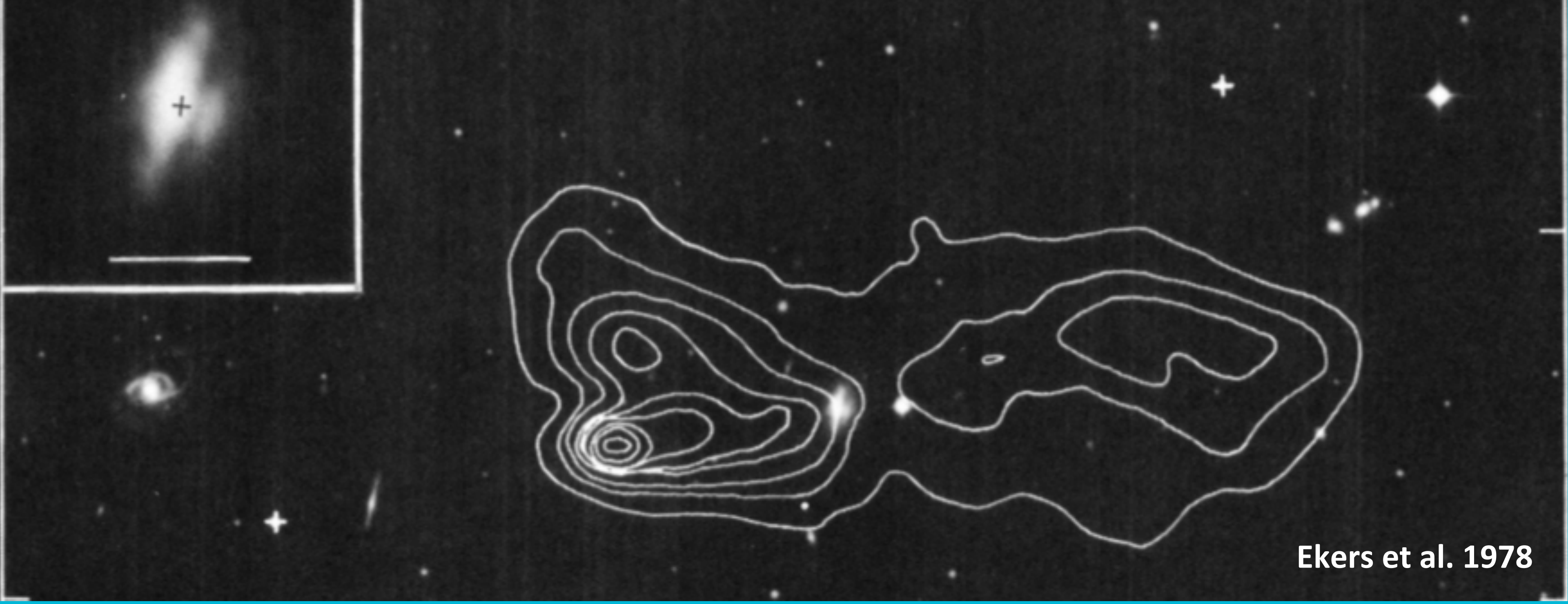

Ekers et al. 1978

The environmental impact on the powerful radio galaxy NGC 612

Julie Banfield
Shane O'Sullivan (University of Sydney)
Bjorn Emonts (CSIRO Astronomy and Space Science)

Active Galactic Nuclei (AGN)

- AGN are becoming recognised as the ***KEY*** element in the galaxy evolution process.
- ***BUT*** how do AGN and galaxy evolution link together?

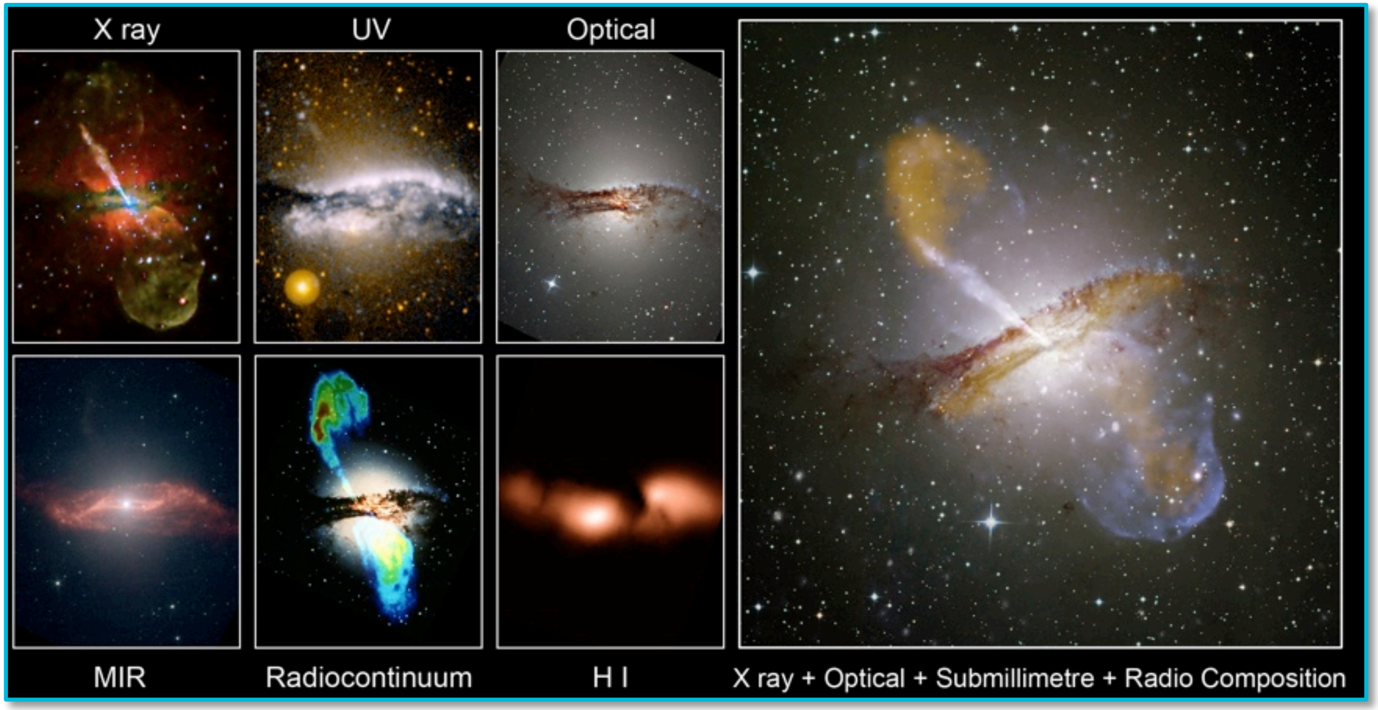
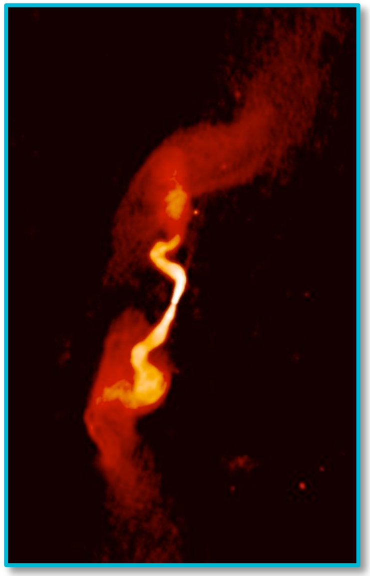
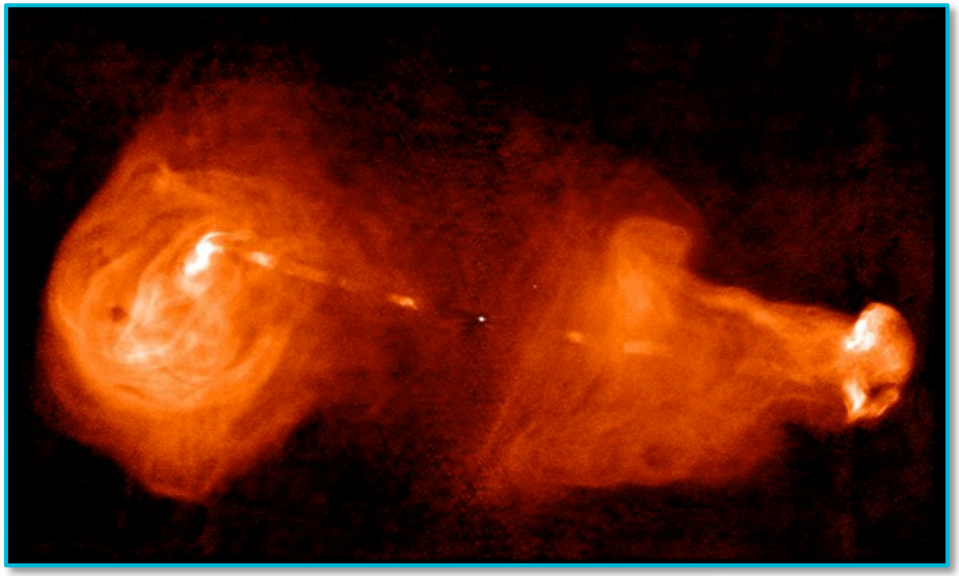
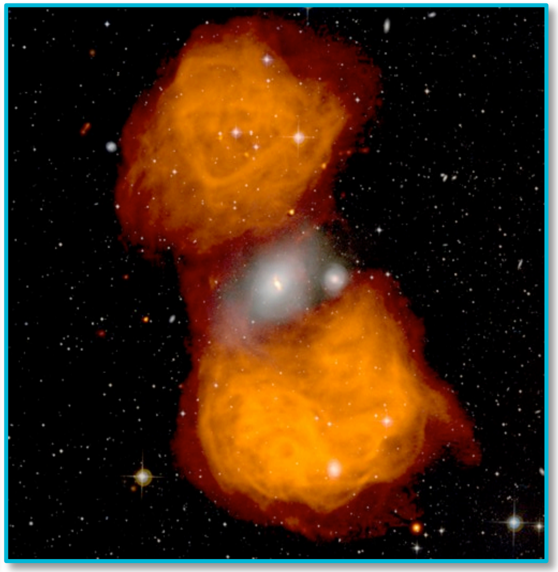
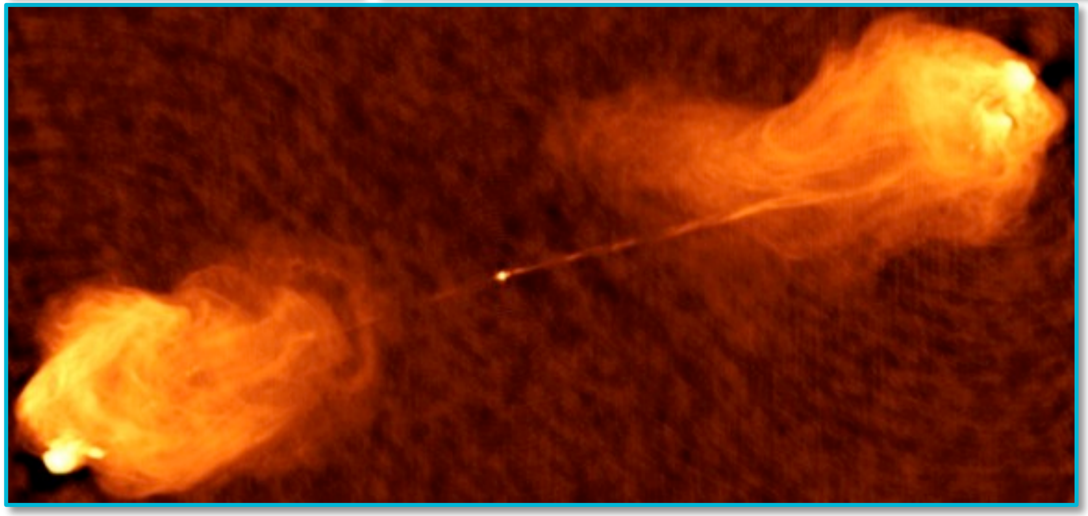
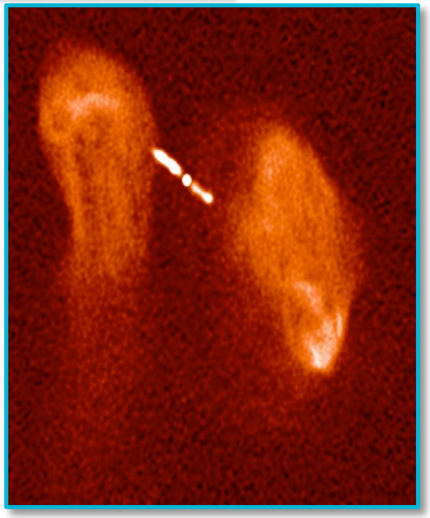


Image by Angel R. Lopez-Sanchez

Active Galactic Nuclei (AGN)

Images courtesy of NRAO/AUI

Active Galactic Nuclei (AGN): FRII

- Fanaroff & Riley (1974)

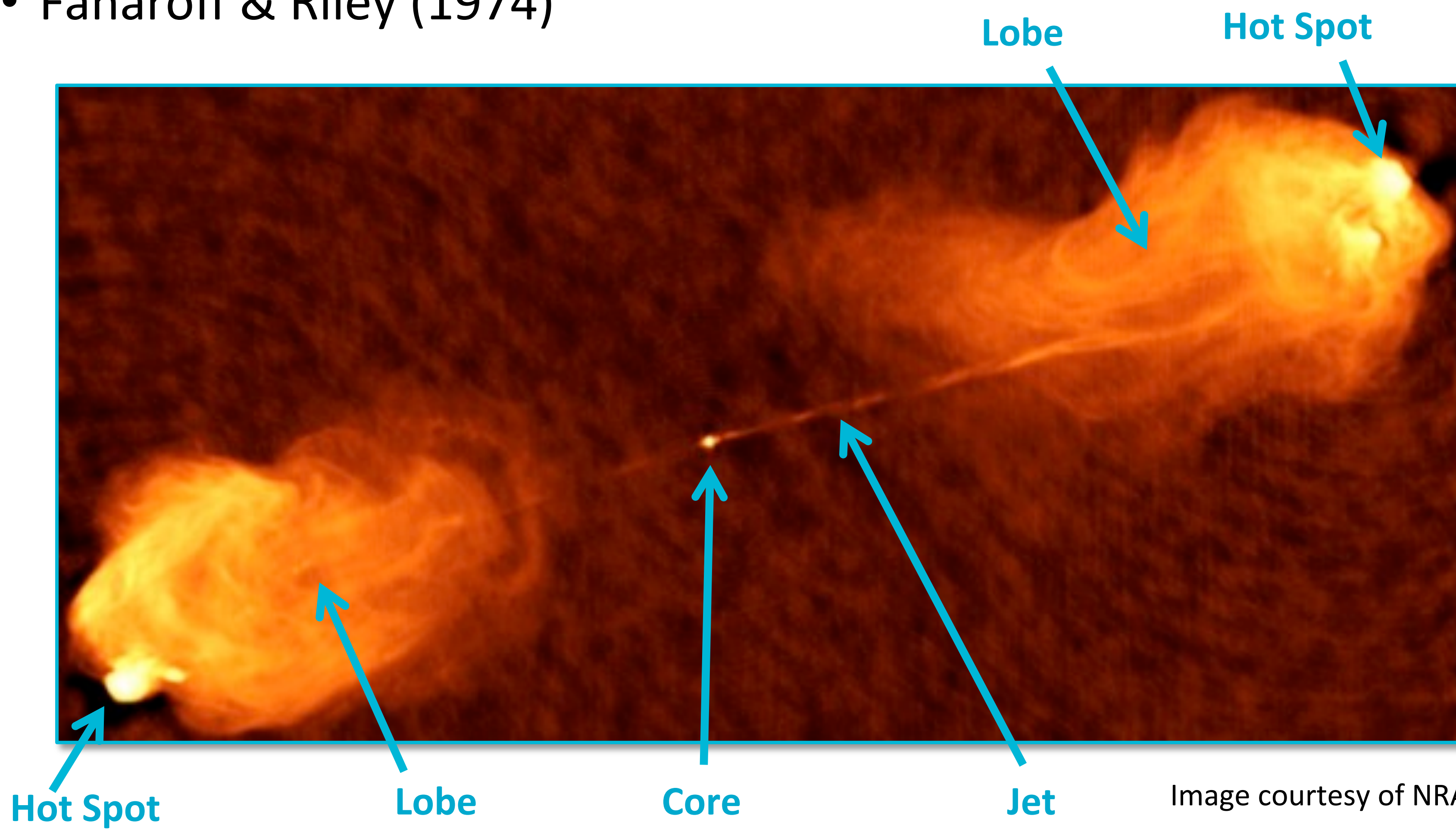


Image courtesy of NRAO/AUI

Active Galactic Nuclei (AGN): FRI

- Fanaroff & Riley (1974)

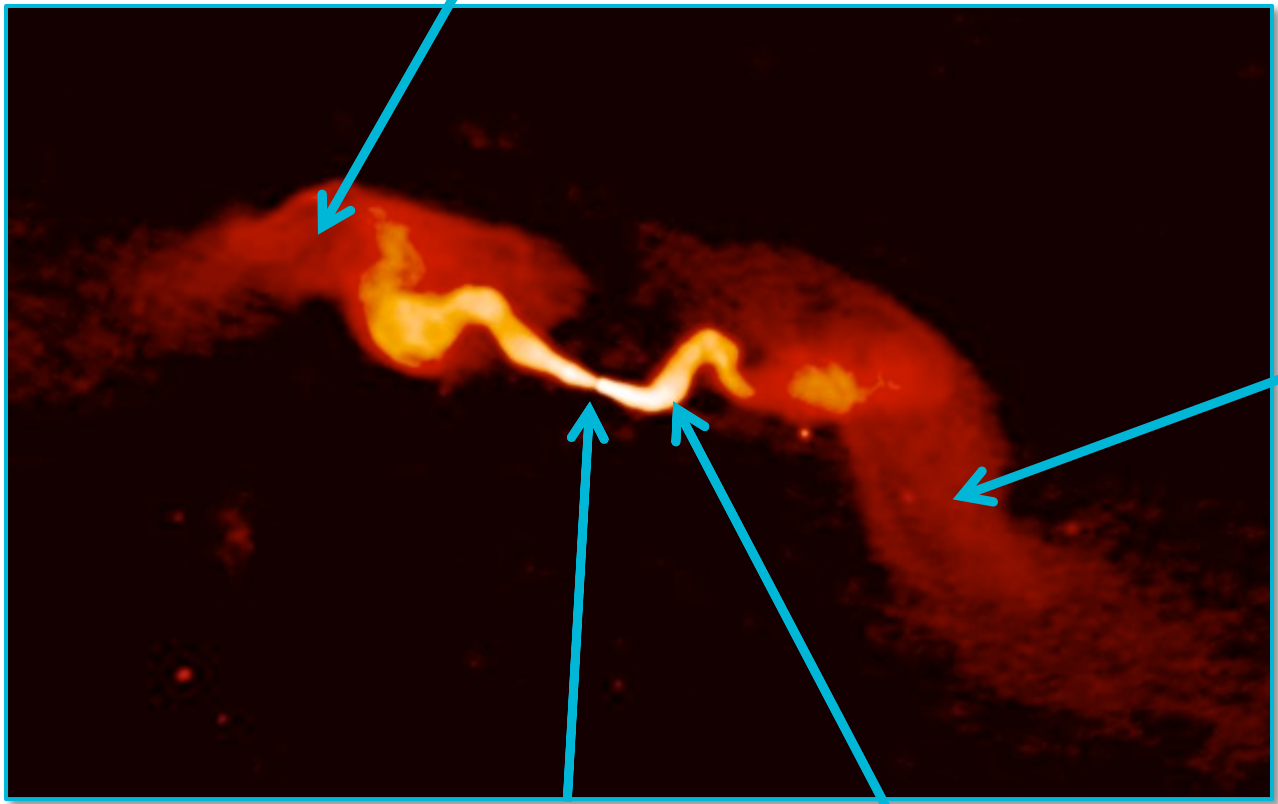
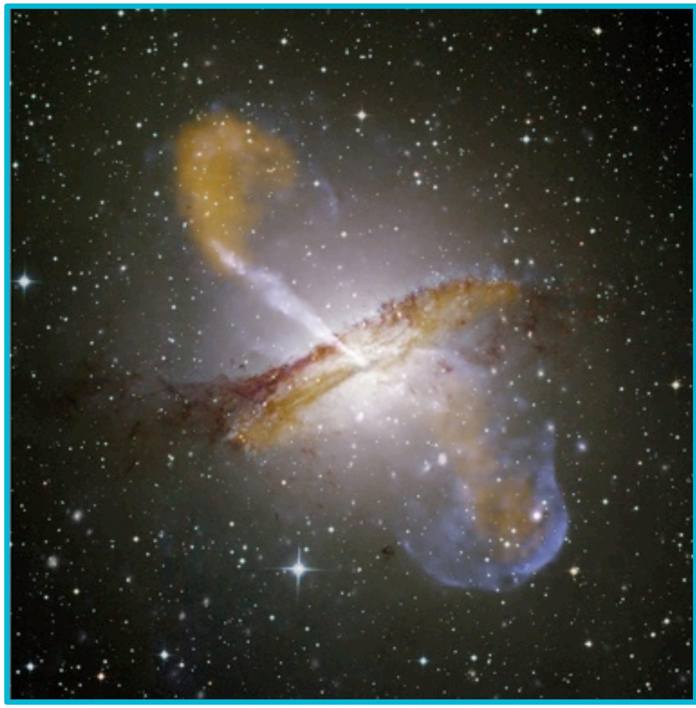
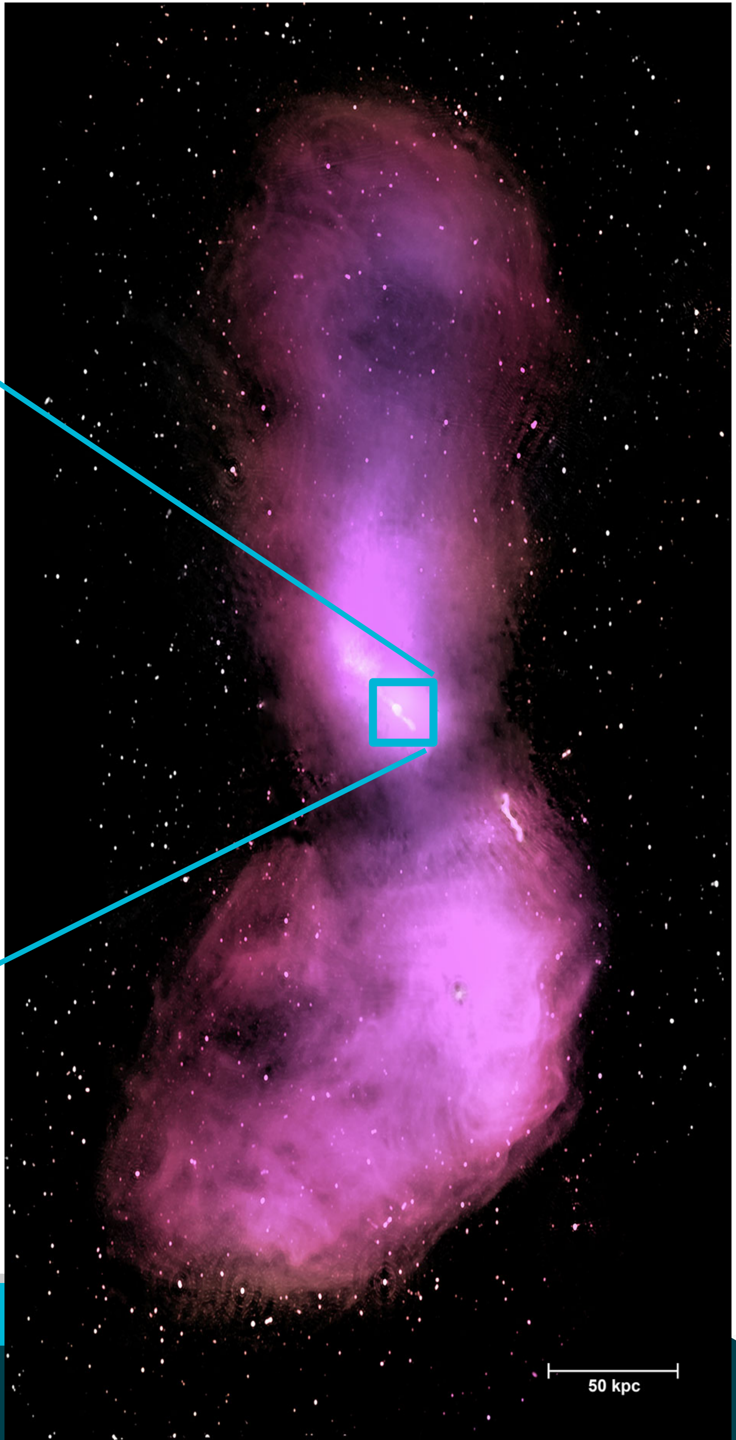


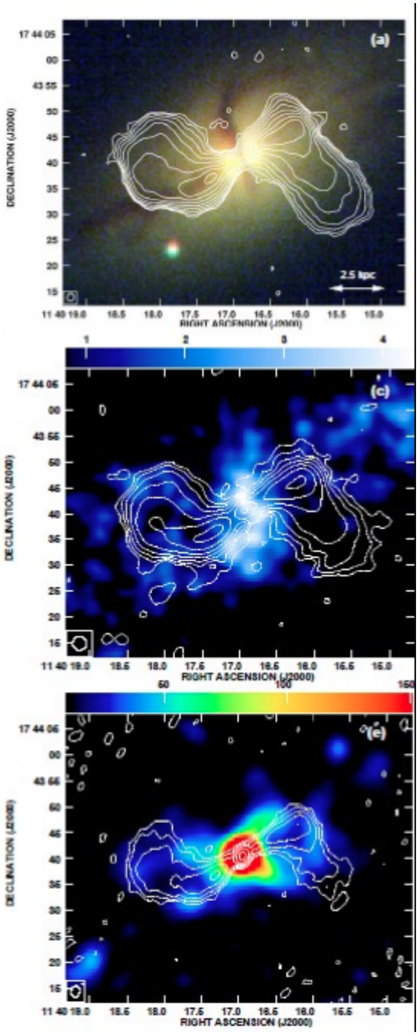
Image courtesy of NRAO/AUI





Courtesy of Ilana Feain

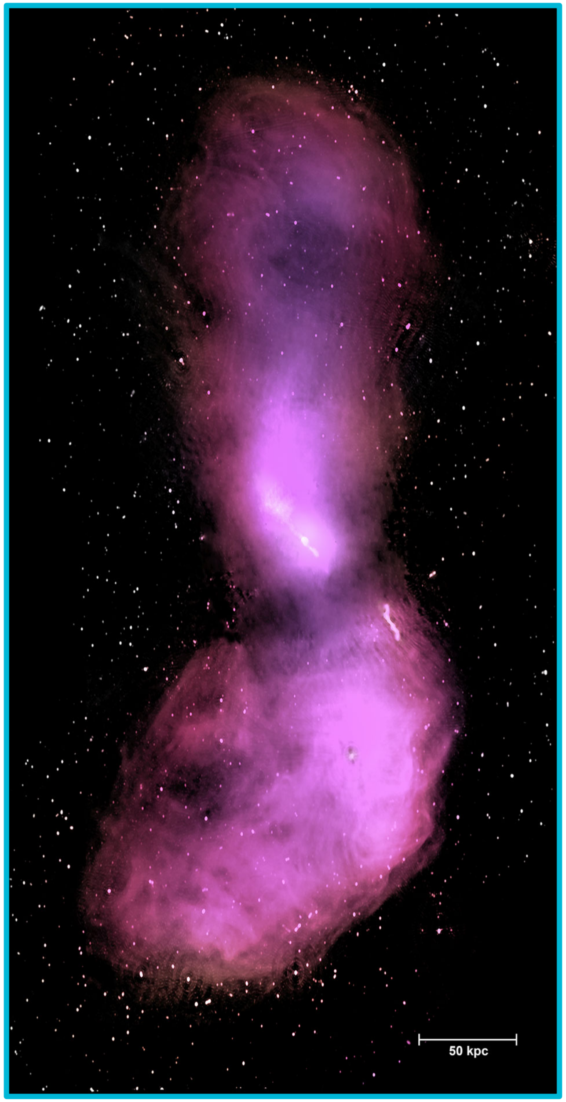
What we think we know



- Large-scale environments are made up of dark matter halos and hot gas (Croston et al. 2013).
- Feedback during the AGN phase plays an important role in moderating galaxy formation and evolution (Croton et al. 2006; Cattaneo et al. 2009).
- Galaxy interactions can trigger an AGN by driving gas into the central region (Shlosman et al. 1990; Haan et al. 2009; Liu et al 2011).
- Enrichment of the IGM with heavy elements.
- Radio galaxies can halt the infall of cool gas in galaxy clusters (Fabian et al. 2006).

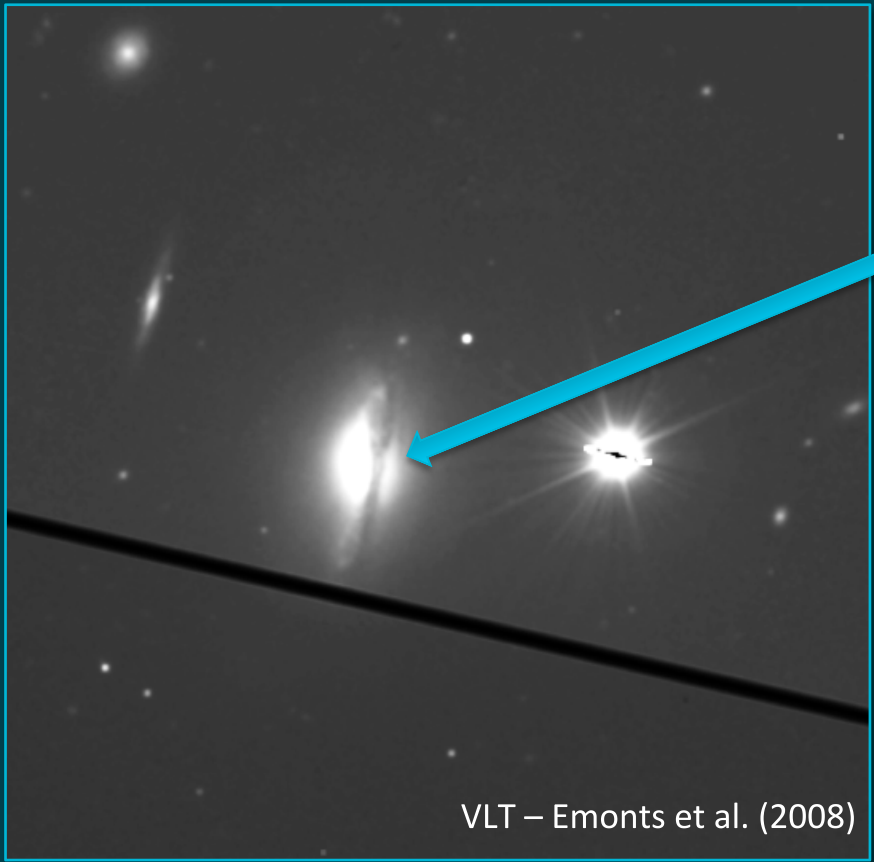
Important things we need to know

- Role of powerful radio galaxies and how/if it changes with redshift.
- Global properties of radio galaxies and global properties of group/cluster gas.
- AGN feedback evolution
- The relationship between luminosity, morphology, size with energy impact. Redshift dependence?



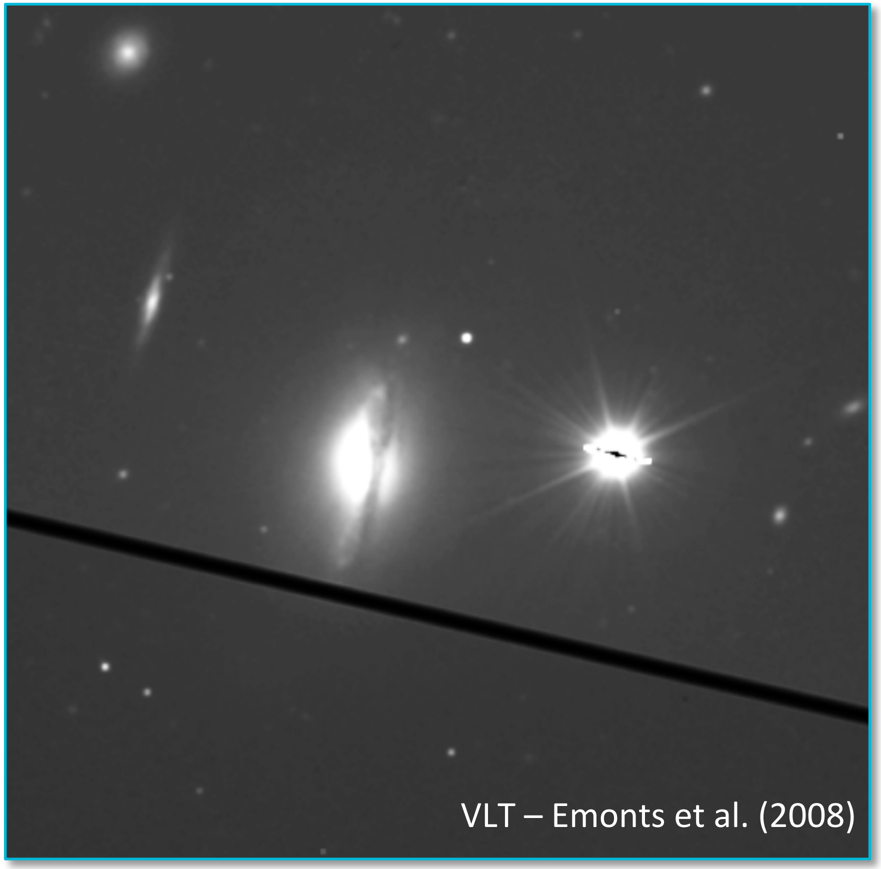
Feain et al. 2011

Our Project:

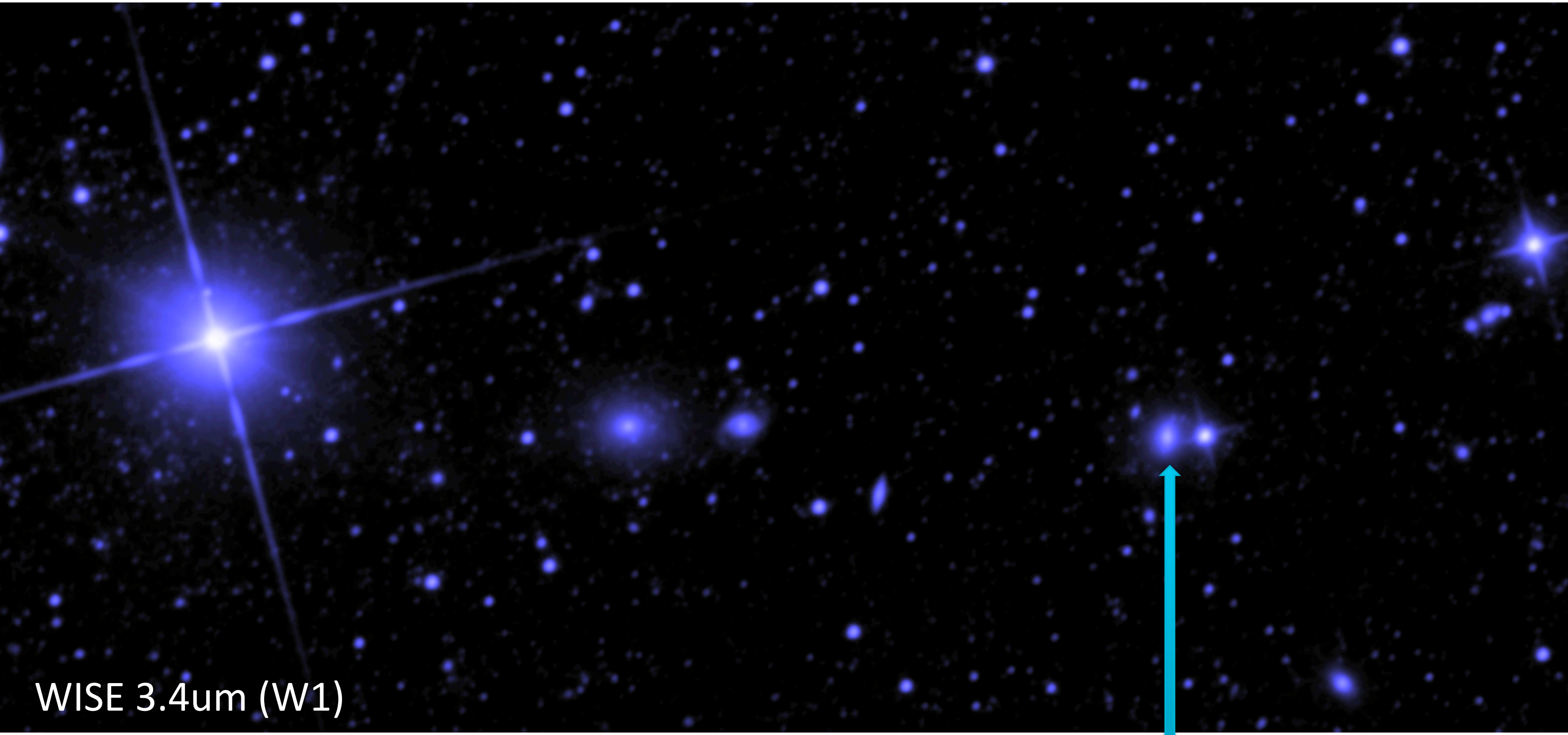


VLT – Emonts et al. (2008)

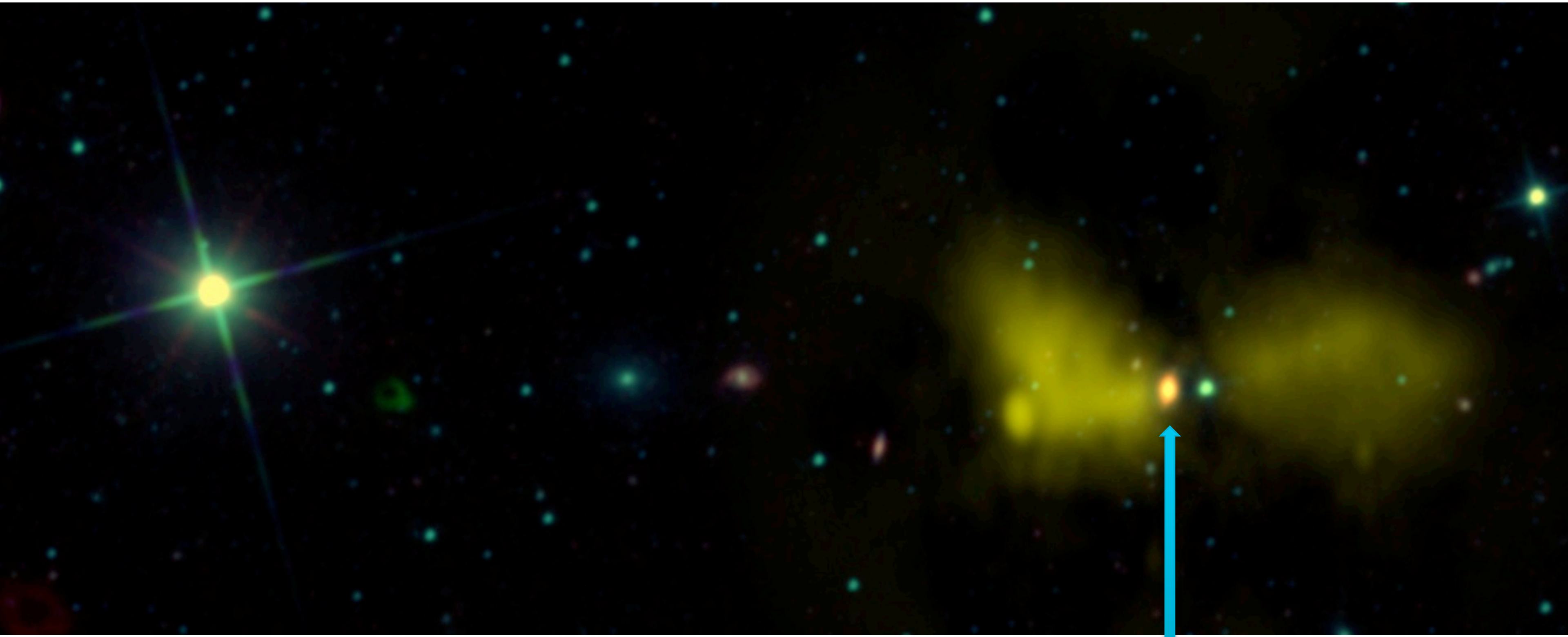
NGC 612



- m_V = 13.8, M_V = -24.5
- B – V = 0.9
- Galaxy Type S0
- z = 0.0290 +/- 0.0008
- Prominent dust lane lying perpendicular to radio axis (Ekers et al. 1978)
- Regularly rotating emission line disc out to 28 kpc (Goss et al. 1980)
- Young stellar population around 0.04 – 0.1 Gyr throughout the stellar disk (Holt et al. 2007)



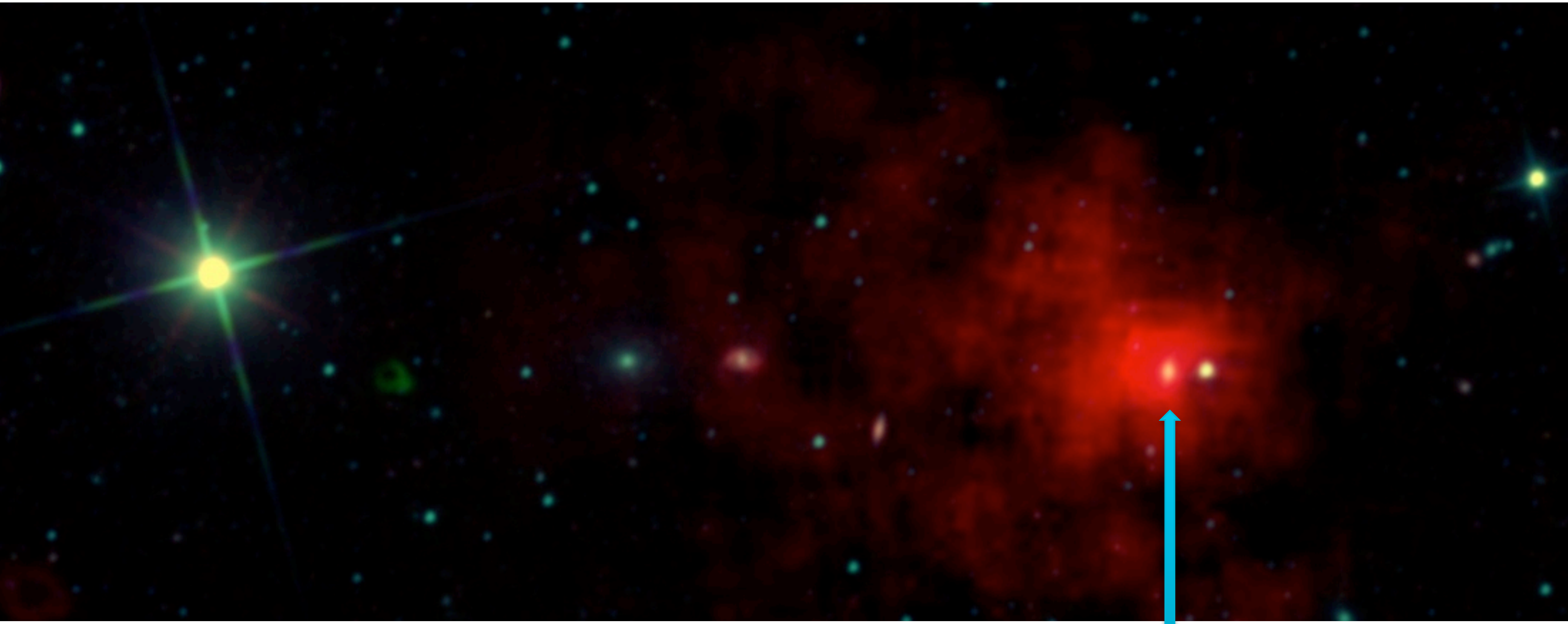
NGC 612



ATCA 16cm (1.3 – 3.1 GHz)

NGC 612

Image Credit: Angel R. Lopez-Sanchez

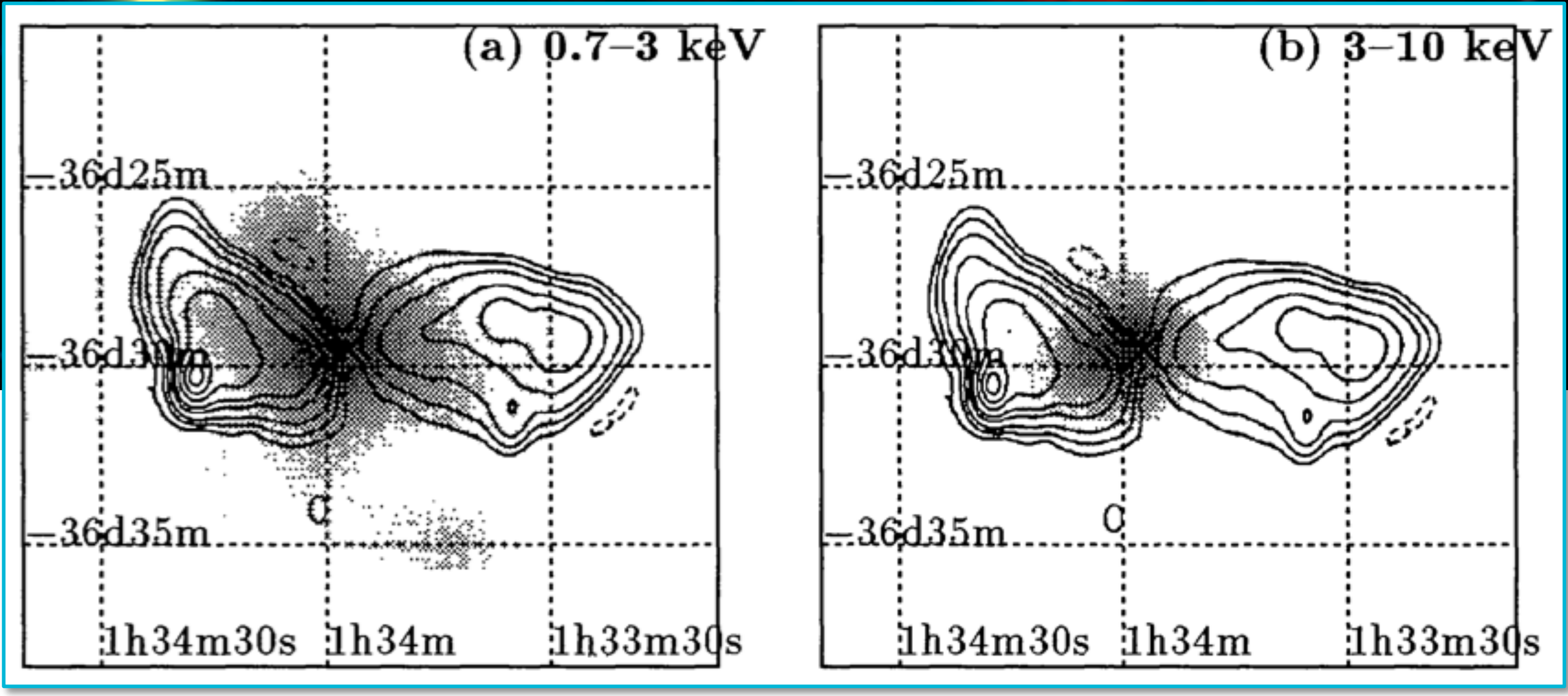


NGC 612

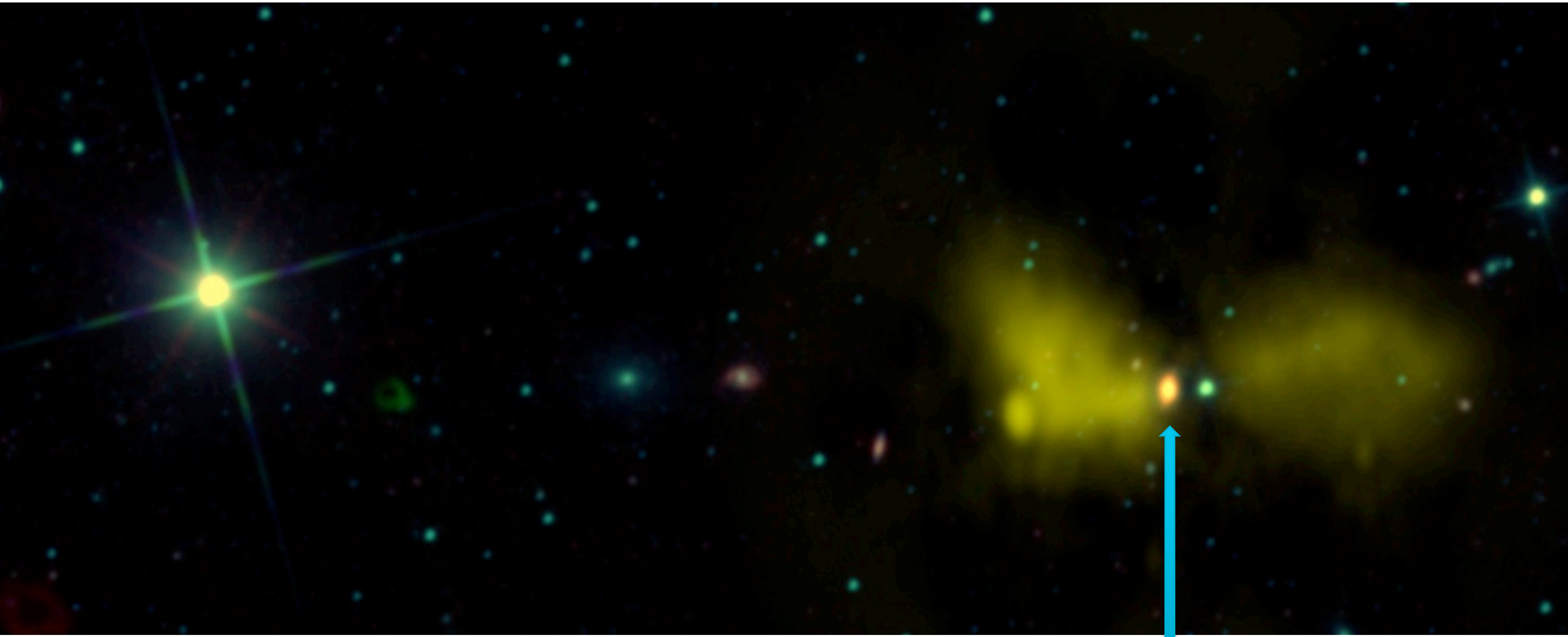
X-ray 0.7 – 3.0 keV

Tashiro et al. (1998)

Image Credit: Angel R. Lopez-Sanchez



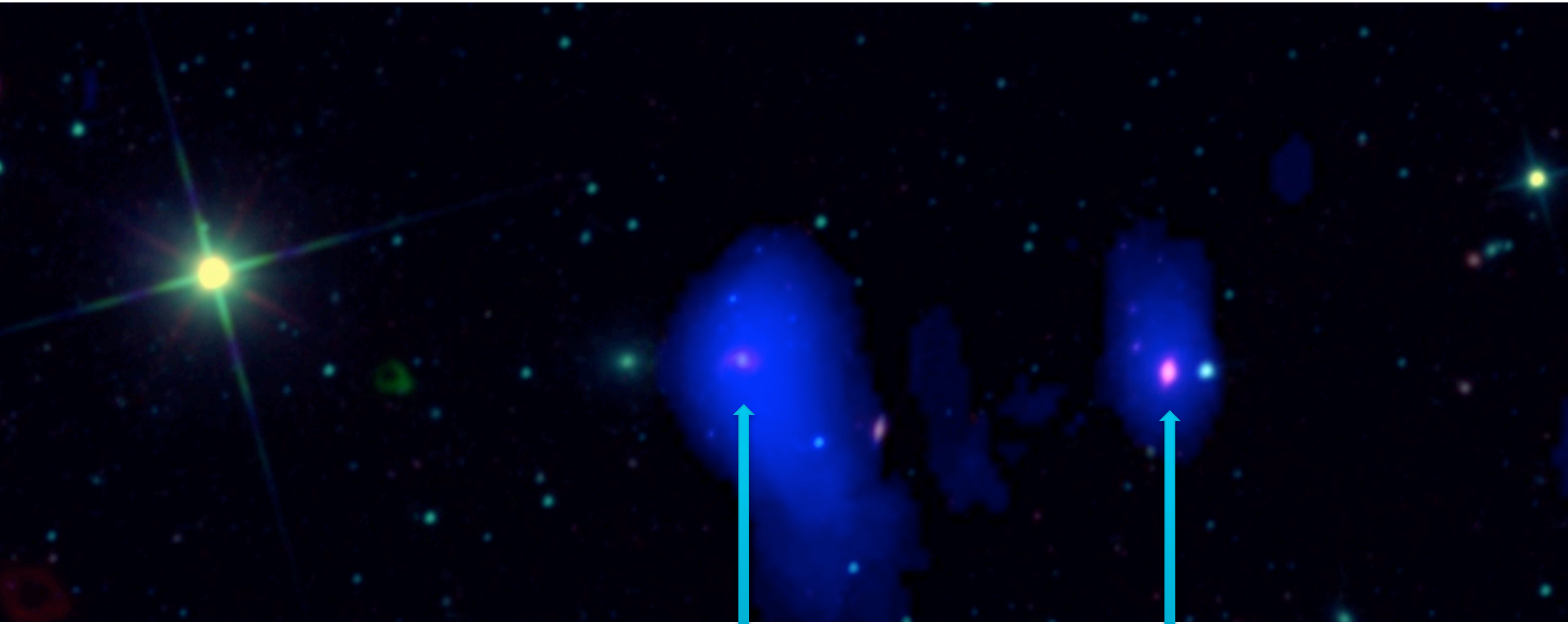
Tashiro et al. (1998)



ATCA 16cm (1.3 – 3.1 GHz)

NGC 612

Image Credit: Angel R. Lopez-Sanchez

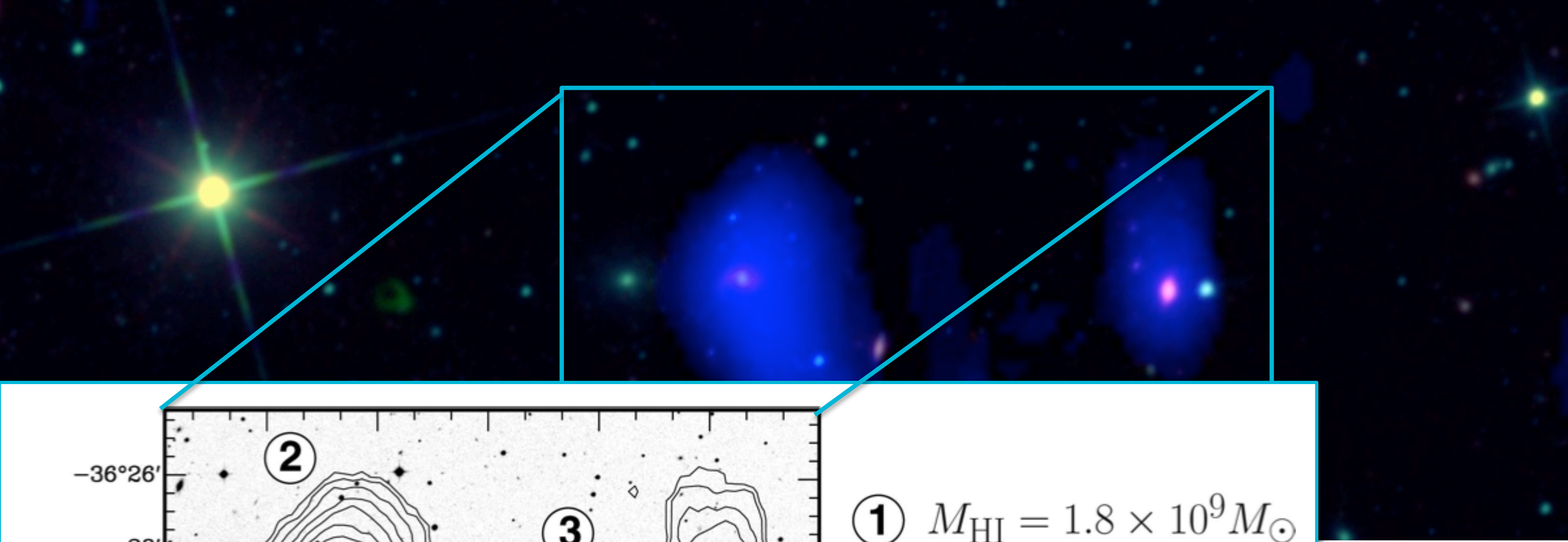


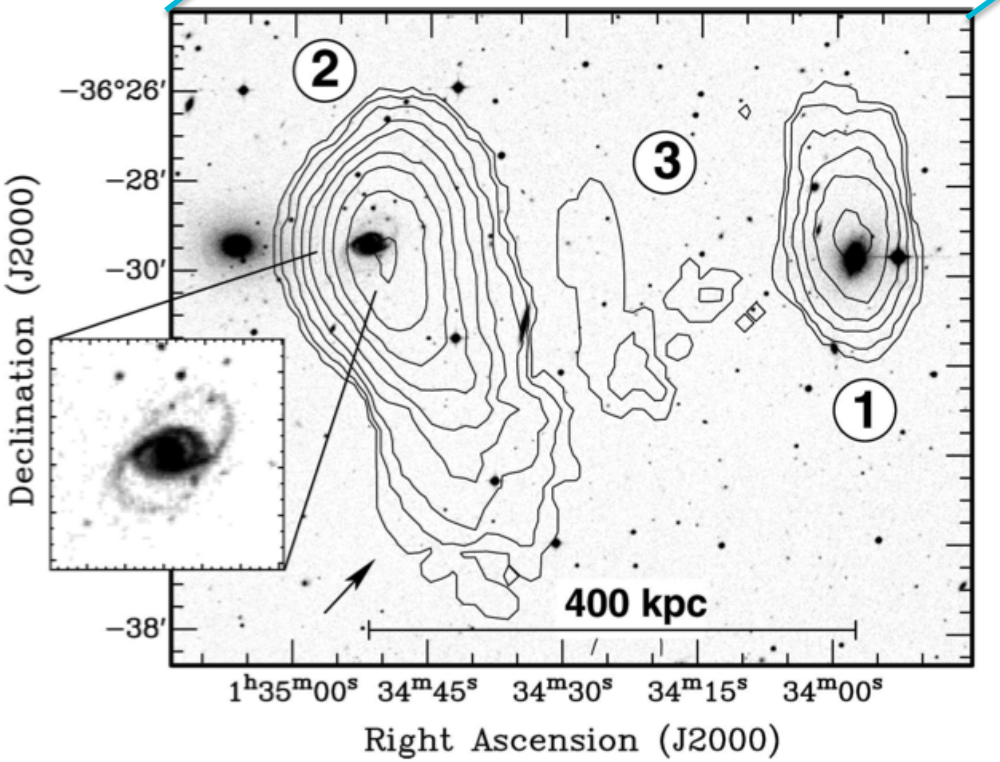
ATCA HI Emonts et al. (2008)

NGC 619

NGC 612

Image Credit: Angel R. Lopez-Sanchez



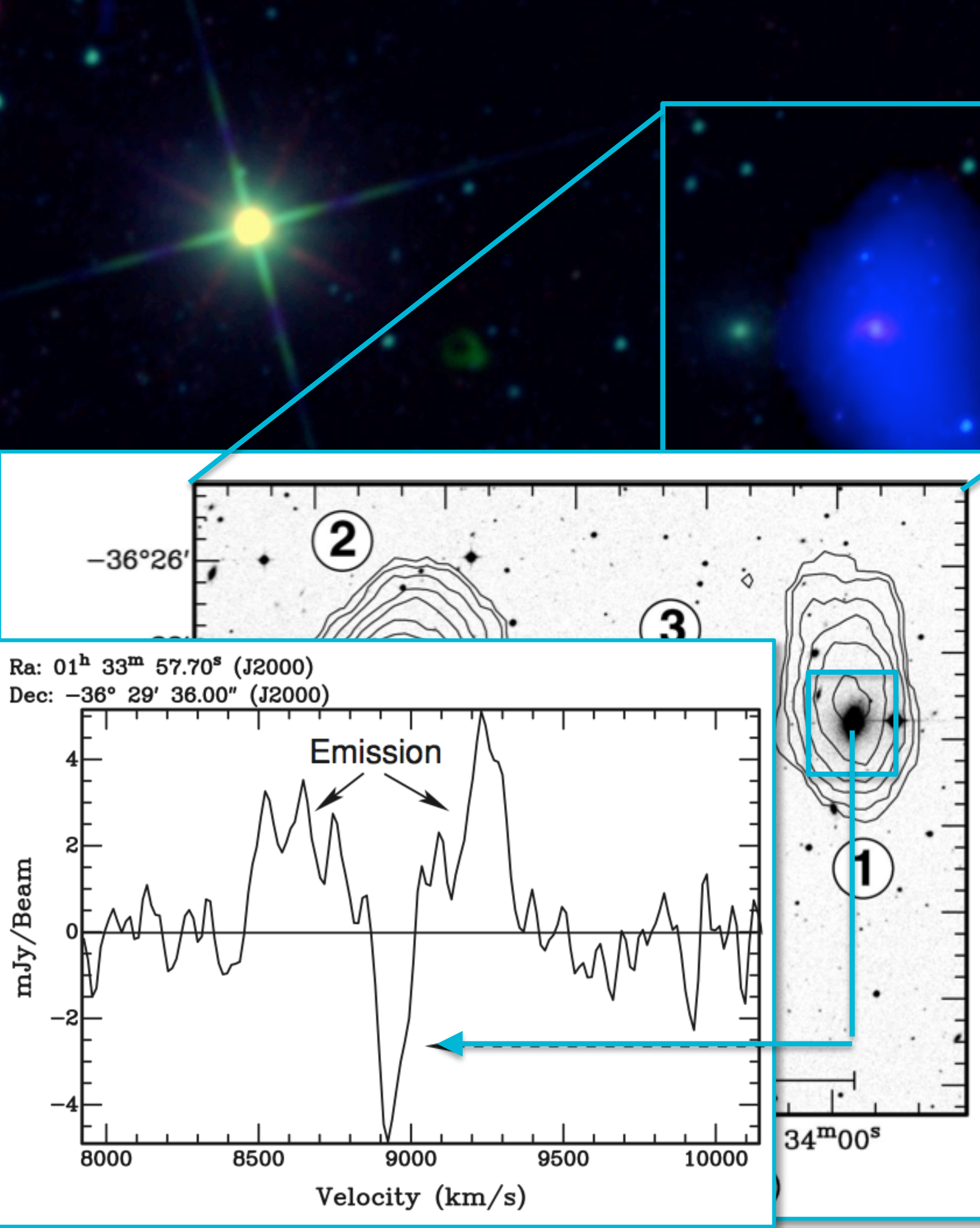


1 $M_{\mathrm{HI}} = 1.8 \times 10^9 M_\odot$

2 $M_{\mathrm{HI}} = 8.9 \times 10^9 M_\odot$

3 $M_{\mathrm{HI}} = 2.9 \times 10^8 M_\odot$

Emonts et al. (2008)



① $M_{\mathrm{HI}} = 1.8 \times 10^9 M_\odot$

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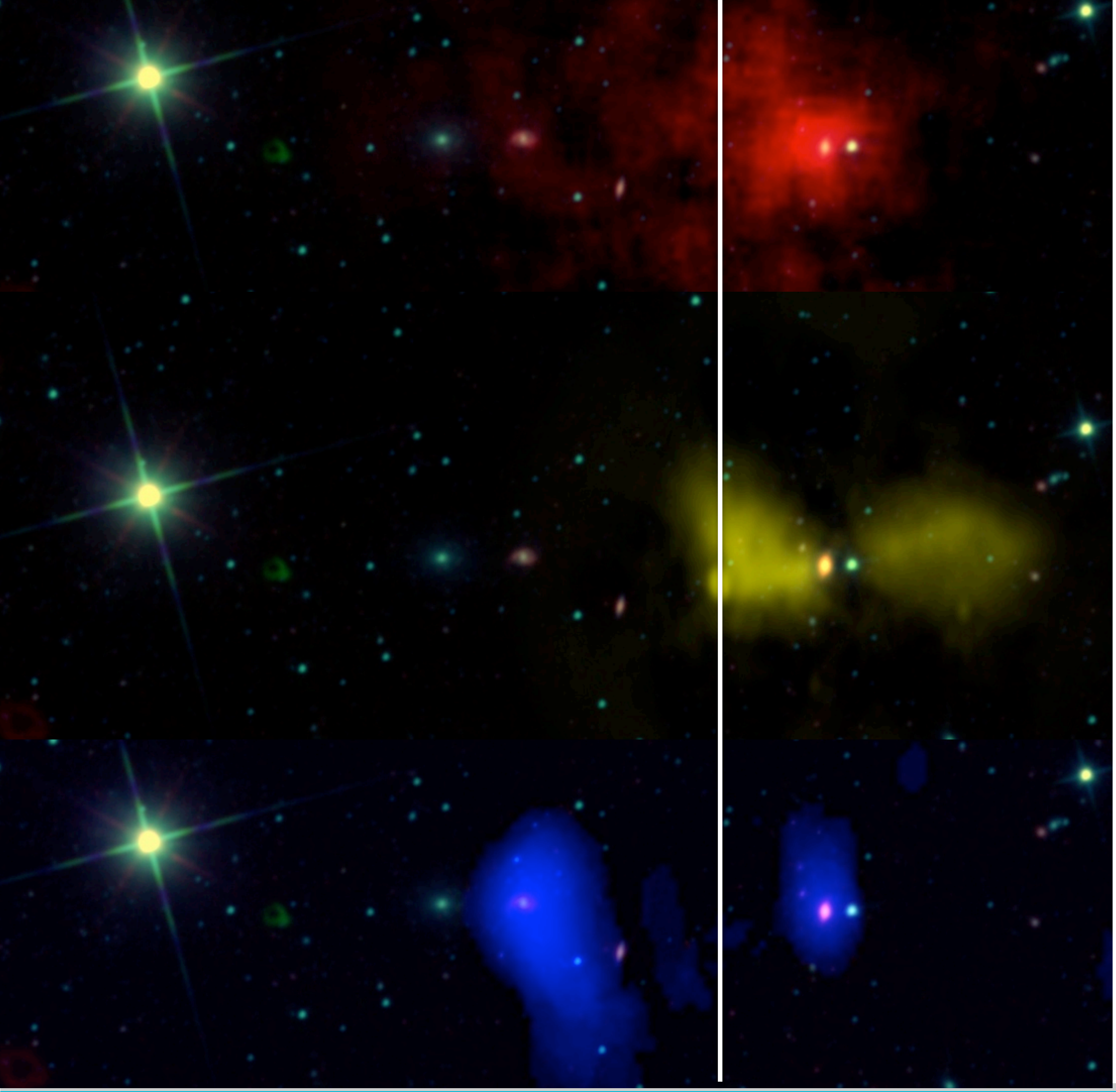
Emonts et al. (2008)



X-ray 0.7 – 3.0 keV

Tashiro et al. (1998)

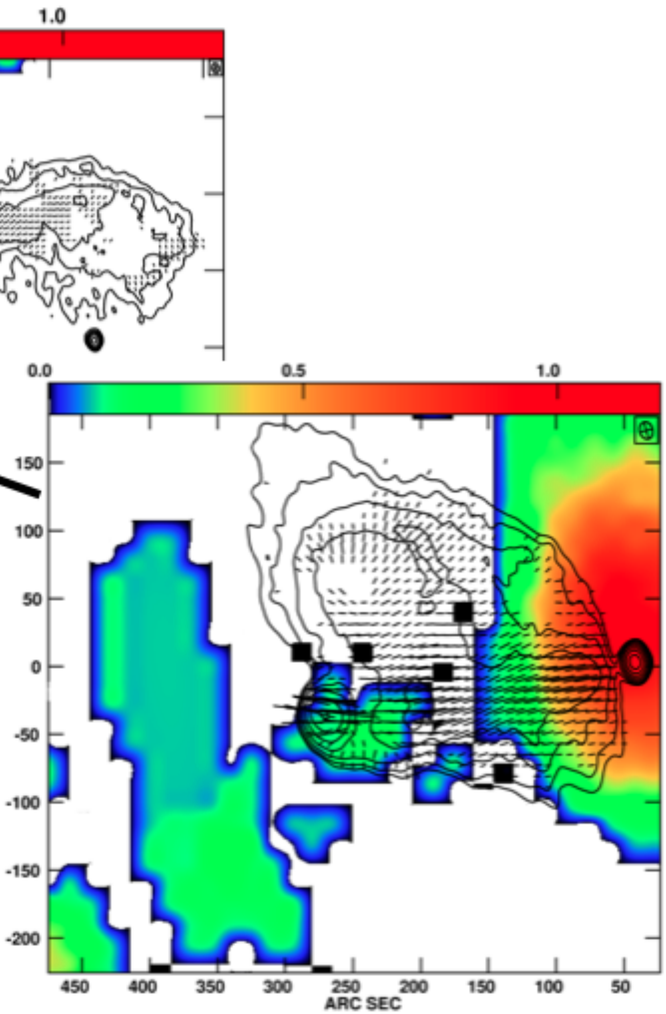
ATCA 16cm (1.3 – 3.1 GHz)

ATCA HI Emonts et al. (2008)

Image Credit: Angel R. Lopez-Sanchez

BUT

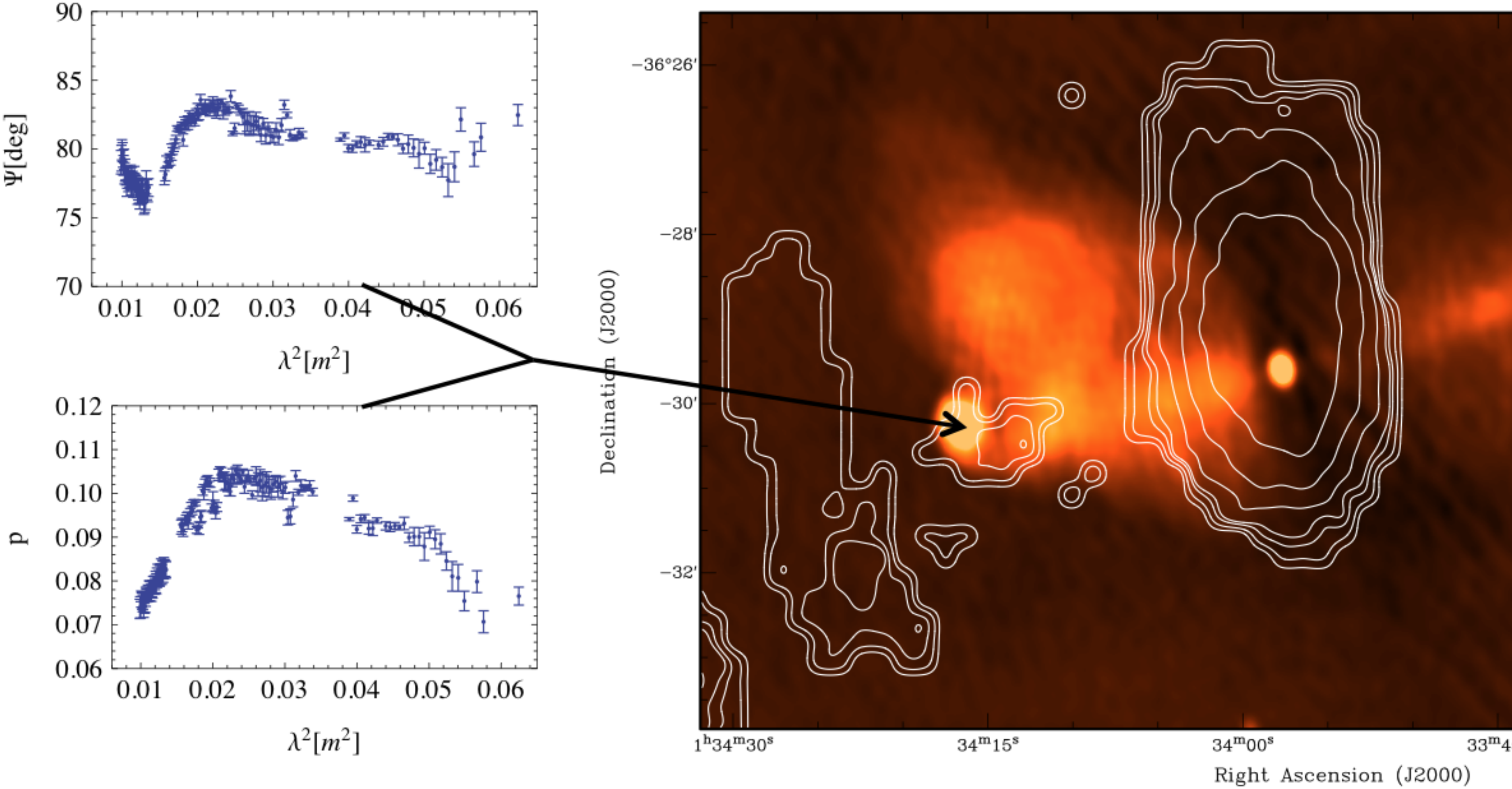
Primary Science Goal



- Does the lobe interact with the IGM?
- Major interaction – large scale mixing of ionized thermal material with the lobe. Results in a unique RM and depolarization structure (O'Sullivan et al. 2012).
- Minor Interaction – lobe has impacted the HI gas but no large scale mixing producing a 'RM skin' effect. Results in the RM structure being strongly correlated with lobe structure (e.g. Bicknell et al. 1990).

Our Results

- Possible interaction of the lobe with the surrounding medium through mixing of ionized thermal material with the relativistic lobe plasma.

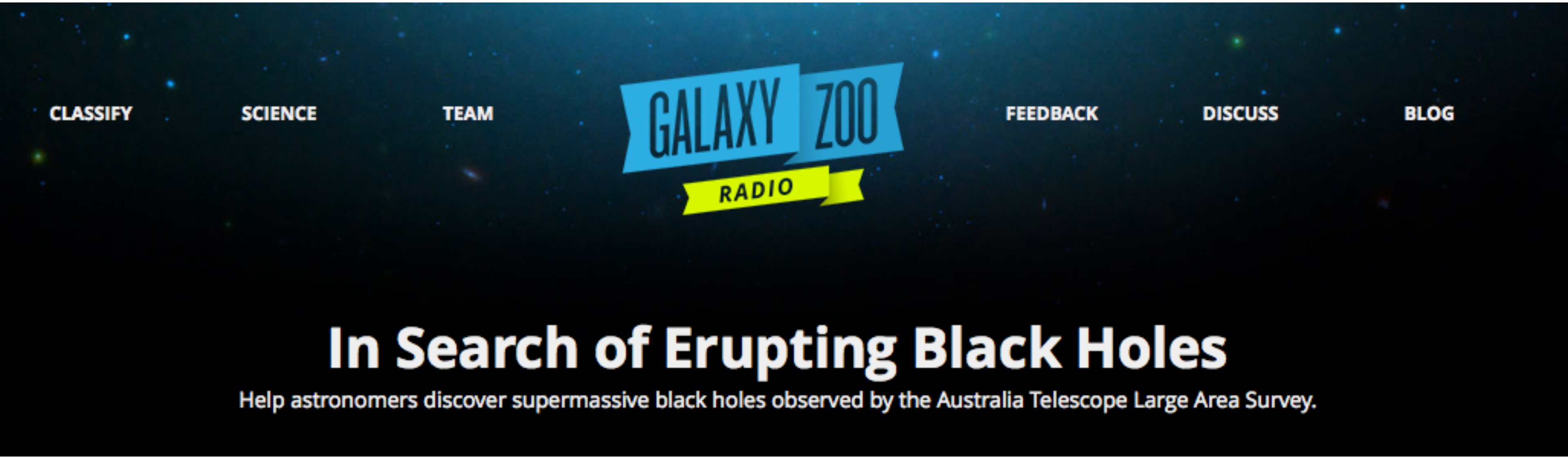


Close Encounter
~1 Gyr ago

S0 with 40-100
Myr young
stellar pop

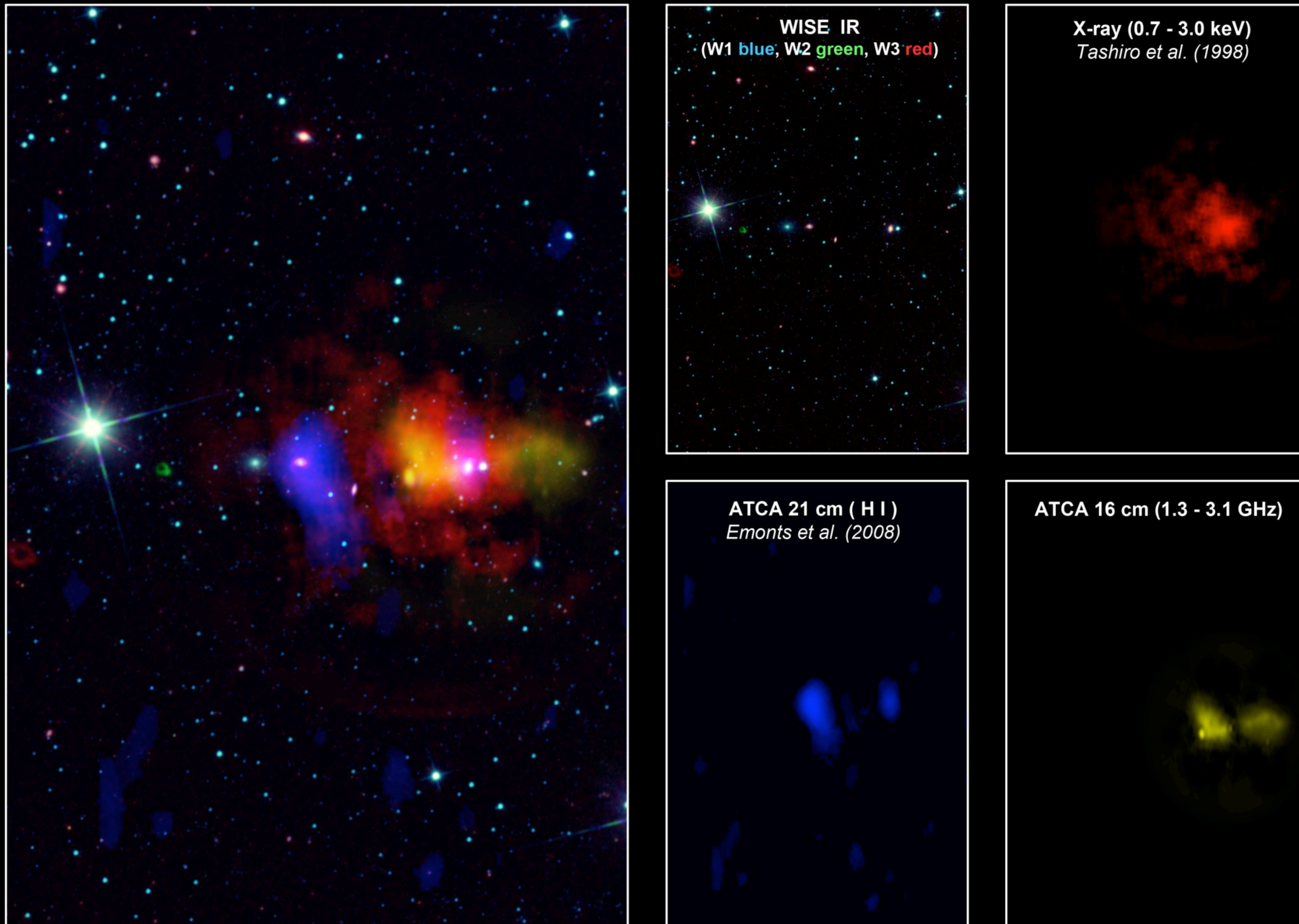
Upper limit age
of AGN is 40
Myr

Where does Galaxy Zoo help?



Ivy Wong will be talking more about this project this week.

Multiwavelength view of the radio galaxy NGC 612



IR using WISE (W1 blue, W2 green, W3 red) + 21 cm HI distribution using ATCA (dark blue, Emonts et al. 2008) + 16 cm (1.3 - 3.1 GHz) radio-continuum using ATCA (yellow) + X-ray (0.7 -3.0 keV) emission (red, Tashiro et al 1998).
Credit: Julie Banfield (CSIRO, Australia), Shane O'Sullivan (Sydney University, Australia) & Björn Emonts (OAN, Spain).

Image credit: Ángel R. López-Sánchez (AAO / MQ)

Magnetic fields reveal possible mixing of ionised thermal material with AGN lobe, evidence 40 Myr in the making.

Thank you

CSIRO Astronomy and Space Science
Julie Banfield

OCE Postdoctoral Fellow

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