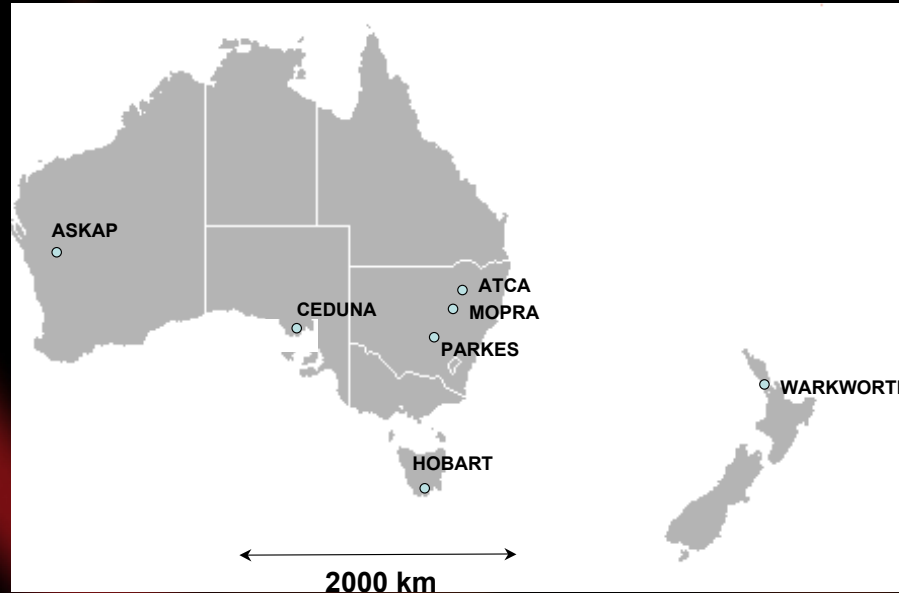




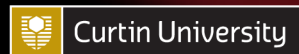
International
Centre for
Radio
Astronomy
Research

Very Long Baseline Interferometry – sharpest tool in the shed



Prof. Steven Tingay
Curtin University

CASS Radio Astronomy School 2012, Narrabri.



THE UNIVERSITY OF
WESTERN AUSTRALIA
Achieve International Excellence



Baseline = 1000 km
Observing frequency = 5 GHz

Angular resolution ~ 10 mas = ATCA angular resolution at 5 GHz $\times (6/1000)$

Sensitivity calculation exactly the same.

So, for detection on long baselines, require compact and bright emission.
High brightness temperature emission:

$$T_b = 1.22 S_\nu / abv^2$$

elliptical Gaussian; T_b in 10^{12} K; S_ν in Jy; a and b in mas; v in GHz; z is redshift

VLBI/Correlation

Deller, Tingay, Bailes & West, 2007, PASP, 119, 318

Deller, Brisken, Phillips, Morgan, Wayth, Tingay, Rottmann, Alef, Romney,
Middelberg, 2011, PASP, 123, 257

<http://cira.ivec.org/dokuwiki/doku.php/difx/start>



The Very Long Baseline Array (VLBA)



NRAO VLBA

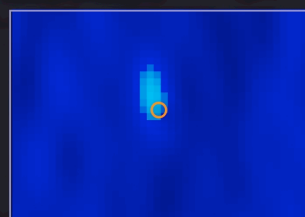


Caught in the Act: Black Hole H1743–322 Launches a Jet

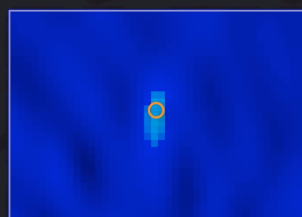
Very Long Baseline Array radio images



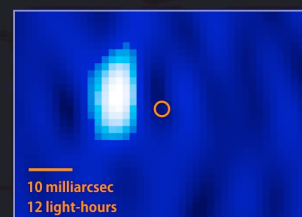
May 28, 2009



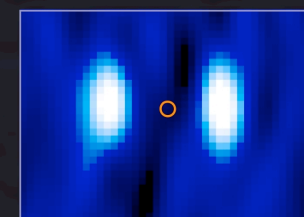
May 30



June 2

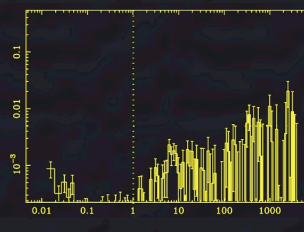
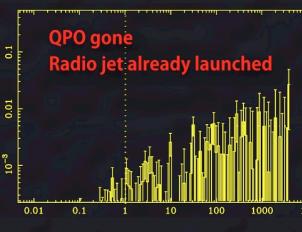
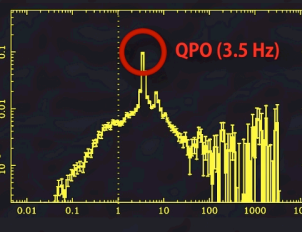
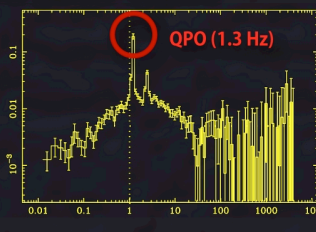
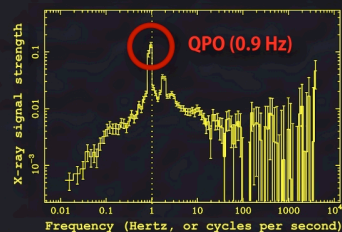


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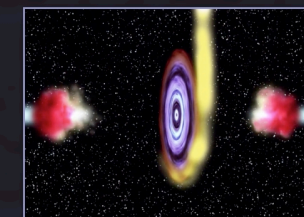
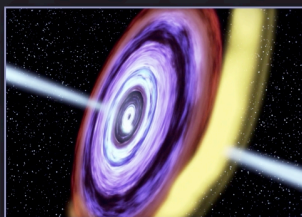
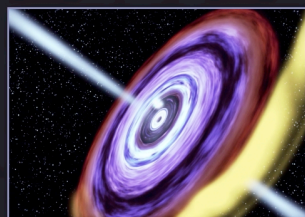


June 6

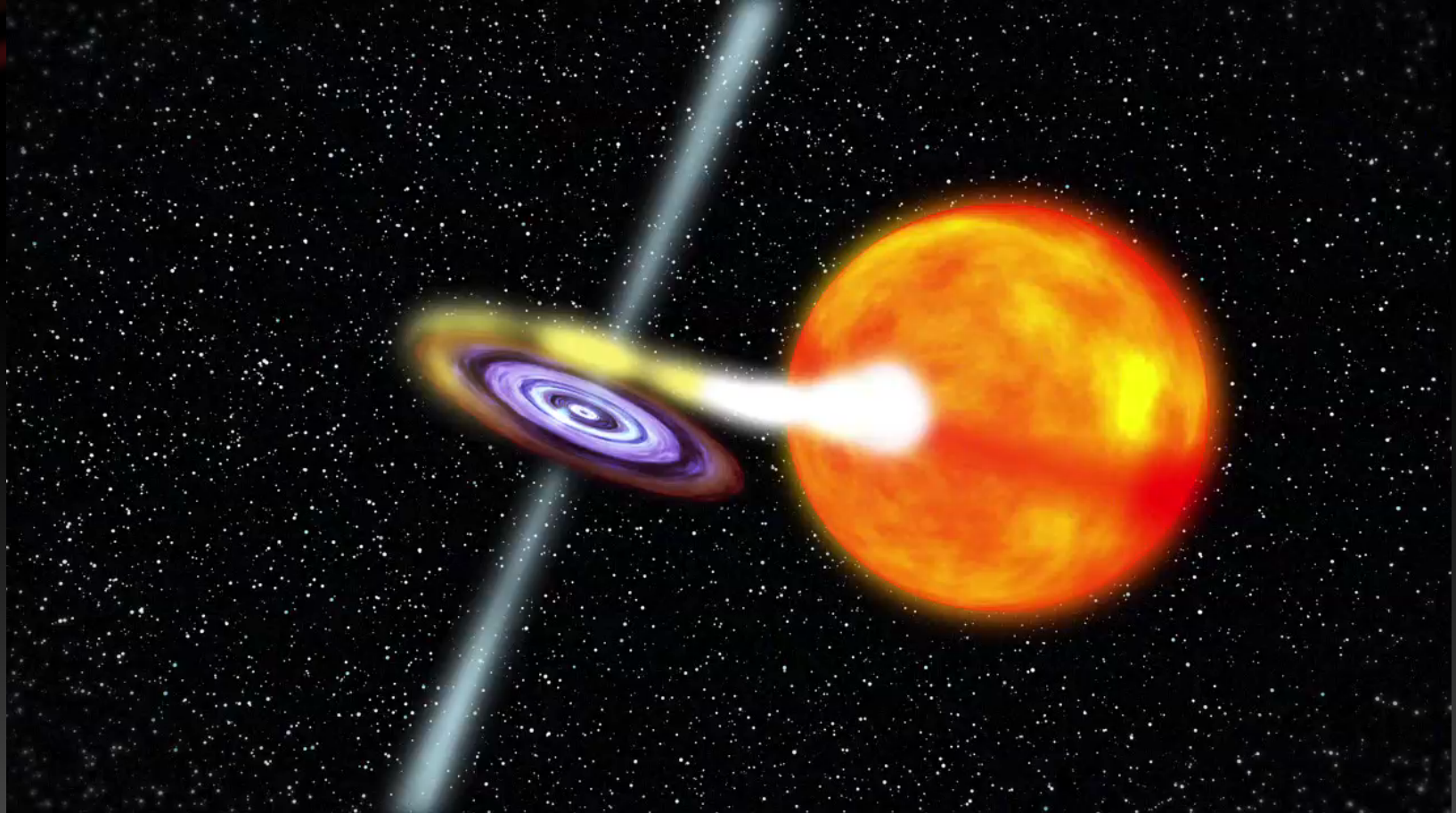
Rossi X-ray Timing Explorer power spectra



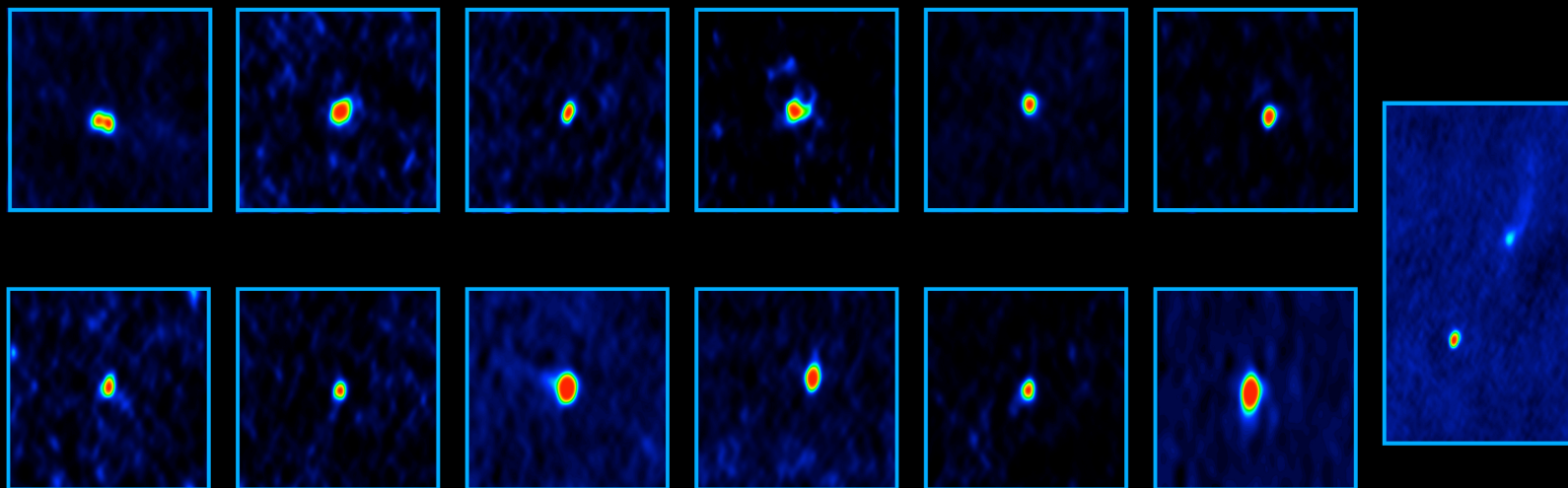
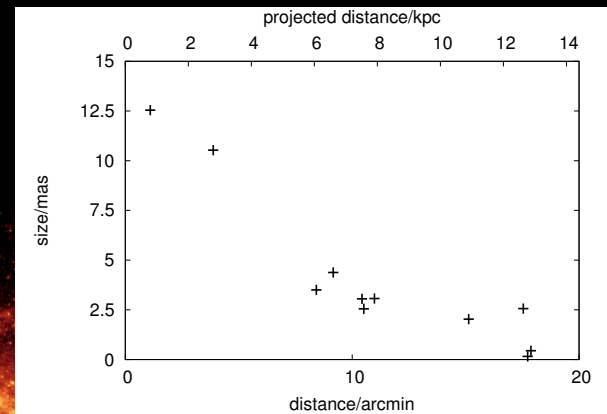
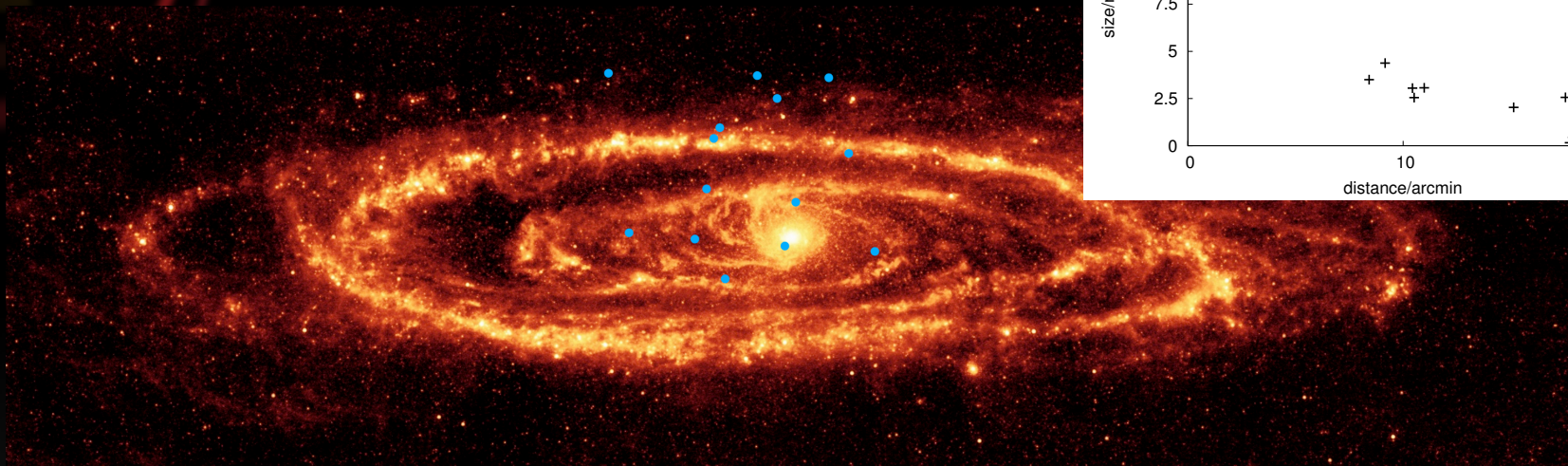
Artist's rendition



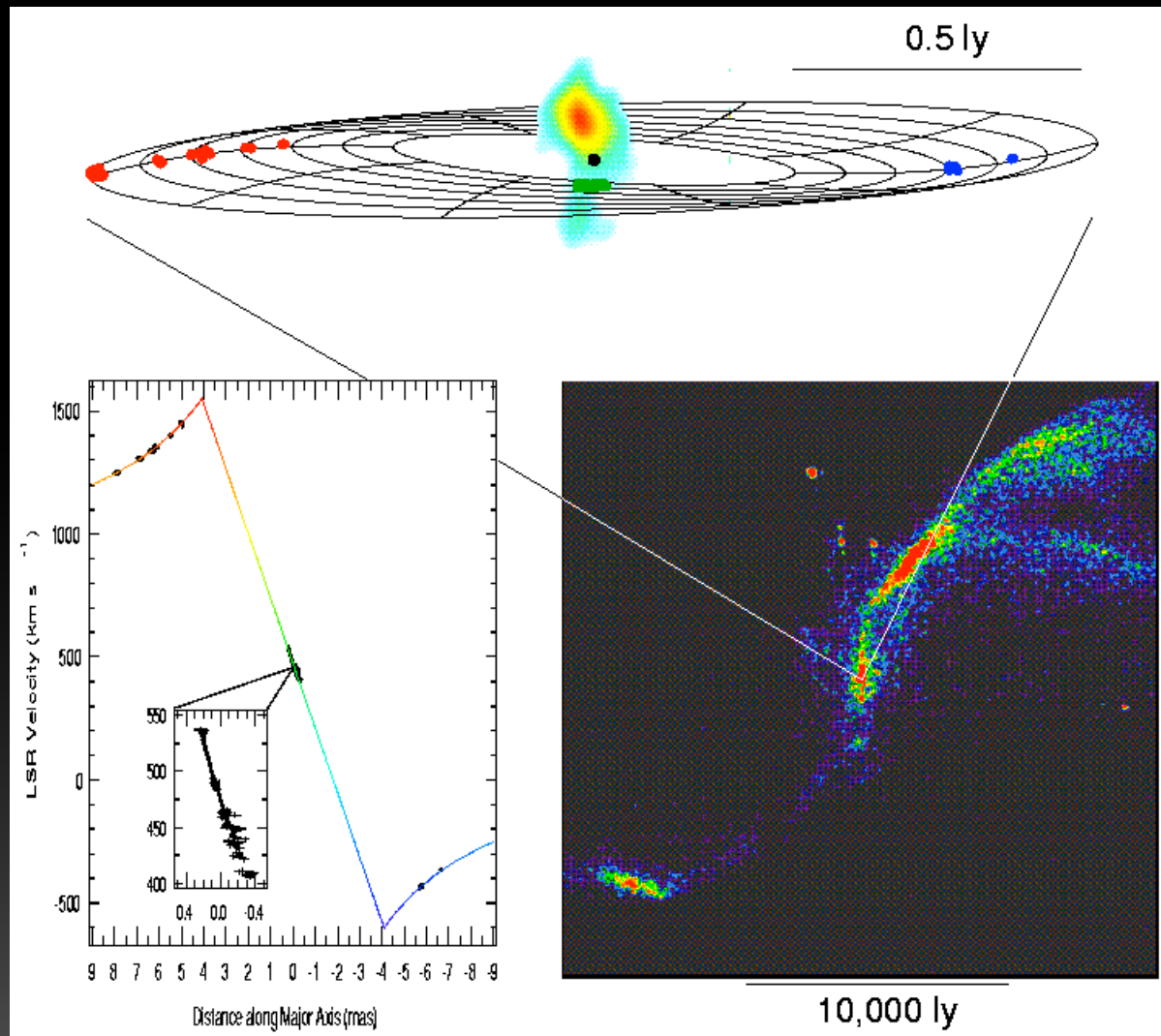
James Miller-Jones et al.



NASA Goddard/RXTE

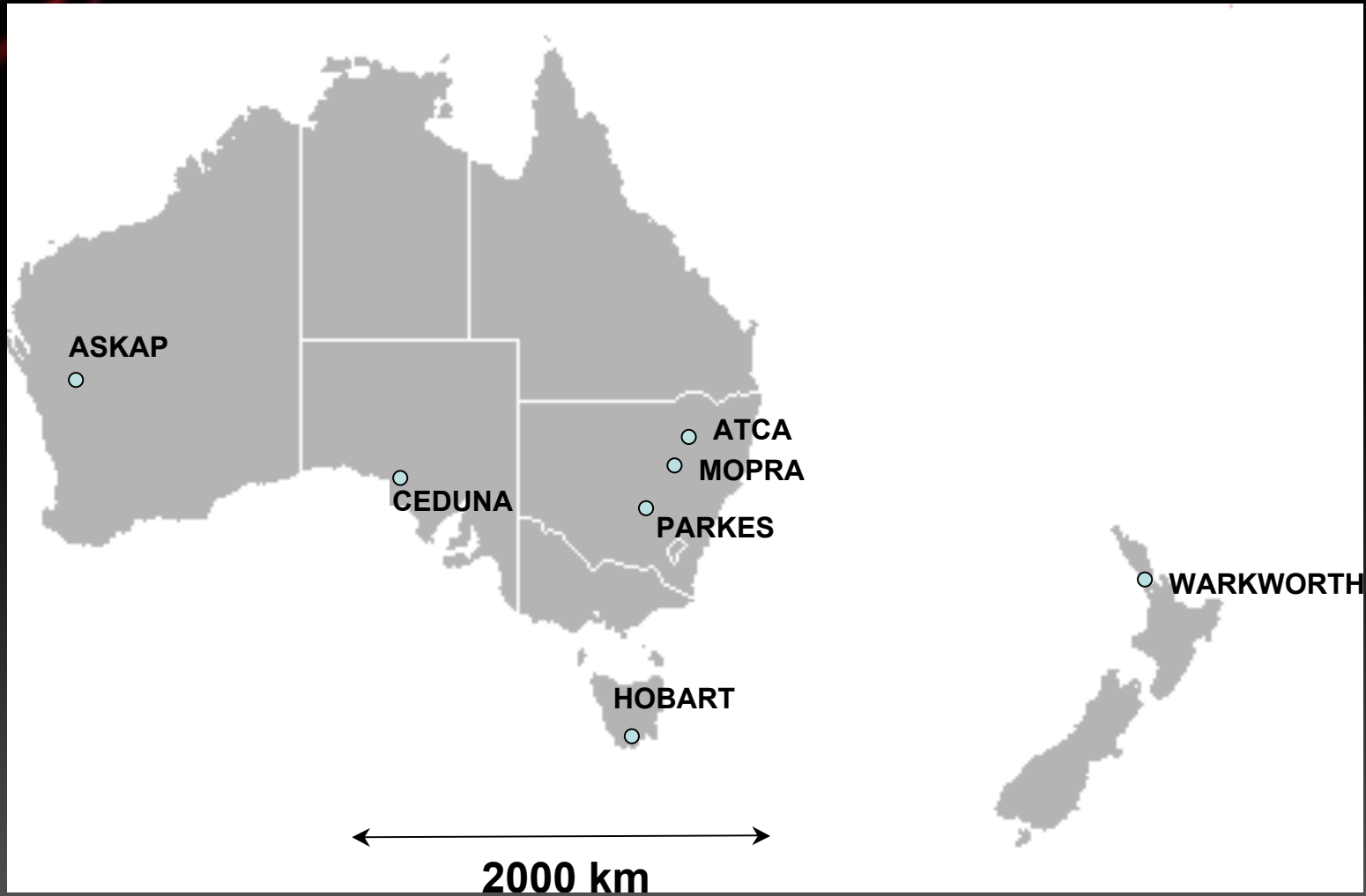


Morgan et al. (2012, in prep.)

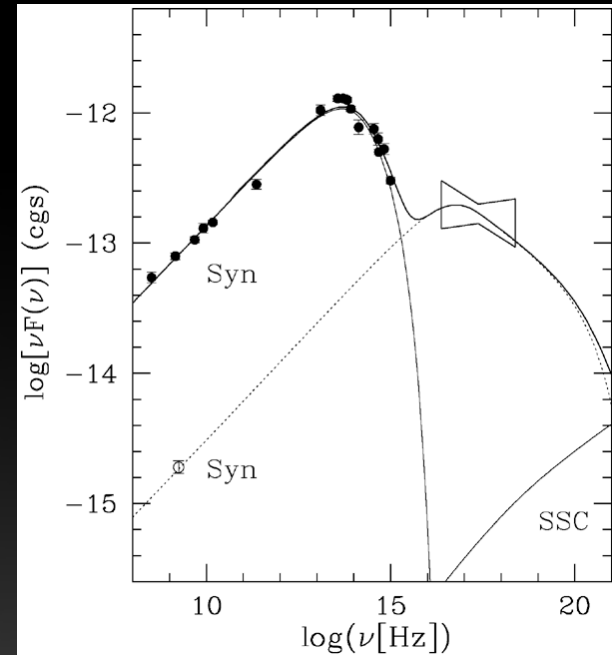
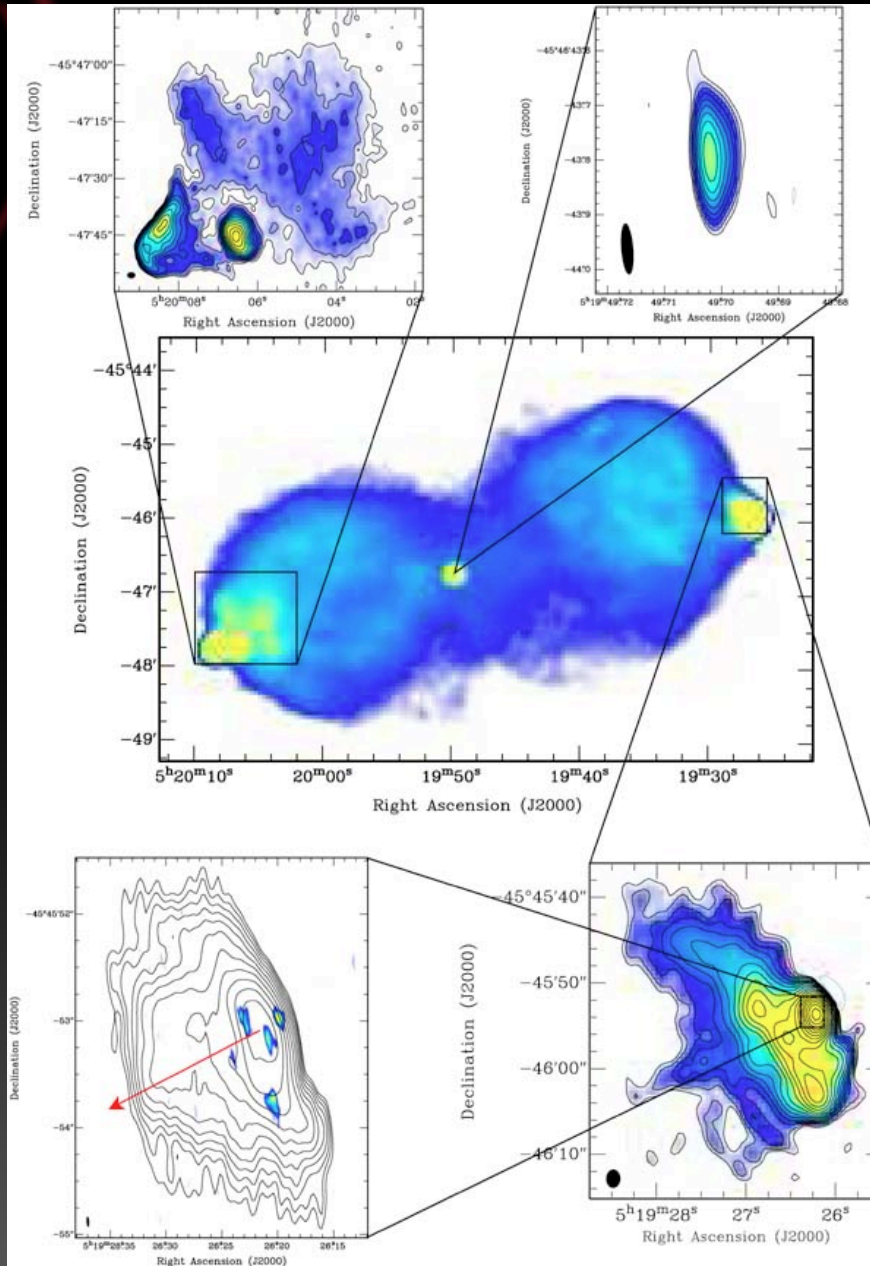


Hernstein et al. (1999)

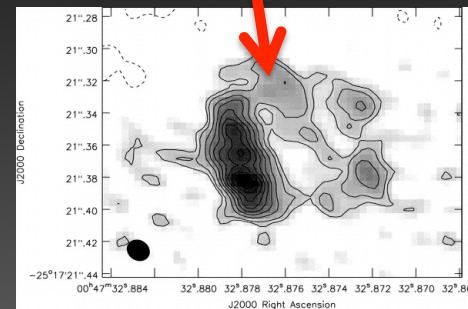
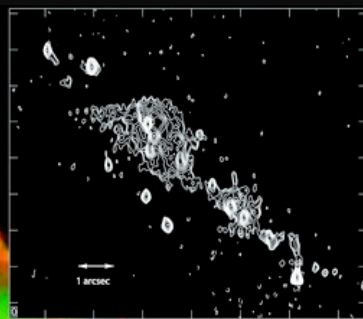
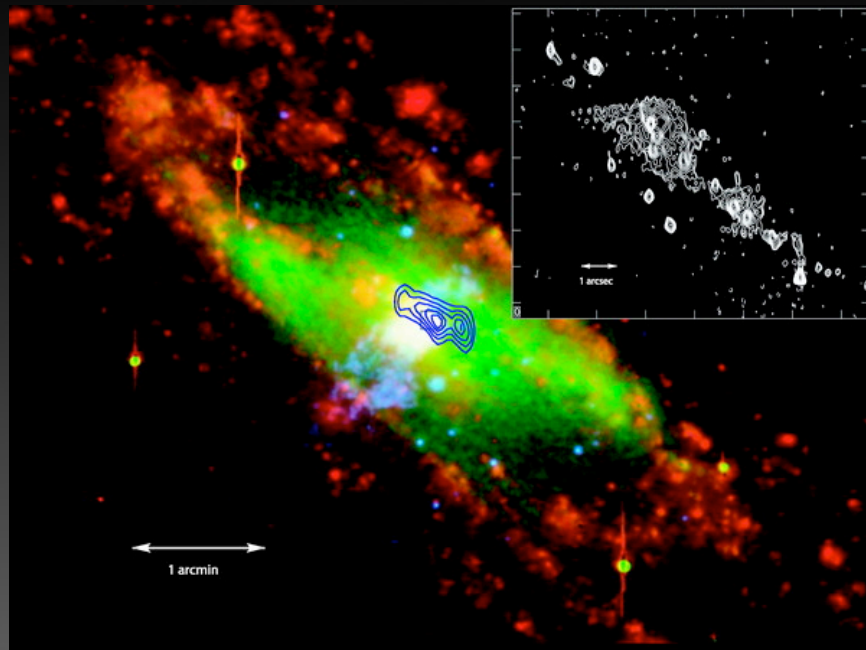
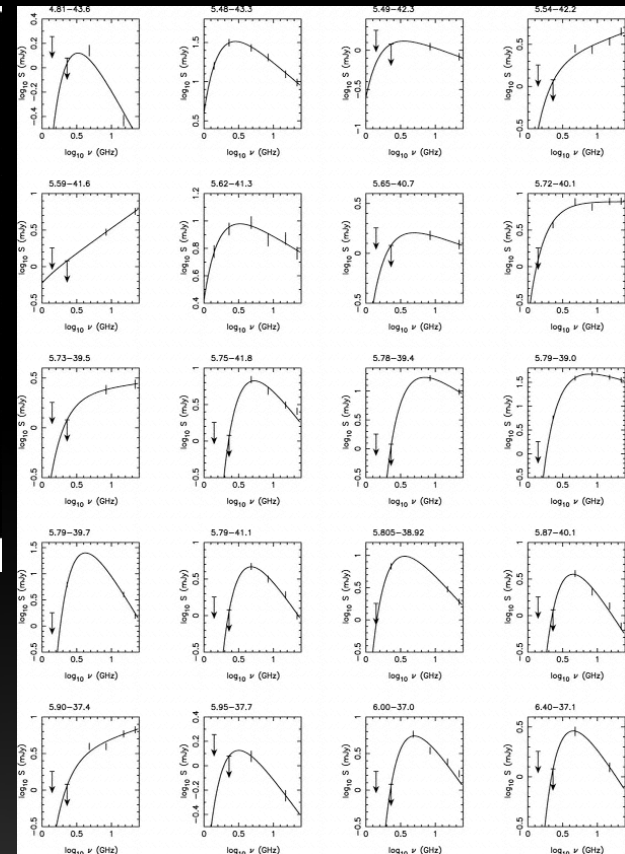
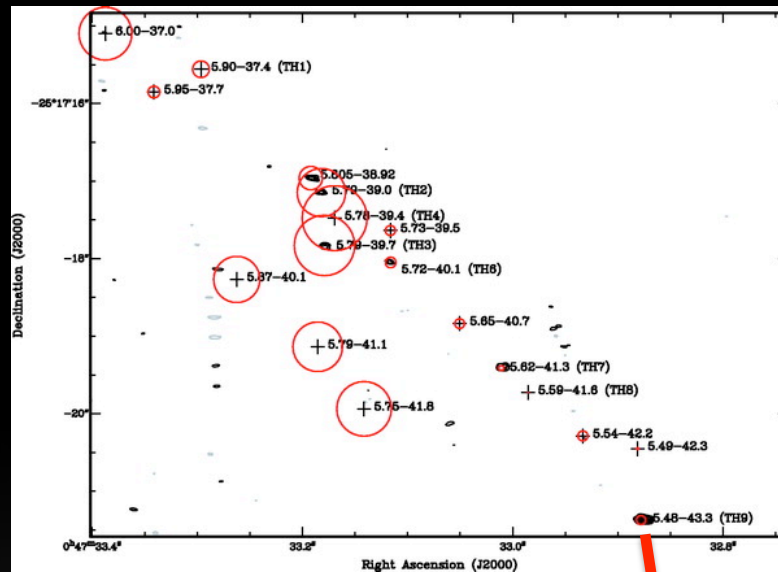




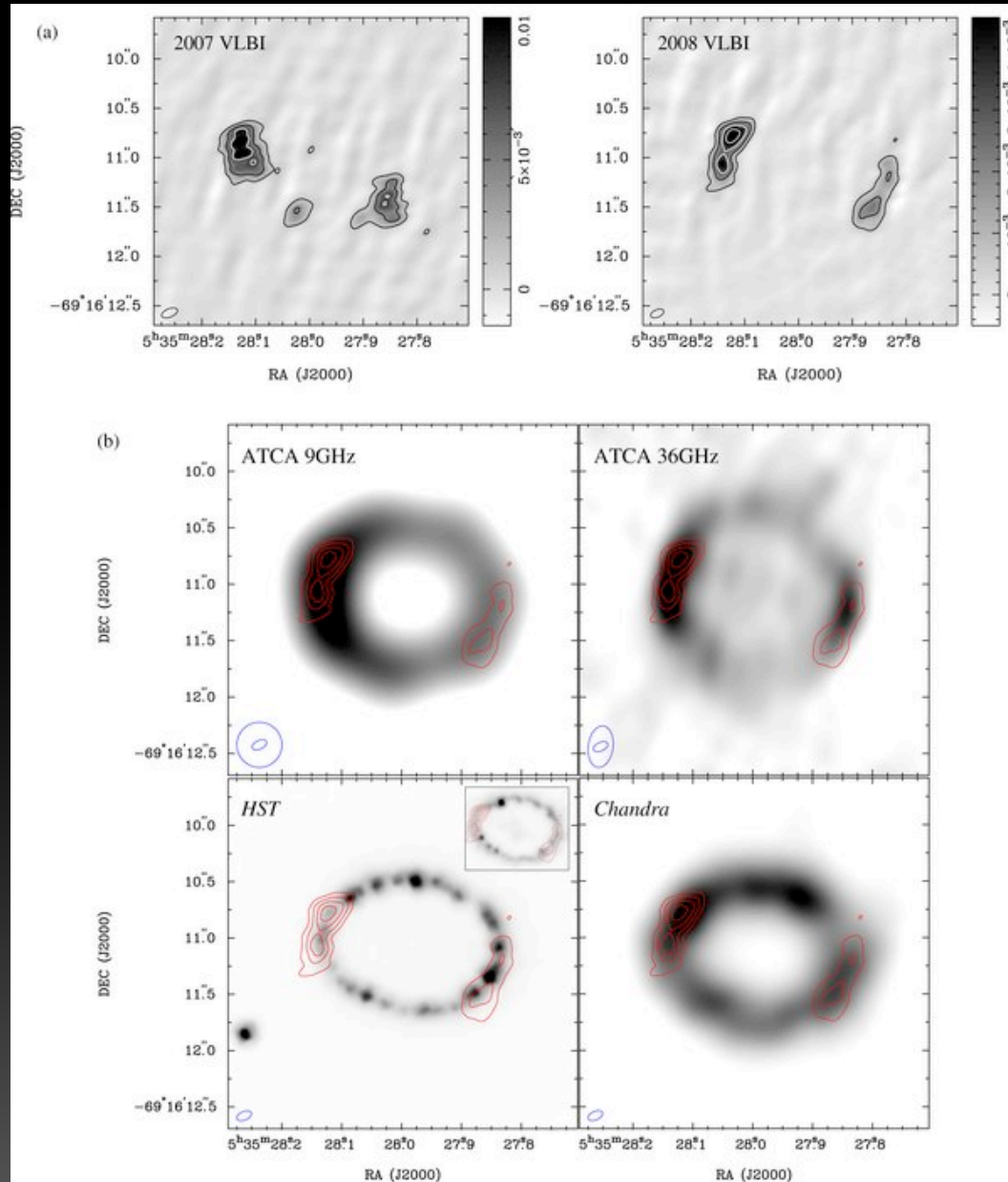
Tzioumis et al. (2010)



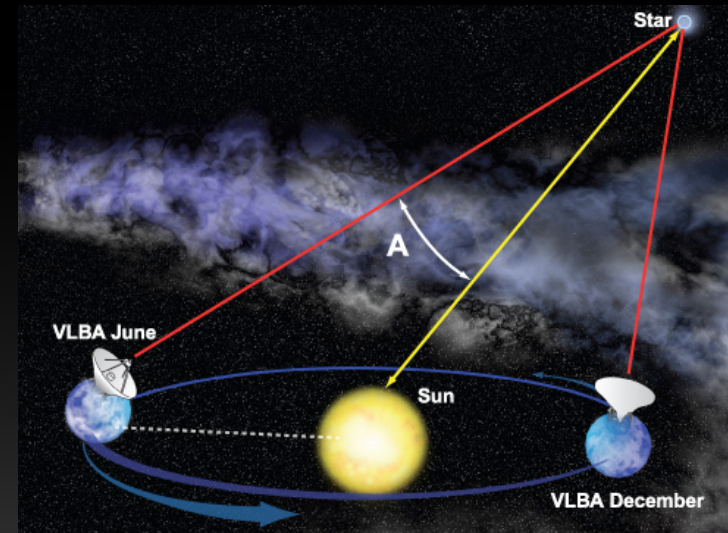
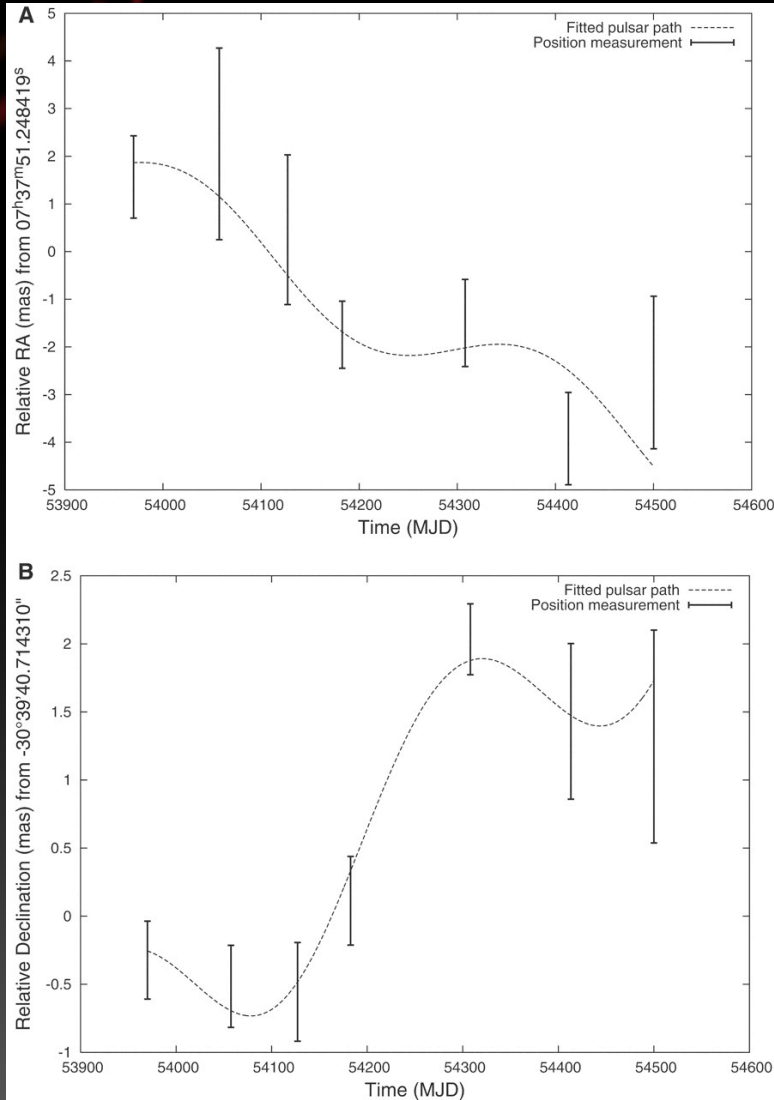
Tingay et al.(2008)



Lenc & Tingay (2006)



Ng et al. (2011)



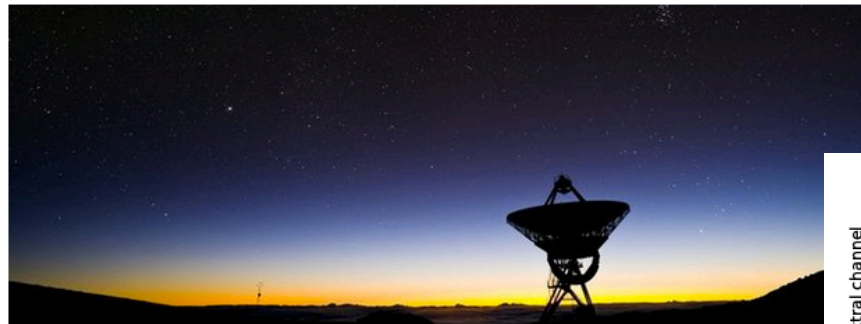
Deller et al. (2009)



1 June 2012 Last updated at 15:50 GMT



'No signal' from targeted ET hunt



Very long baseline interferometry results in an effective antenna of many kilometres in size

The hunt for other intelligent civilisations has a new technique in its arsenal, but its first use has turned up no signs of alien broadcasts.

Australian astronomers used "very long baseline interferometry" to examine Gliese 581, a star known to host planets in its "habitable zone".

The hunt for aliens is fundamentally a vast numbers game, so the team's result should come as no surprise.

Their report, [posted online](#), will be published in the *Astronomical Journal*.

In recent years, interest in such targeted searches has begun to surge as the hunt for planets outside the Solar System continues to find them at every turn.

Astronomers currently estimate that every star in the night sky hosts, on average, 1.6 planets - implying that there are billions of planets out there yet to be confirmed.

But a number of stars have already been identified as playing host to rocky planets at a distance not too hot and not too cold for liquid water - the first proxy for amenability to life.

ET or AT&T?

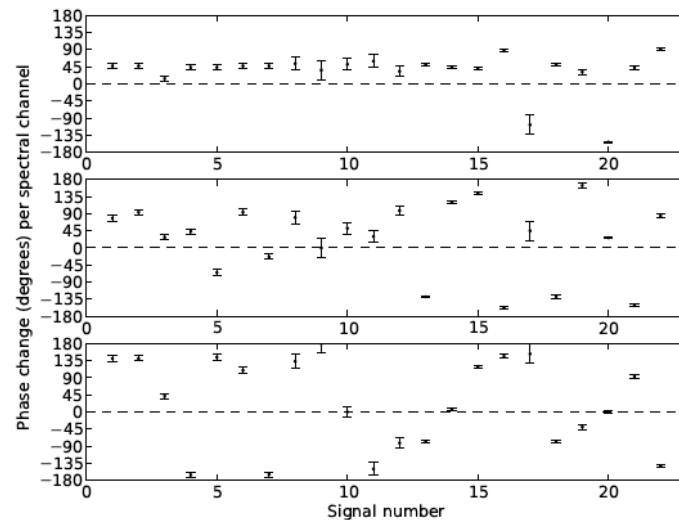
Gliese 581, a red dwarf star about 20 light-years away, is a particularly interesting candidate for the Search for Extraterrestrial Intelligence, or Seti.

Related Stories

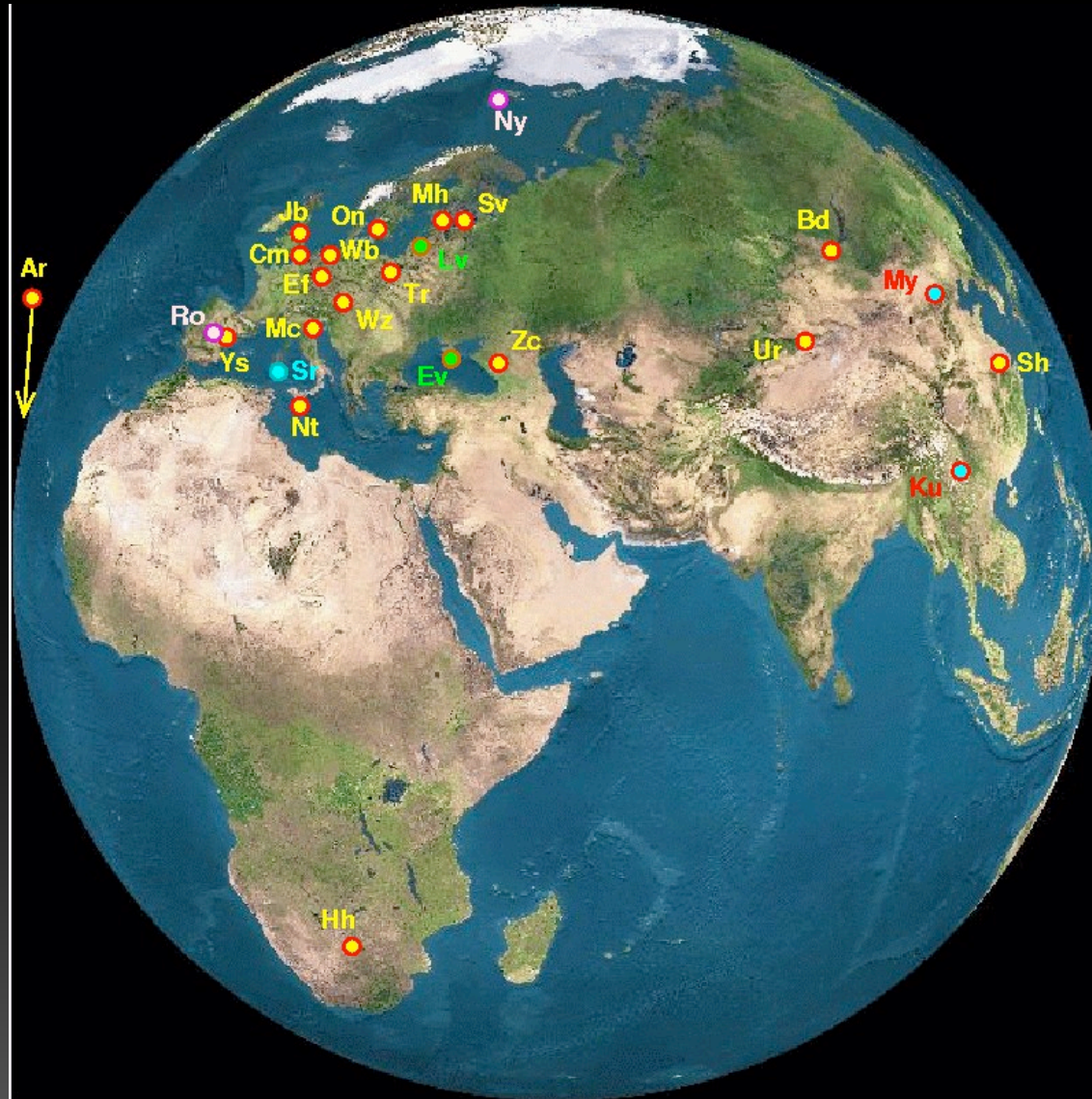
[Study says most have planet](#)

[Murky exoplanet host life'](#)

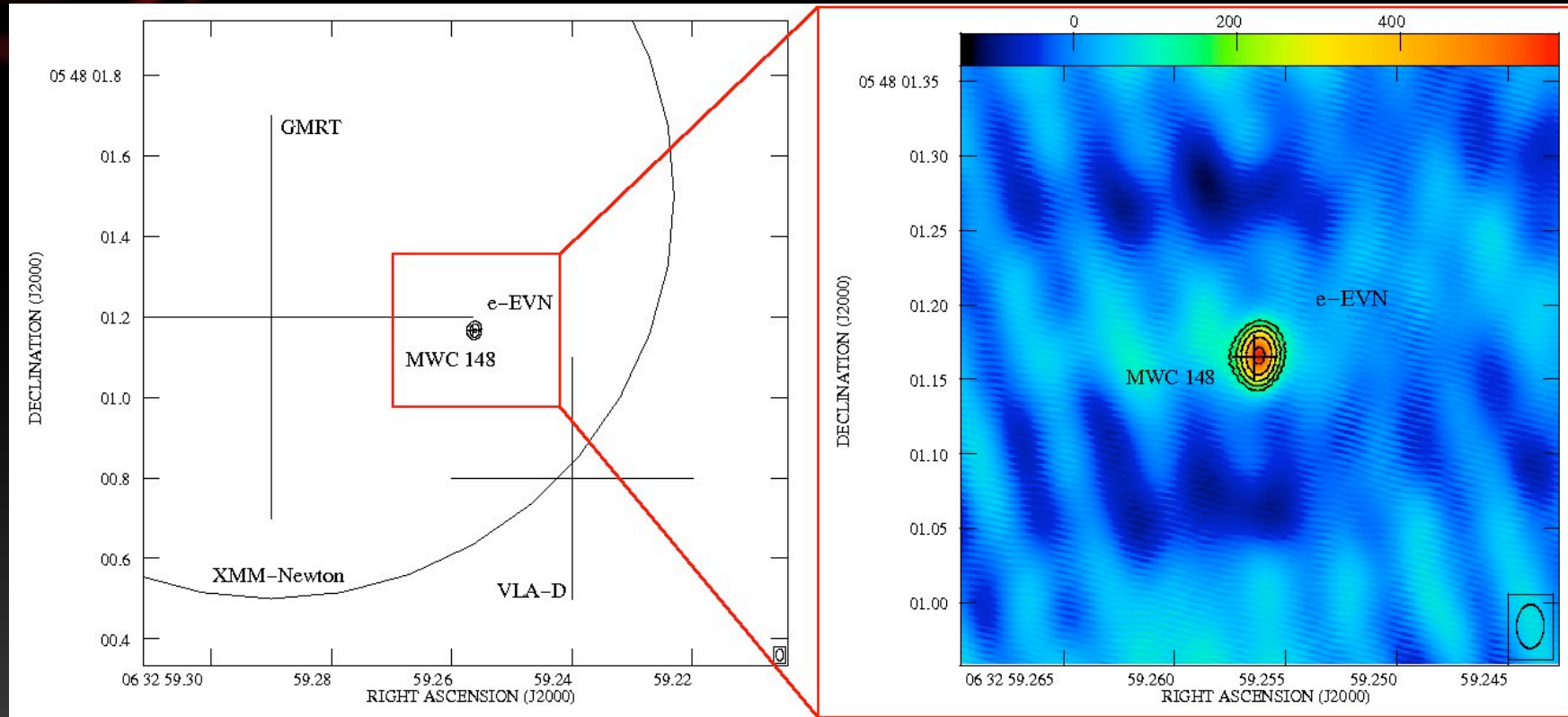
[Most liveable alien worlds ranked](#)



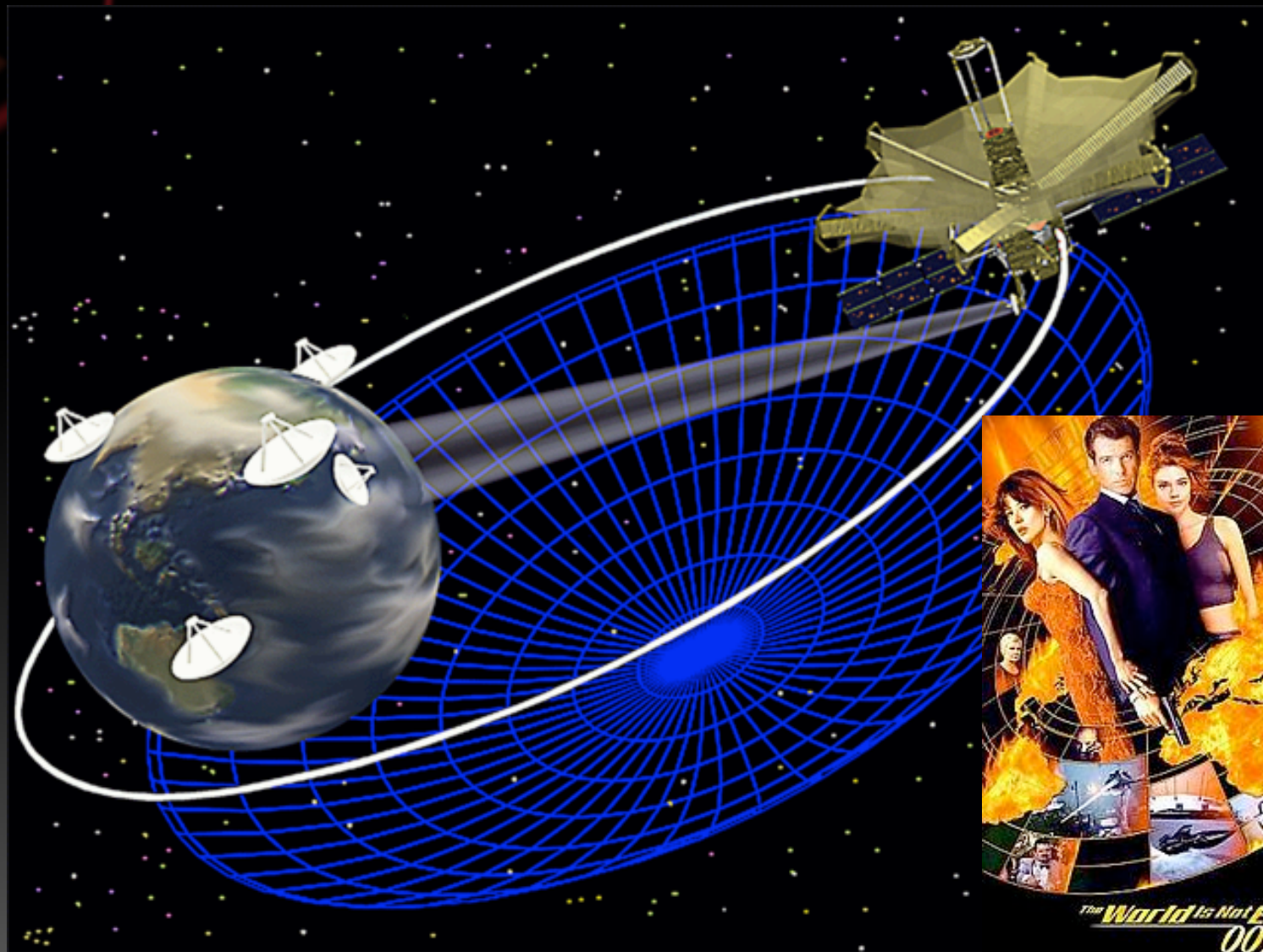
Rampadarath et al. (2012)



EVN



http://www.astro.uni.torun.pl/~magda/EVN_NEWSLETTER/May11/EVN_Newsletter_29_May11.htm#transient

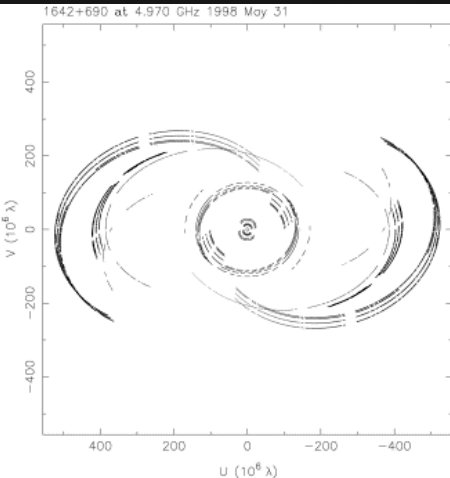
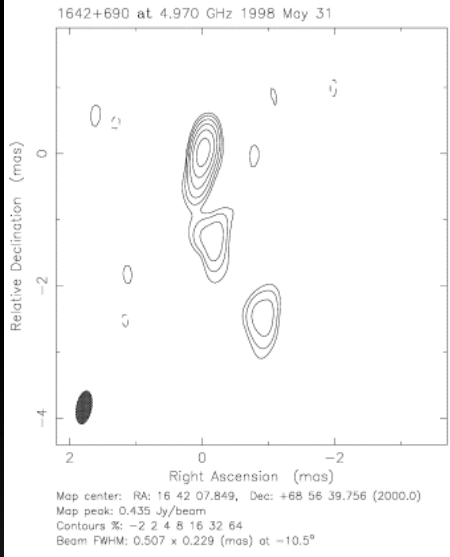
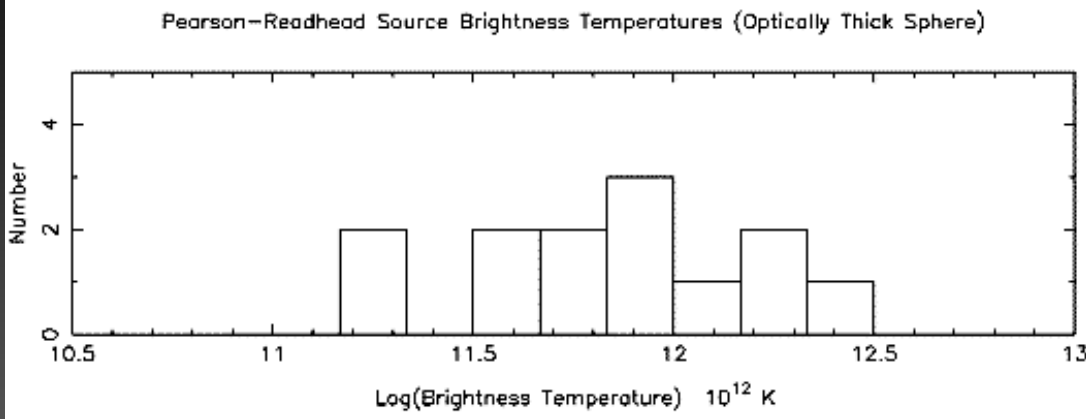
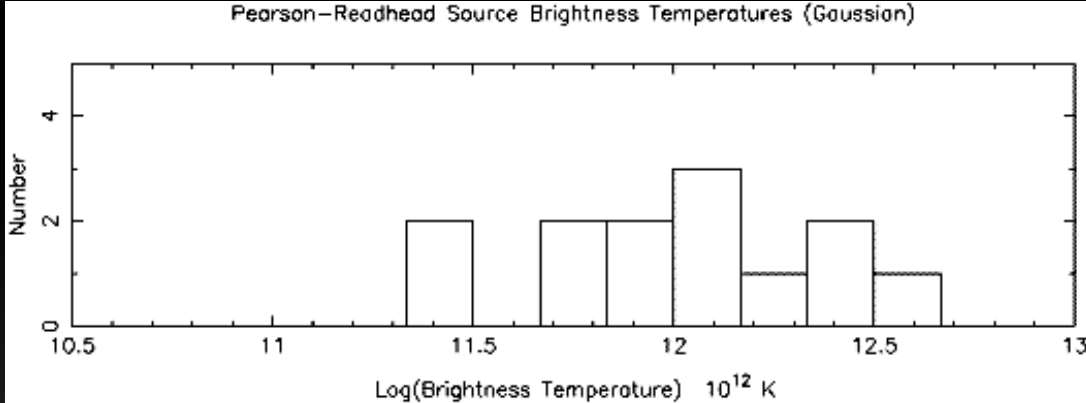


VLBI Space Observatory Programme



$$T_{12, \text{of}}(v_{\text{of}}) = \frac{1.22 S_{\text{jet}}(v_{\text{jet}})}{(1+z) a b v_{\text{jet}}^2} \delta_{\text{jet}} = T_{12, \text{jet}}(v_{\text{jet}}) \left(\frac{\delta_{\text{jet}}}{1+z} \right),$$

$$v_{\text{of}} = \frac{\delta_{\text{jet}}}{1+z} v_{\text{jet}},$$



Tingay et al. (1999, 2001)



Russia's RadioAstron space observatory

The RadioAstron observatory with an unprecedented high resolution capability will make it possible to observe remote objects in space

Parabolic antenna

- Diameter: 10 meters
- Comprises 27 carbon-plastic "petals"

Broad-beam antennas

Focal module

This is the first Russian orbital radio telescope

It will study:

- Galaxy nuclei
- Black holes
- Neutron stars
- Interstellar plasma clouds
- The Earth's gravitational field
- And many other objects and phenomena in the Universe

Ordered by: **Federal Space Agency**

Chief contractor: **Lavochkin Research and Production Association**

Scientific equipment developed by: **Astro Space Center of the Russian Academy of Sciences' Lebedev Physics Institute**

The RadioAstron observatory was launched on July 18, 2011.

Active service life: **At least five years**

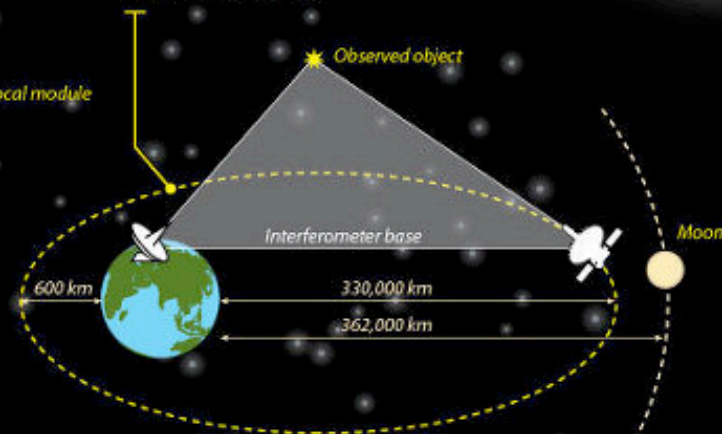
Navigator service module

High-capacity radio facility

Solar batteries

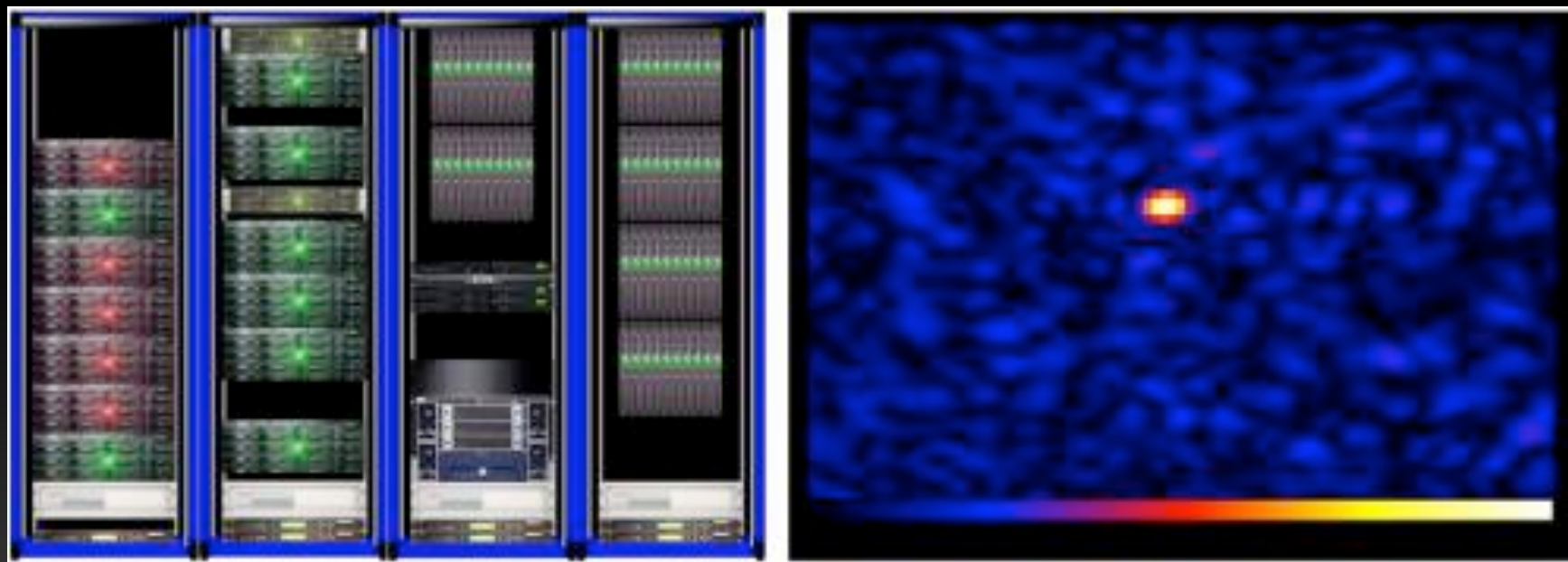
Highly elliptical orbit

- Apogee: 330,000 kilometers
- Perigee: 600 km
- Orbital period: 8.2 days



The RadioAstron observatory will operate with an international network of ground-based radio telescopes. This huge ground- and space-based telescope system, also called an interferometer, will provide the finest angular resolution.

This will make it possible to obtain images of remote objects with a resolution exceeding that of NASA's Hubble orbital telescope a thousand times over



<http://phys.org/news/2012-07-earth-fringes-effelsberg-radioastron-difx.html>



SUMMARY

- Very Long Baseline Interferometry (VLBI) the highest angular resolution direct imaging technique in all of astronomy;
- Long baselines sensitive to smallest structures and highest brightness temperature emission;
- Tracer of most energetic and dynamic processes in the Universe:
 - Active Galactic Nuclei;
 - Pulsars;
 - Supernovae;
 - GRBs;
 - X-ray binaries;
 - MASERS.
- Also, novel techniques:
 - SETI
- Regional and global VLBI arrays available, Australian LBA only VLBI facility in Southern Hemisphere;
- Plenty of help to get started at Curtin University and CASS ATNF.