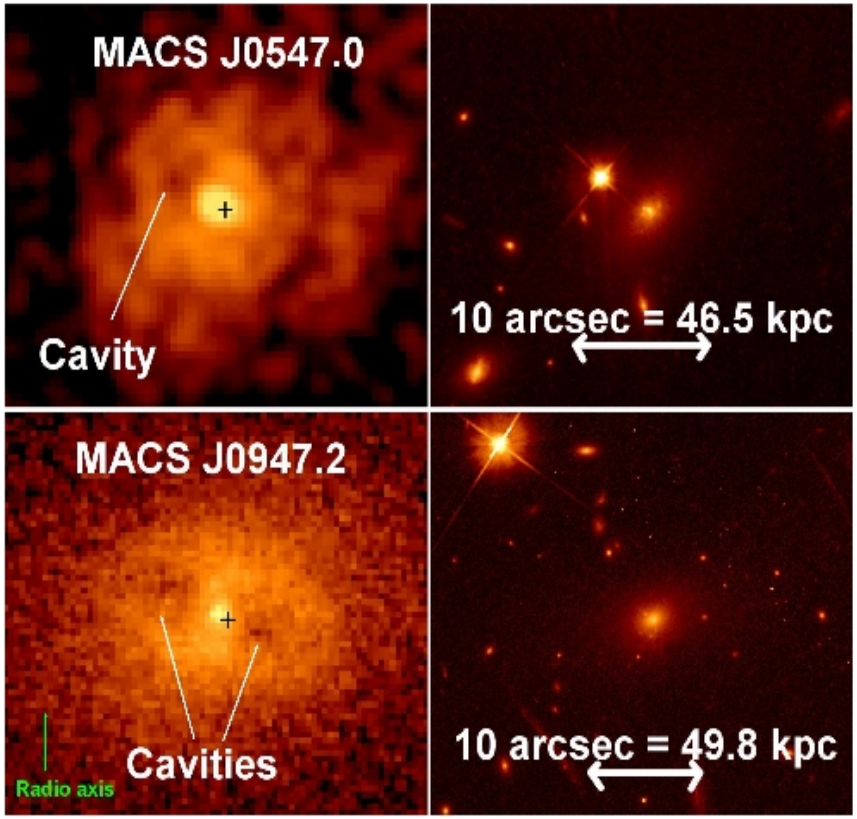

Section of Fig. 2, Hlavacek-Larrondo et al, 2012 (accepted by MNRAS)

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	Detected	Not Detected
L	9	0
C	36	3
X	25	0

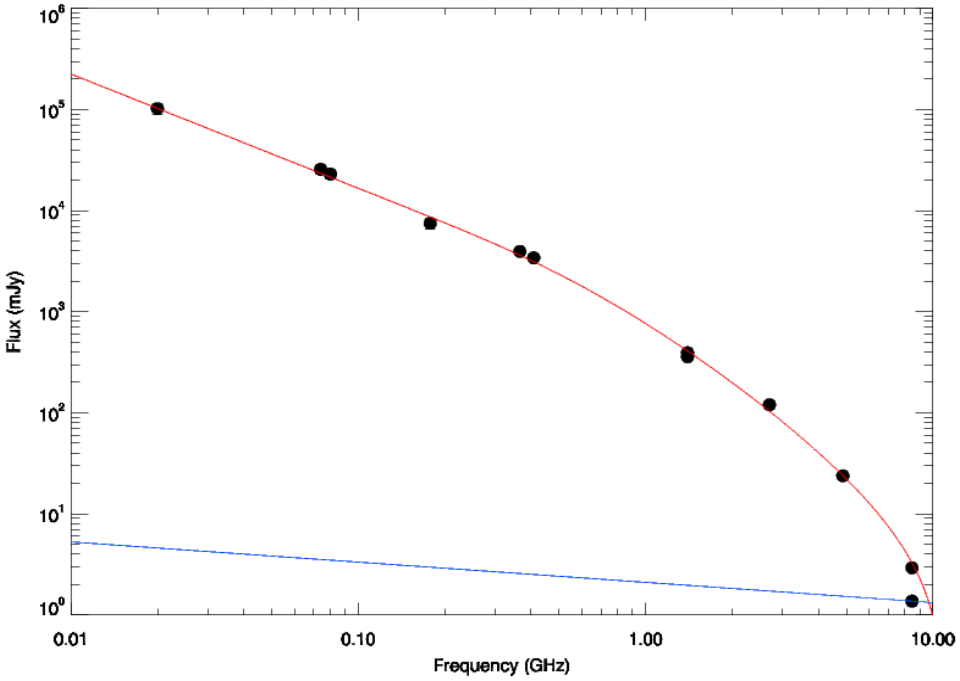
VLA radio BCG detection rate for subset of observations of clusters that are known to exhibit line emission (cool core) clusters

	Detected	Not Detected
L	-	-
C	39	6
X	37	8

ATCA radio BCG detection rate for observations of line emitting (cool core) clusters

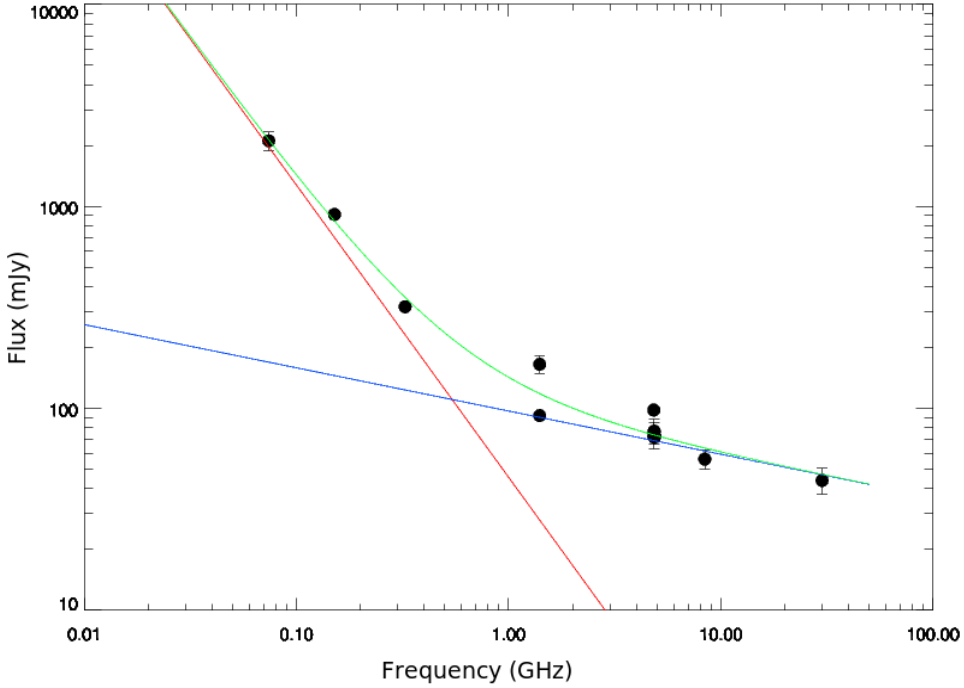
Separating the Core from the Diffuse Emission

Z808



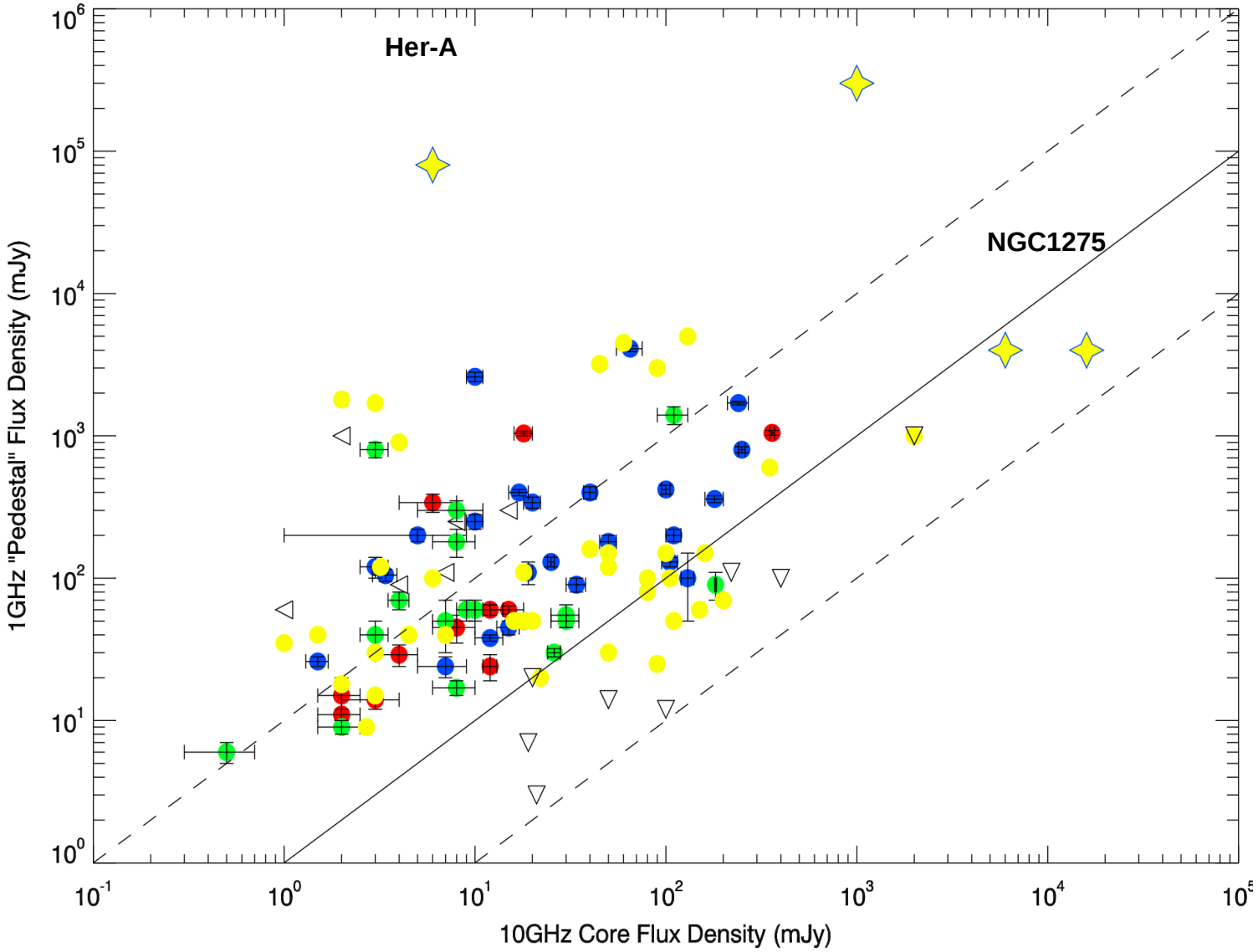
Clearly resolved, extended emission with a distinct core.

Z8276



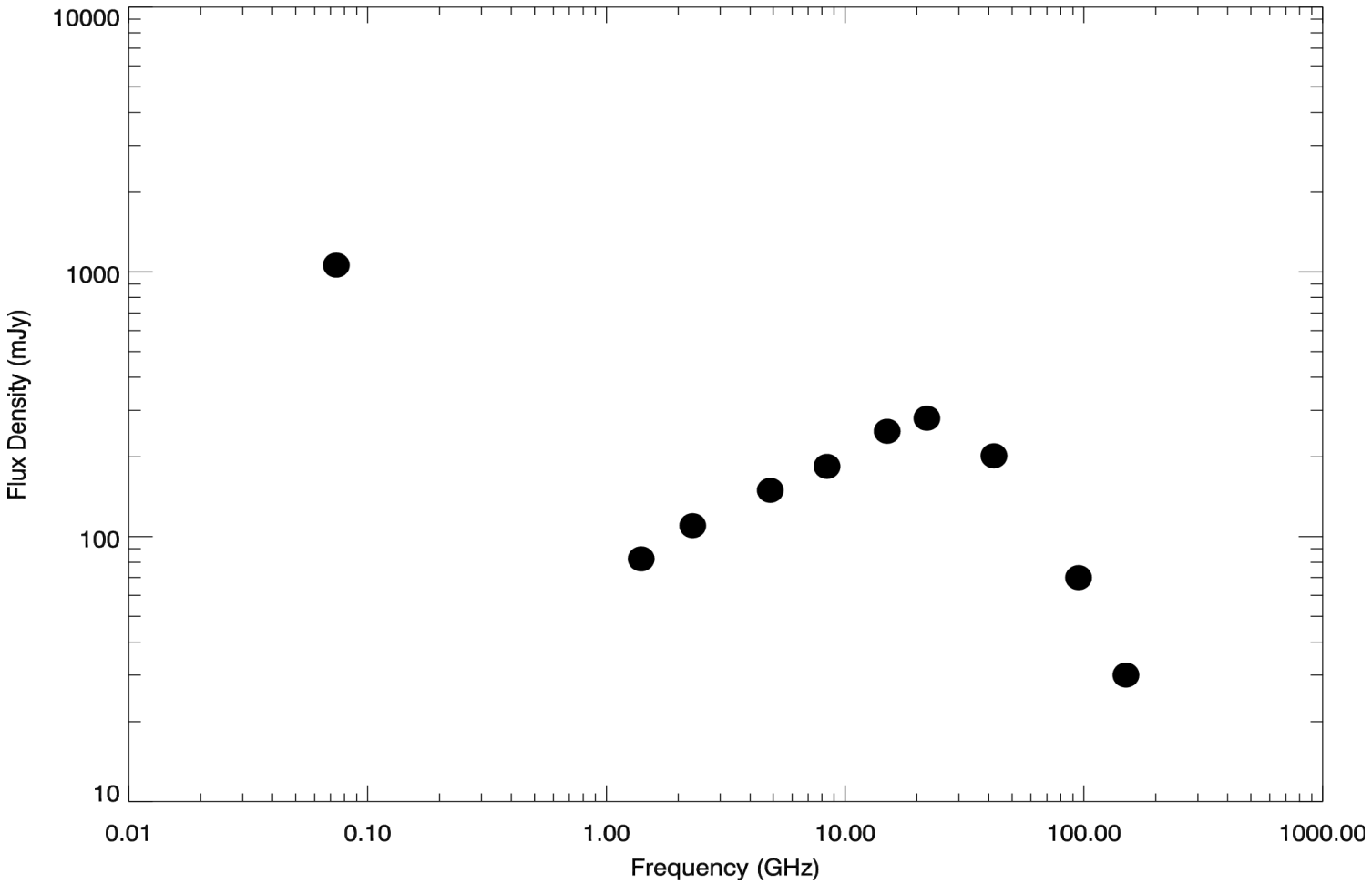
Unresolved flat-spectrum core at higher frequencies with a steep-index diffuse emission component seen at low frequencies.

Varied Population

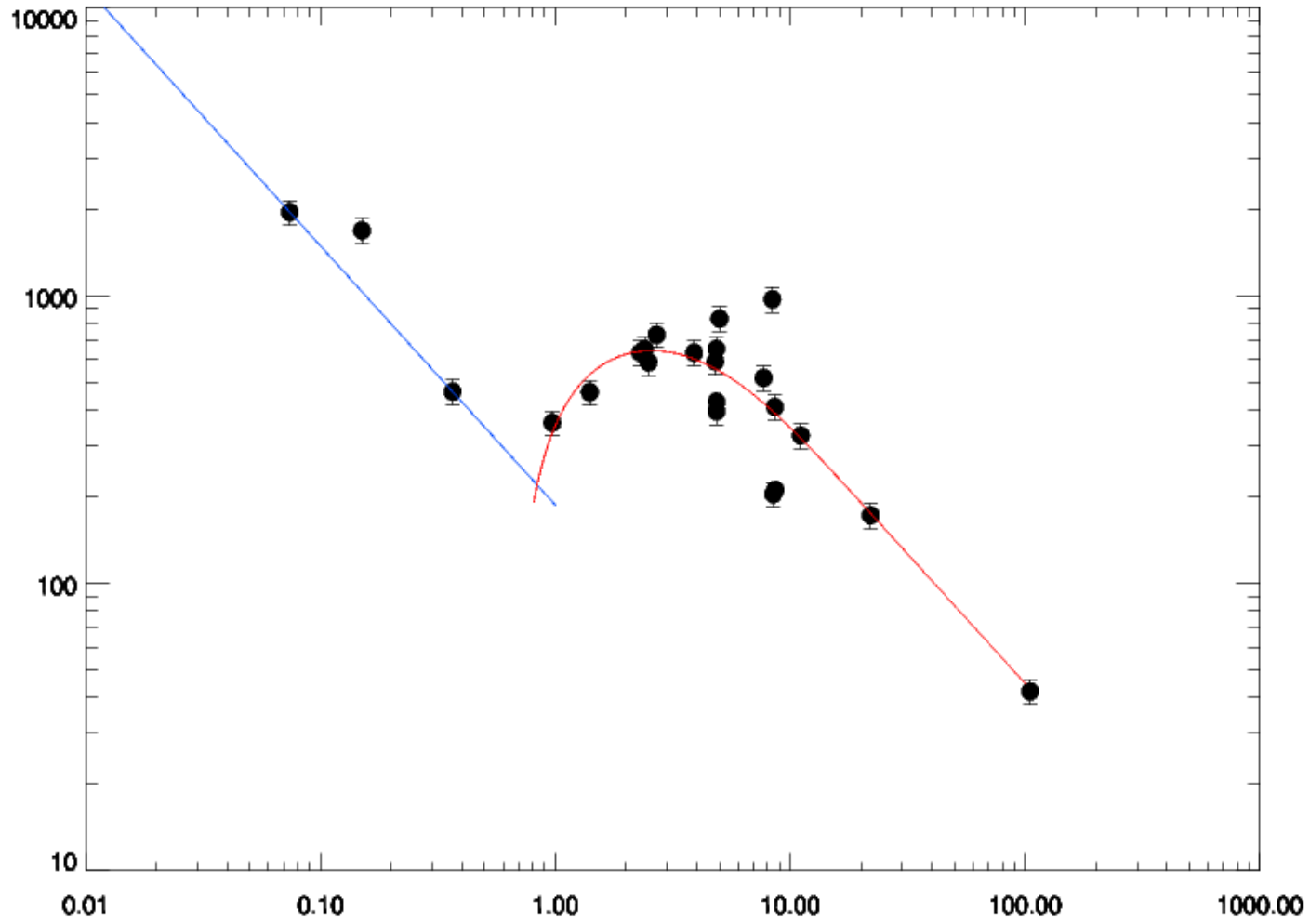


Wide variety of spectral types observed – FRI, FRII, CSS, GPS

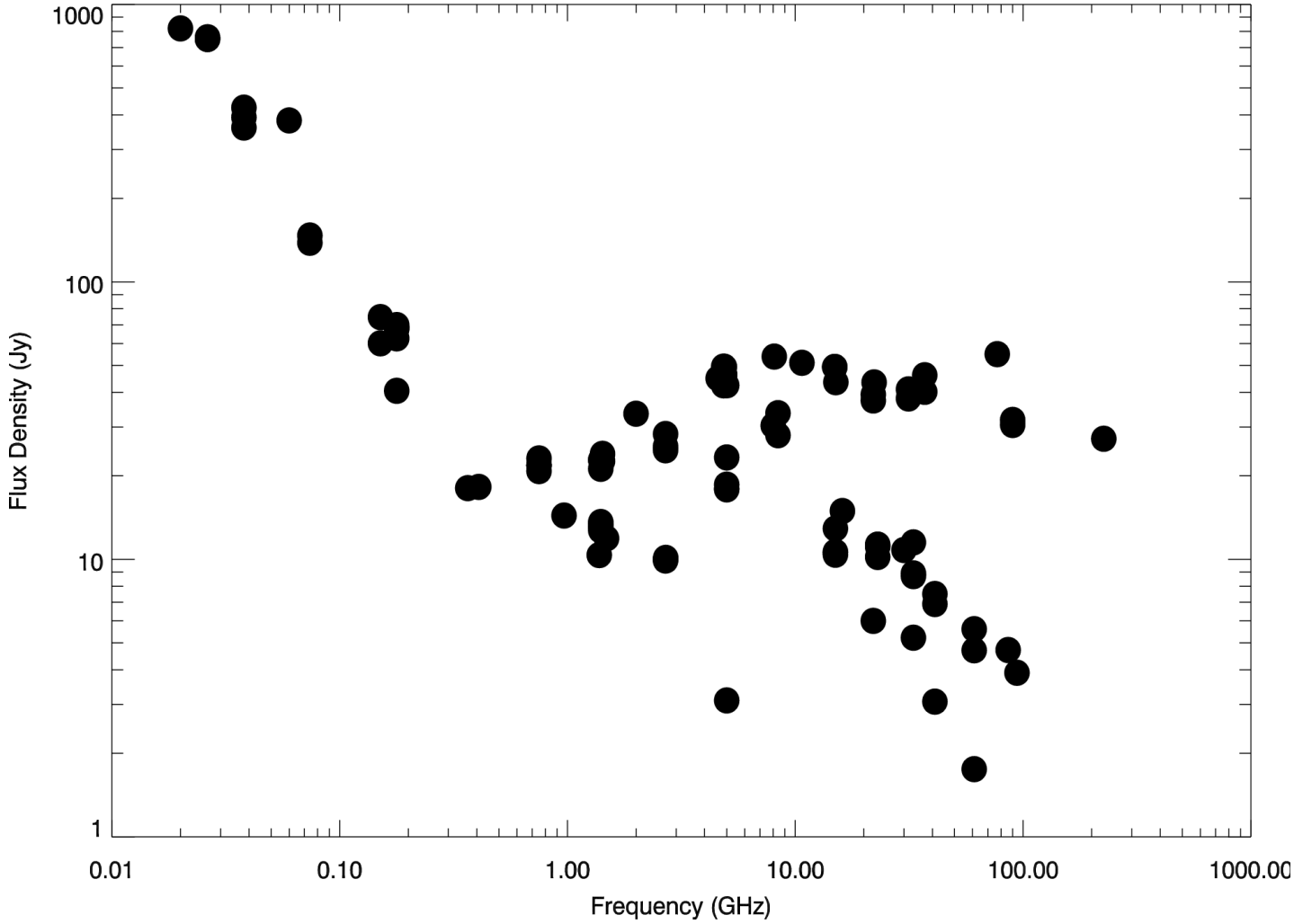
RXCJ0439.0+0520



RXCJ1558-14 / PKS1555-140



NGC1275 / 3C84



Peaked Radio Sources

Require a statistically robust sample of these high-frequency peaked sources.

Get the higher frequency radio LF to determine the energy output of BCGs at these frequency.

SED breakdown to allow separate LF for the cores and diffuse emission.

Quantify the level of contamination of S-Z surveys from weaker, flat spectrum sources in the BCGs.

Much better than extrapolating fluxes from 1.4GHz to ~20GHz with a constant spectral index...this clearly wont always give a good estimate!

Peaked Radio Sources

Awarded time to observe 42 flat/inverted radio spectrum BCGs with GISMO 2mm(150GHz) on the IRAM 30m.

Core is variable by nature.

Support by near-simultaneous observations using AMI (15GHz). Applications in to additionally observe with CARMA (90GHz) and ATCA (20-40GHz).

Planck* should detect the bright end of the LF for these objects *(see Planck Collaboration 2011, A&A, 536A, 14P).

Deeper, targeted campaign should have the corresponding faint end ready for time of Planck data release in late 2012.

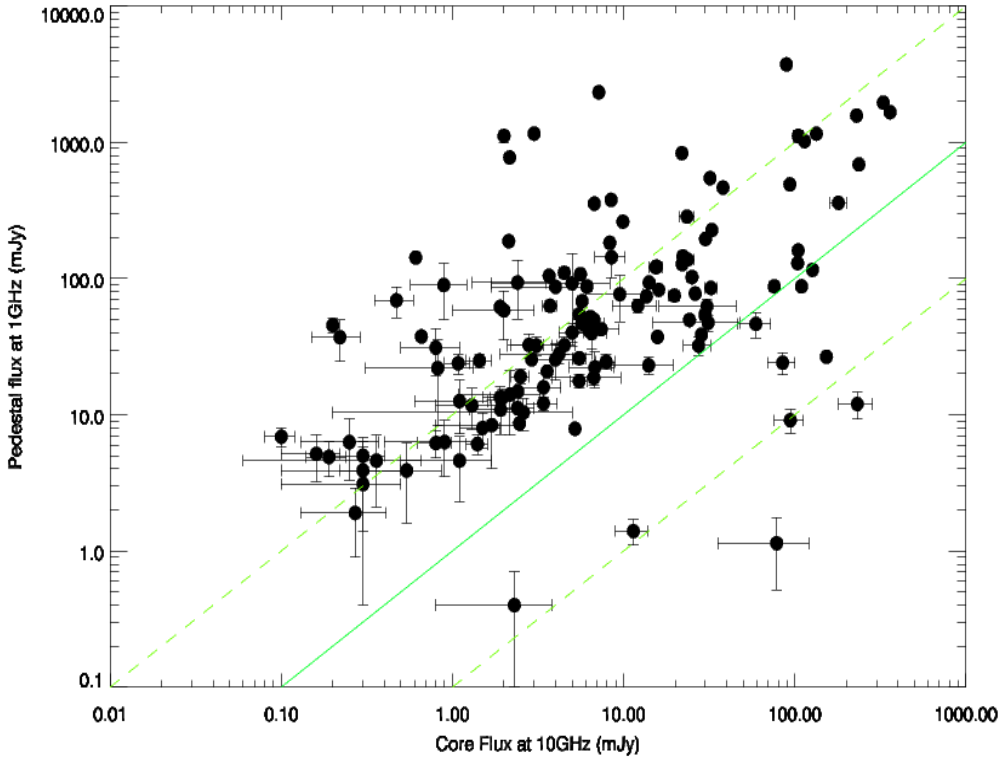
HI Absorbers

Probe cooled gas close to the central AGN.

Gas is clumpy - expect wide variety in detected column densities between sources and variety of profile shapes.

Four well known literature detections (Cyg-A, Hydra-A, Perseus-A, A2597)

Need a consistent sample of similar sources to determine the population average dynamics of this gas – the high frequency peaked sources provide the best targets for this campaign.



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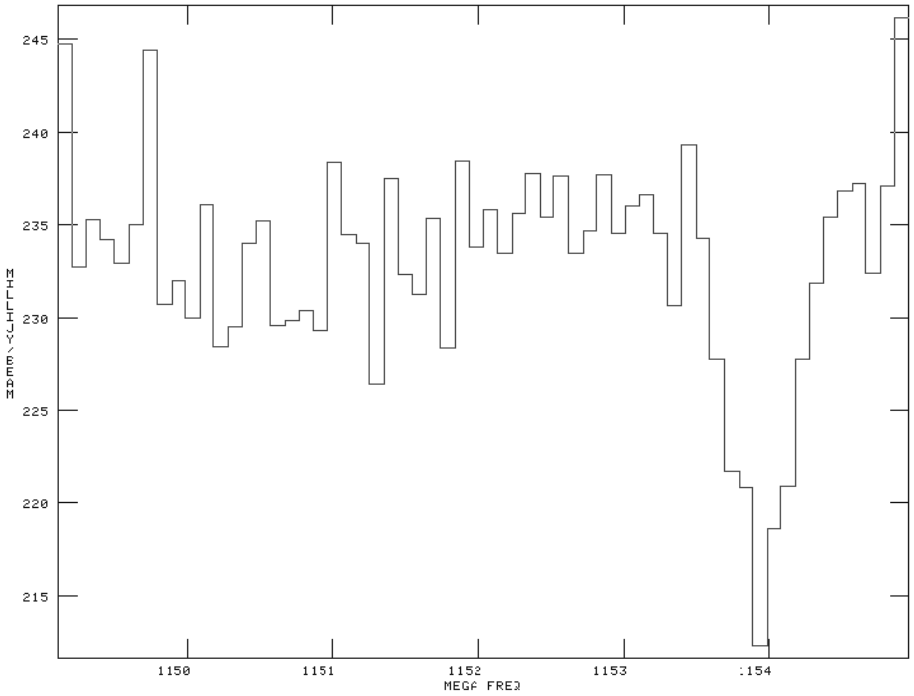
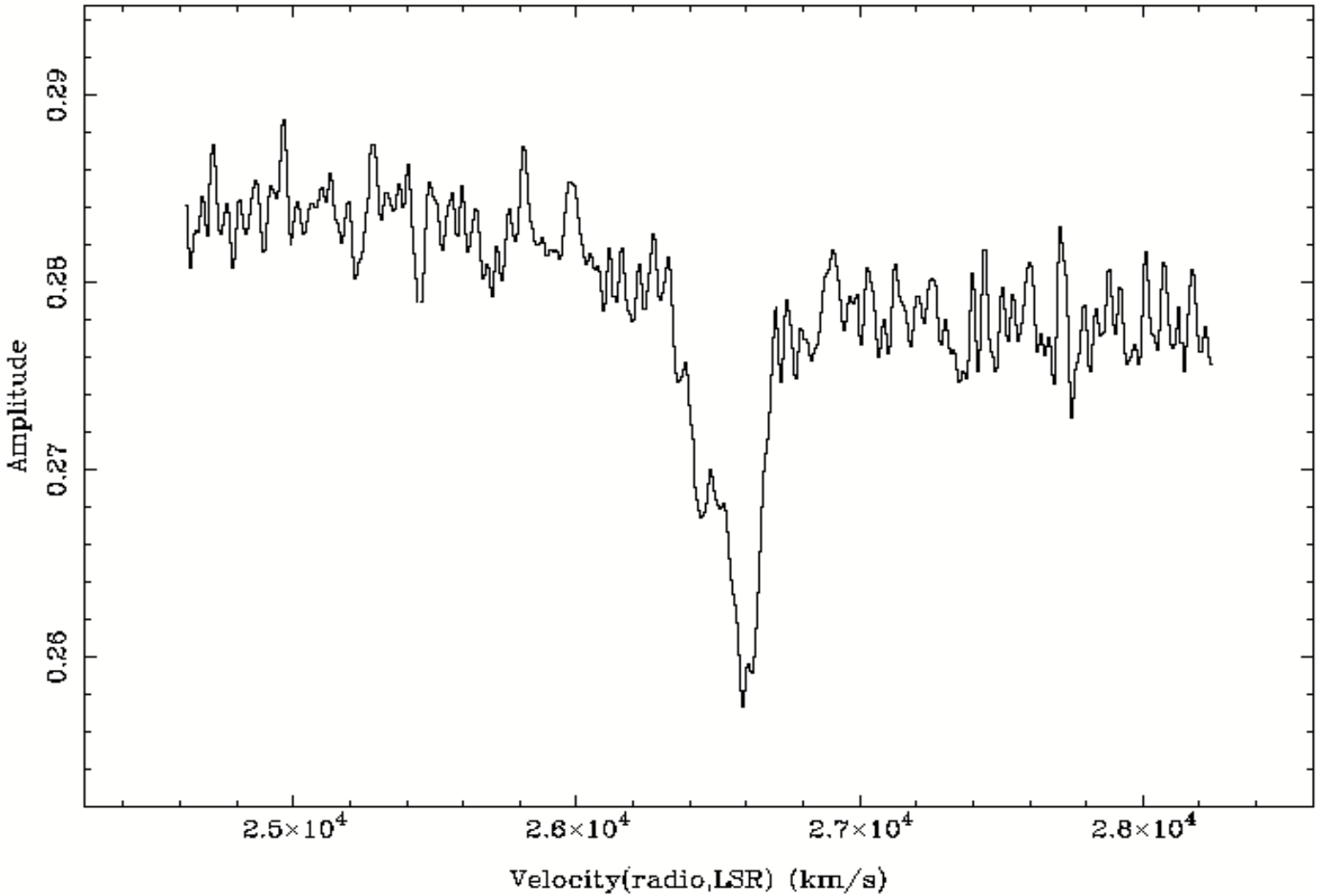


HI absorption trough against A2390

HI Absorbers: RXJ1558-1410



HI Absorbers

Ongoing campaign using the WSRT and ATCA

ATCA: 1x detection, 3x upper-limit

WSRT: 3x detected, 3x undetected (although RFI affected), 2x pending

Plus the additional 4x detections from the literature.

Early results tentatively support the material being out-flowing (5/8 blueshifted, 1/8 redshifted, 2/8 no shift relative to BCG).

Require larger sample to properly characterise the average velocity distribution of the gas.

Summary

- **AGN feedback required to explain the deficit of cold, molecular gas in cluster cores**

- **Radio analysis of BCGs complicated by presence of nuclear core component**

- **Need to observe higher radio frequencies to consider these inverted sources to better constrain energy available from the BCGs to suppress cooling.**

- **HI absorption against compact cores is the best probe of the gas near to the central black hole.**