Radio Telescopes Around the World

Lincoln Greenhill

Thirteenth Synthesis Imaging Workshop

2012 May 29– June 5

NRAO

Associated Universities, Inc.

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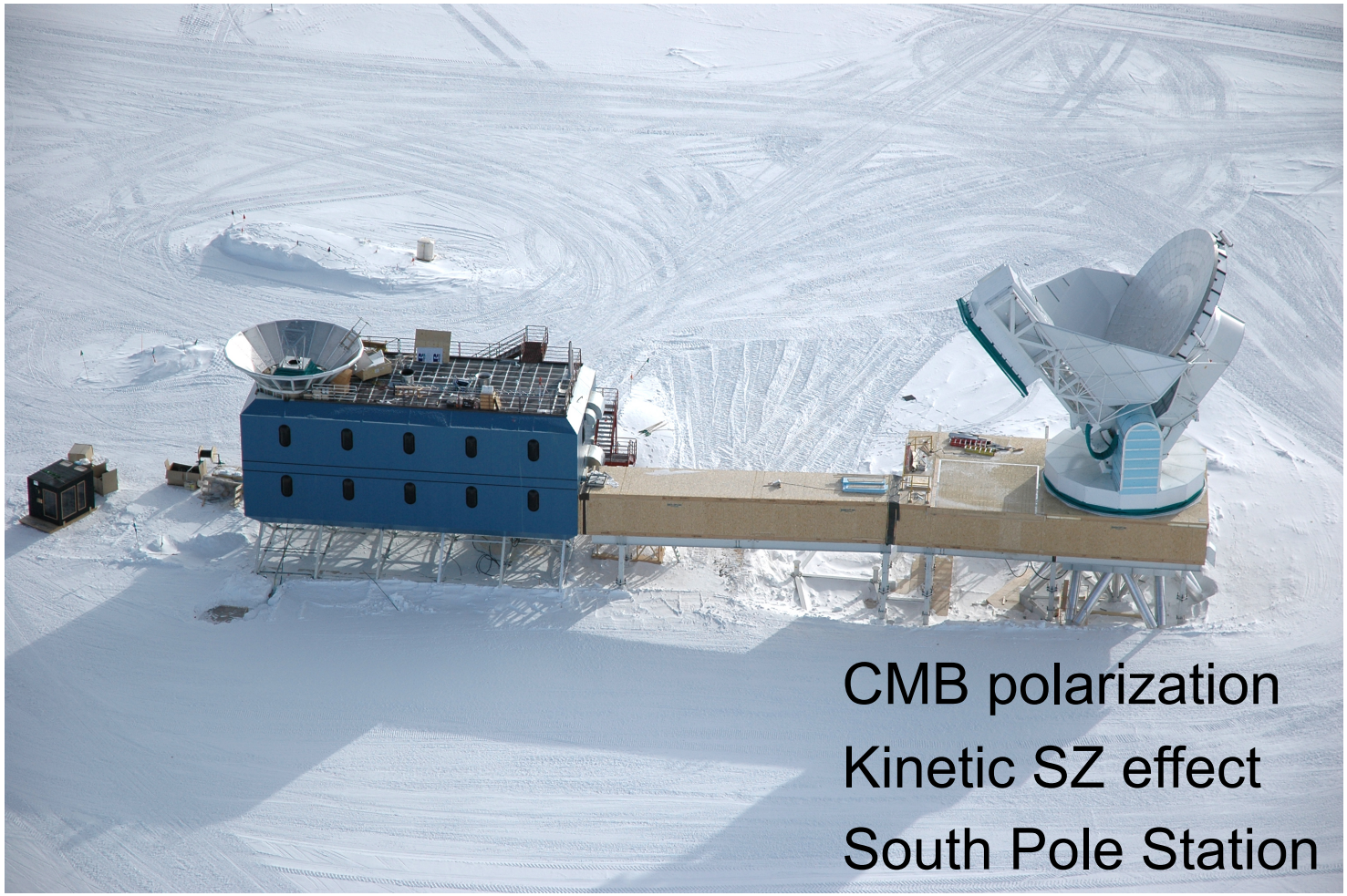
Radio Telescopes Around the World

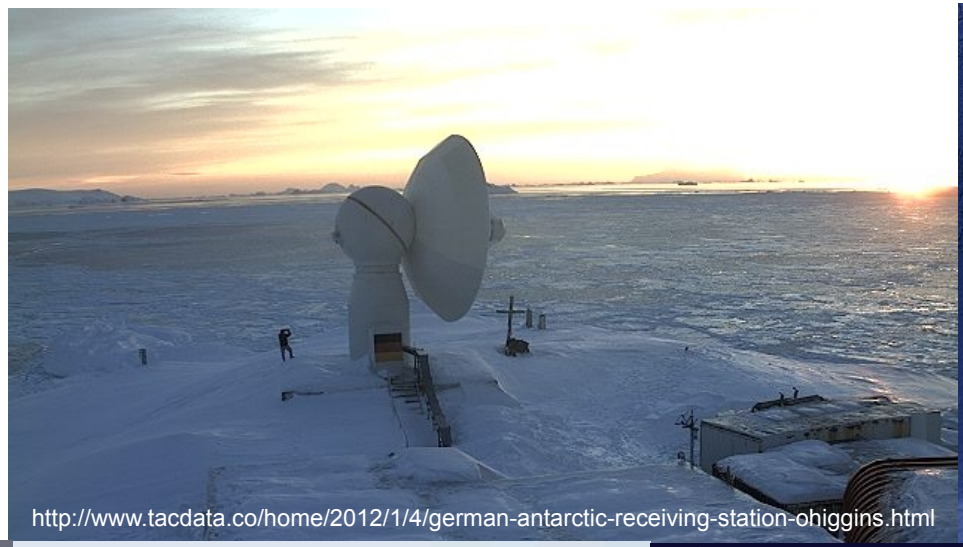
- What drives location?
  - m/cm-wave
    - RF quiet conditions
      - e.g., the AU SKA site: 600 km into the WA desert
  - mm/submm
    - dry conditions
      - Atacama, Greenland, Antarctica, Mauna Kea
      - baloons, space
    - absent tropospheric O_2 line
  - VLBI
    - geographic distribution (diversity a/o filling)
    - super-terrestrial baselines

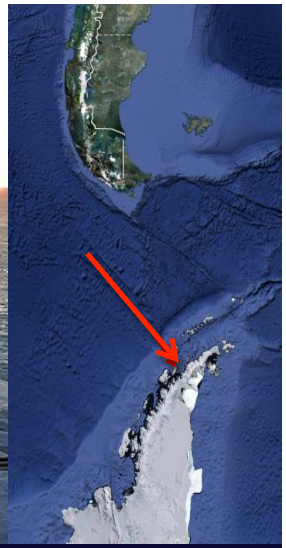
Radio Telescopes Around the World

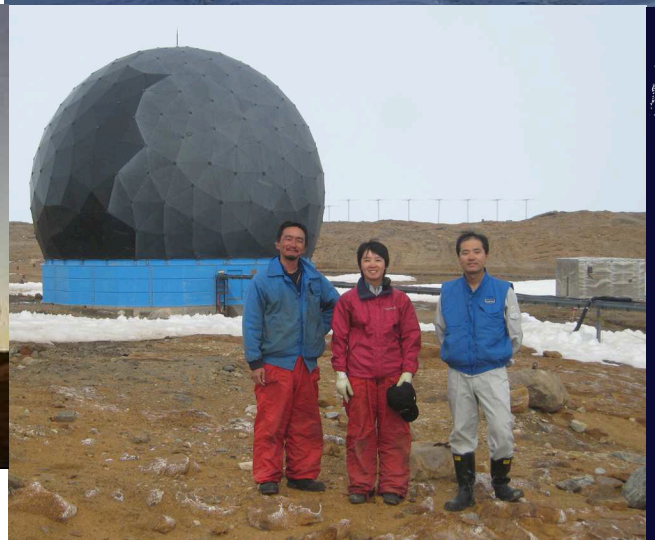


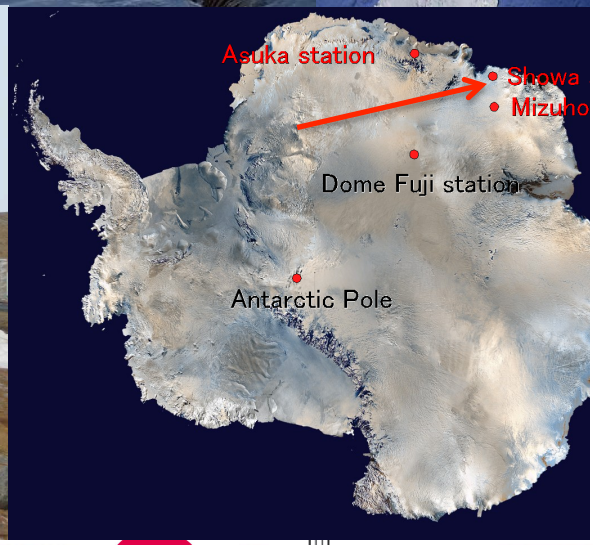
Radio Telescopes Around the World

- Telescopes at extremes
  - Antarctica:
    - Syowa, O'Higgins
  - Arctic:
    - Ny Alesund
  - VLBI stations









Radio Telescopes Around the World

SAO Submillimeter Array
Mauna Kea (180-700 GHz)

Opting for Altitude

ALMA
Atacama (84-950 GHz)

Radio Telescopes Around the World

Opting for Altitude

CSO

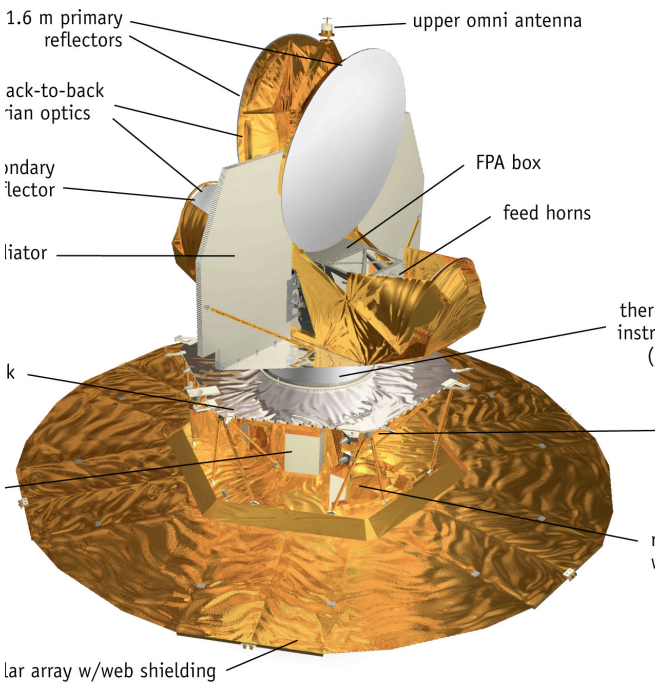
JCMT

Radio Telescopes Around the World

RadioAstron/Spektr-R (1-22 GHz)

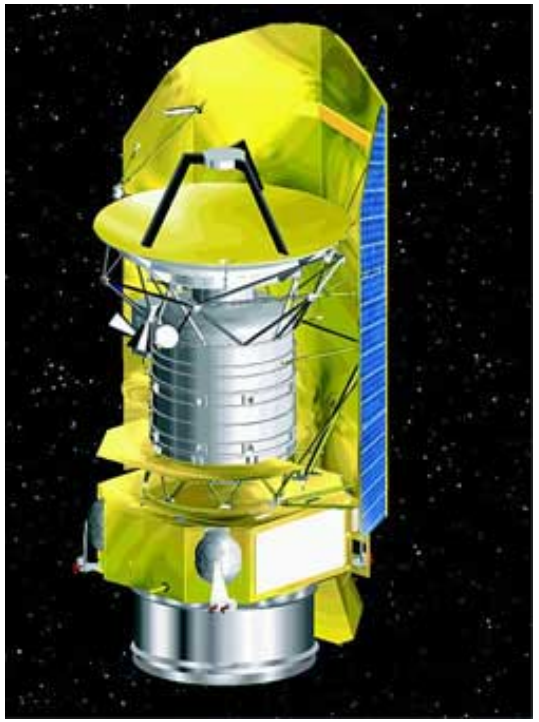
10,000-390,000 km orbit

Radio Telescopes Around the World



WMAP (23-94 GHz)

Planck (100-857 GHz)



Herschel (>480 GHz)

"Radio Telescopes Around the World"

How many are there?

First stop … Google

2nd Hit

10 Spectacular Radio Telescopes around the World ~ Kuriositas

www.kuriositas.com/.../10-spectacular-**radio-telescopes-around**.html

Mar 24, 2012 – **Radio telescopes** can be found the **world over**. They are used in radio astronomy, the science of studying, at radio frequencies, celestial objects ...

kuriositas

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Radio Telescopes Around the World

SATURDAY, 24 MARCH 2012

10 Spectacular Radio Telescopes around the World

Like Send 181 likes. Sign Up to see what your friends like.

Take a whistle stop tour of some of the most spectacular radio telescopes in the world and find out about what actually goes on there. On almost all of the continents these giants command the landscape as they survey the skies.

Radio Telescopes Around the World

Image Credit Flickr User CHUCKage

Radio telescopes can be found the world over. They are used in radio astronomy, the science of studying, at radio frequencies, celestial objects such as galaxies and stars as well as more difficult to understand phenomena such as Masers and Pulsars. They also collect and track data from space probes and satellites that we have shot up in to the atmosphere and space. Here are some of the more significant and - in terms of design - beautiful radio telescopes in the world.

Radio Telescopes Around the World

Image Credit Flickr User CPG Grey

Now for the science - the VLA has investigated any number of astronomical issues. Radio galaxies are studied there, as are gamma ray bursts and black holes. It has also been used to receive data from the Voyager 2 spacecraft as it went past Neptune. It is something of a film star in its own right - with an impressive filmography that would induce jealousy in many an upcoming actor. It upstaged Jodie Foster in *Contact* and was the setting for the start of *2010*. You can also see it in the sci-fi films *Arrival*, *Terminator Salvation* and *Independence Day*. It has even featured in a number of pop videos.

not rec. for Rick Perley

Radio Telescopes Around the World

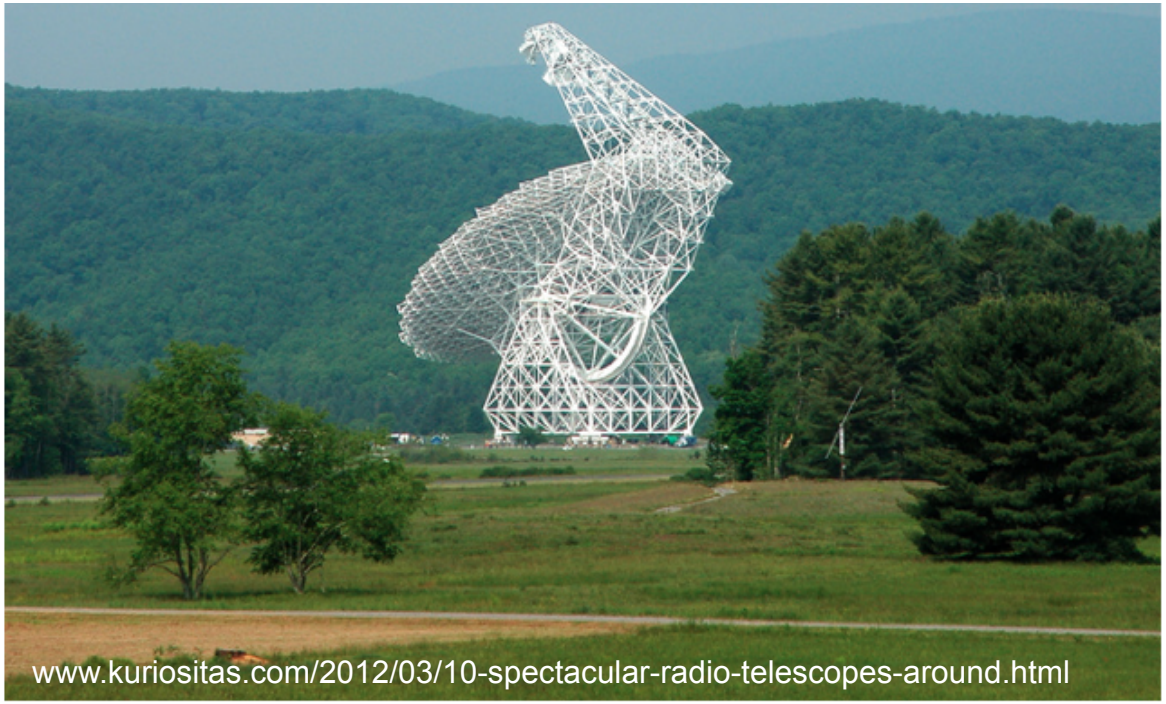

Image Credit Flickr User sofafort

It operates in several modes. Normal mode is when it is properly and fully functioning. It also has a safe mode which is used for maintenance and effectively shuts the whole thing down. Finally there is snow mode which is used to combat the severe West Virginian winters. In this mode it heats up enough to melt off the snow from its structure. It has been the site of numerous discoveries, including that of three millisecond pulsars and a large magnetic field in the Orion Cluster. It also discovered a hydrogen gas superbubble (a cavity in space that can measure hundred of light years across) over twenty three thousand light years away.

Radio Telescopes Around the World

The Lovell Telescope at Jodrell Bank

Image Credit Flickr User C@rl Jones

It was originally known, on its completion in 1957 as the Mark 1, but is now known the world over as the Lovell Telescope. The dish had a diameter of just over seventy six meters and it is the third largest movable radio telescope on planet earth. Amazingly, it is a symbol of recycling as well - one would imagine that these enormous beasts would have to be made from scratch. However, Britain in the 1950s was not cash rich and the motor systems of the Lovell were made from the gun turret mechanisms of two retired battleships.

Radio Telescopes Around the World

Image Credit Flickr User amandabhslater

The telescope has been used to track a number of probes, including the Pioneer 5, to which it sent commands. It also tracked the soviet Luna 9 probe that landed on the moon in 1966. In an extraordinary cheeky bit of Britishness the chaps at Lovell 'stole' the facsimile transmissions of pictures from the moon and they were published by the British press before the Russians had a chance to release them. It has also been used for a large variety of scientific observations, including SETI and measuring the distance between bodies in the solar system.

For the experts: do you recognize this antenna?

Radio Telescopes Around the World

Image Credit Flickr User ToniFish

To give it its full name, the Parkes Radiothermal Telescope is the pride of Australia. It was put in to play in 1961 and has a sixty four meter dish. Like some of the other telescopes featured here, it has also been in the movies, the most notable being *The Dish*, a fictional account of its involvement in relaying the images of the Apollo 11 landing on the moon around the world.

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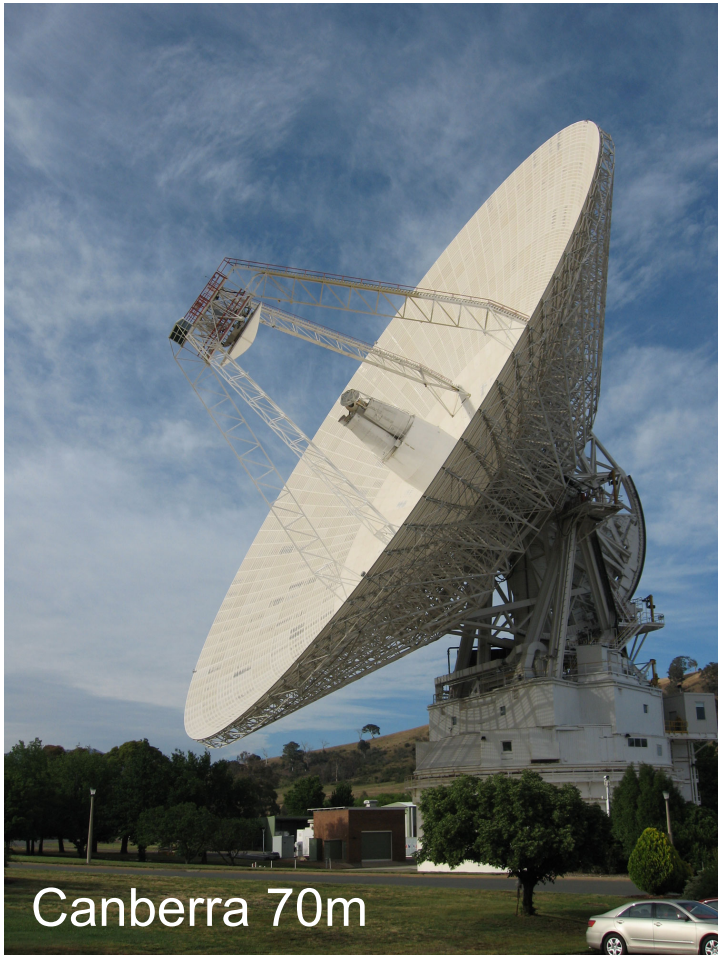
Radio Telescopes Around the World

Caption: CSIRO's Parkes radio telescope. Credit: David McClenaghan, CSIRO



Digression: what do these telescopes have in common?

Radio Telescopes Around the World

The heritage of a Master Equatorial

Innovative solution to a difficult engineering problem

Radio Telescopes Around the World

"unusual" configurations

Nancay

transit instr.
tilting flat refl.

Radio Telescopes Around the World

"unusual" configurations

innovative solution to building A_e

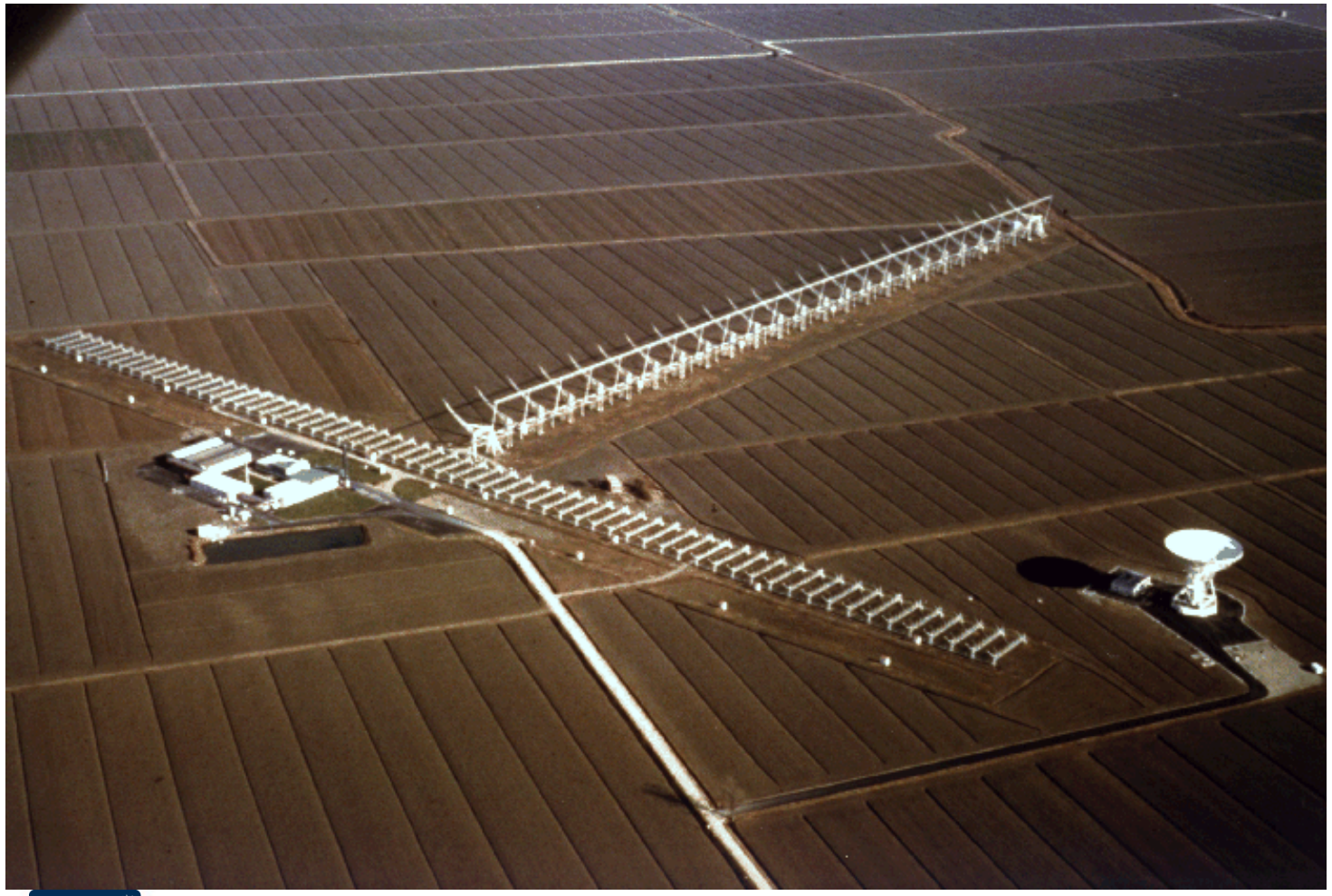
Molonglo

steerable

synthesis instr.

multiple feeds fan beam

Radio Telescopes Around the World



Northern Cross

steerable

synthesis instr.

multiple feeds fan beam

off-axis

"Radio Telescopes Around the World"

How many are there?

First stop … Google

About 2,040,000 results (0.32 seconds)

1st Hit

Telescopes around the world

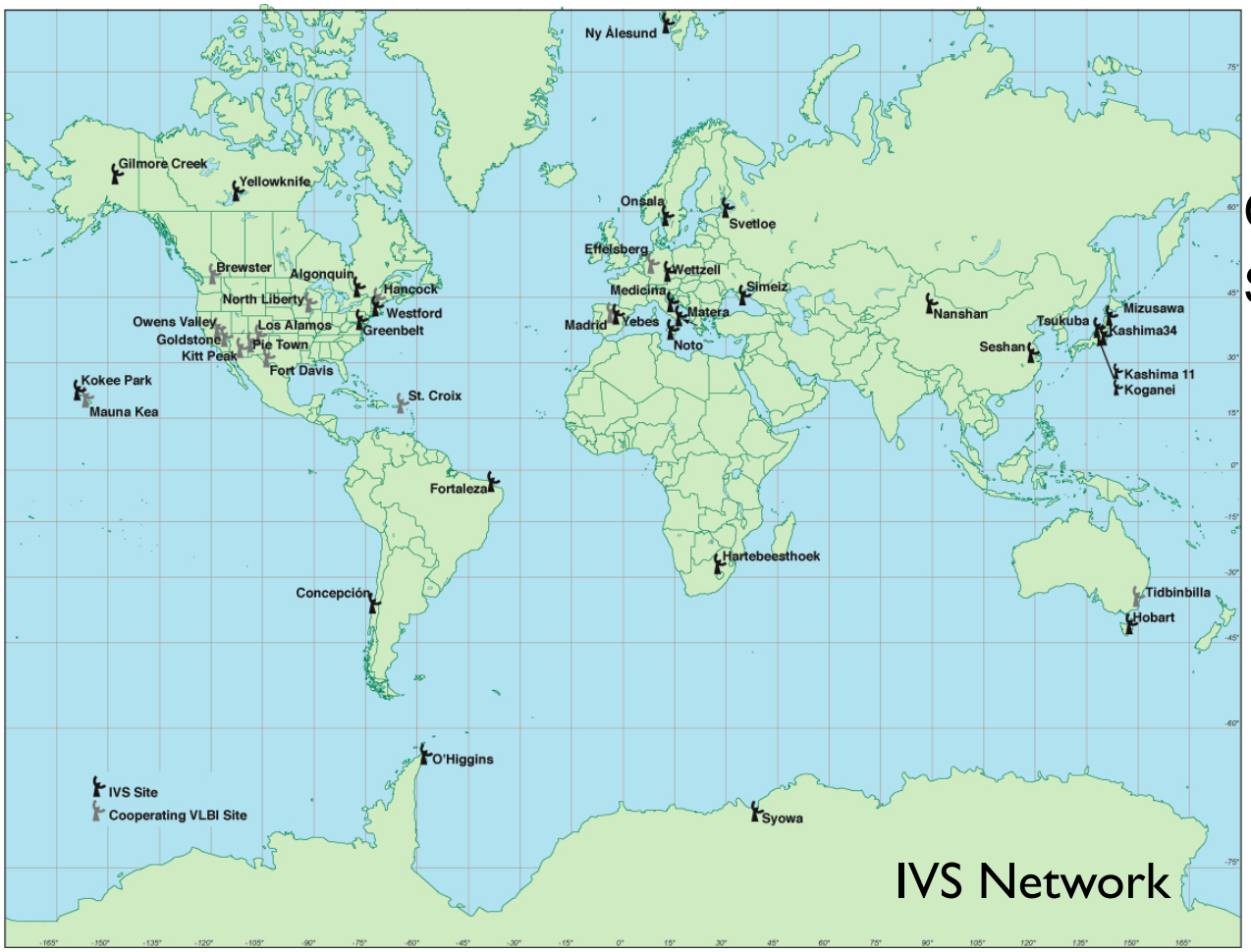
www.astro.uni-bonn.de/~rcbruens/links/**world**_map.html

Radio telescopes around the world. Click on the images to access the homepages of the telescopes.

Radio Telescopes Around the World – 26

www.astro.uni-bonn.de/~rcbruens/links/world_map.html

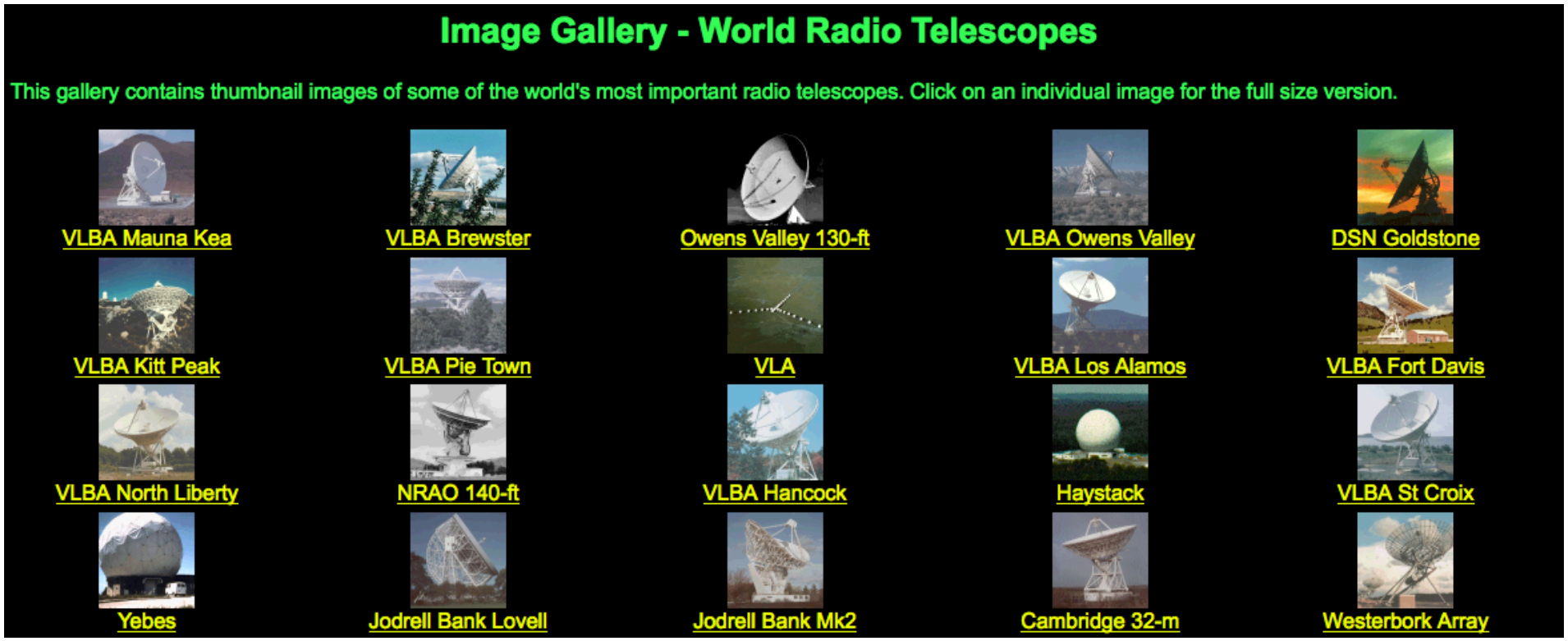
Radio Telescopes Around the World – 40



Obvious omissions

Some additions

Radio Telescopes Around the World – 45



mainly VLBI apertures

www.jb.man.ac.uk/vlbi/gallery/radtel.html

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Radio Telescopes Around the World – 108

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List of radio telescopes

From Wikipedia, the free encyclopedia

This is a **list of radio telescopes** - over one hundred - that are or have been used for radio astronomy. The list includes both single dishes and interferometric arrays. The list is sorted by region, then by name; unnamed telescopes are in reverse size order at the end of the lists.

This list is incomplete; you can help by expanding it.

Four antennas radio telescope, at the Atacama Large Millimeter Array (ALMA)

Contents [hide]

Africa [edit]

Name	Location	Remarks
HartRAO 26m	Hartebeesthoek Radio Astronomy Observatory, Johannesburg, South Africa	26 m dish.[1]
HartRAO XDM	Hartebeesthoek Radio Astronomy Observatory, Johannesburg, South Africa	15m *Experimental Demonstrator Model* originally build as a technology demonstrator for MeerKAT[2]
Indlebe	Durban University of Technology, Durban, South Africa	5 meter parabolic reflector[3]
KAT-7	Carnarvon, South Africa	Seven, 12 meter dishes, measuring 1200-1950 MHz.
MeerKAT	Carnarvon, South Africa	A pathfinder for the Square Kilometre Array.[4]
Precision Array for Probing the Epoch of Reionization (PAPER)	Carnarvon, South Africa	Sixty-four, two-meter dishes, measuring 100-200 MHz. Currently, this interferometer has more dishes than any other.

Antarctica [edit]

Name	Location	Remarks
Degree Angular Scale Interferometer (DASI)	Amundsen-Scott South Pole Station	13-element interferometer measuring anisotropies in the cosmic microwave background.[5]

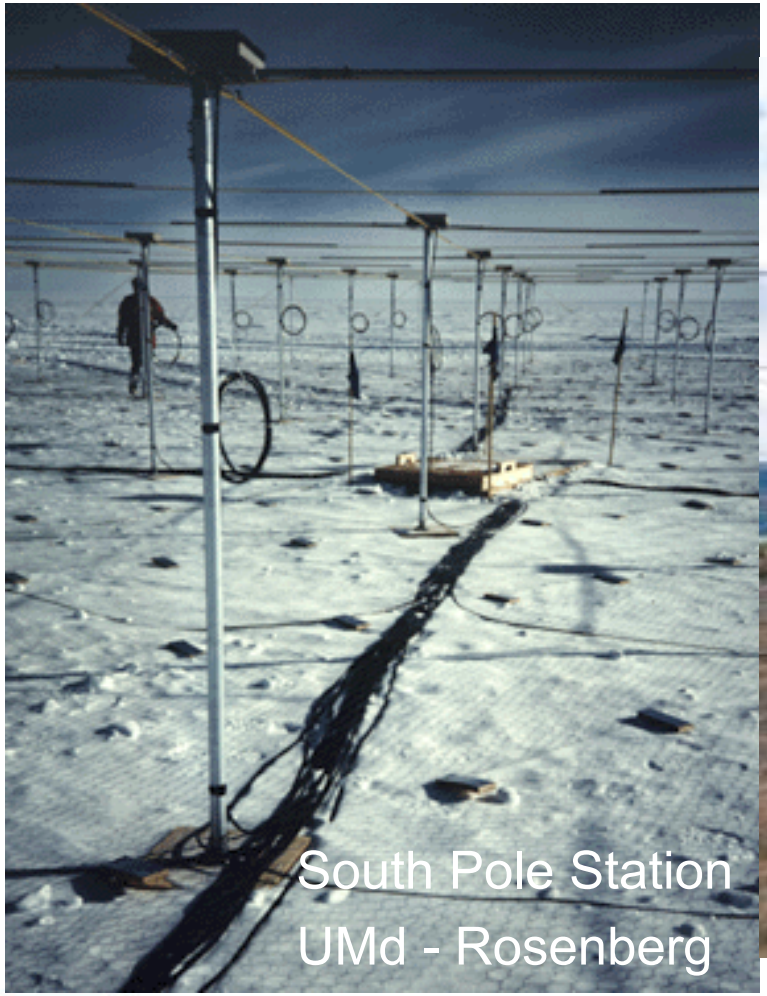
- Some retired
- Some perhaps not well instrumented
- Excludes: geodetic network, VLBA, VERA, EAVN, KVN, …
- Excludes: WMAP, Planck, Herschel
- Excludes: imaging riometers

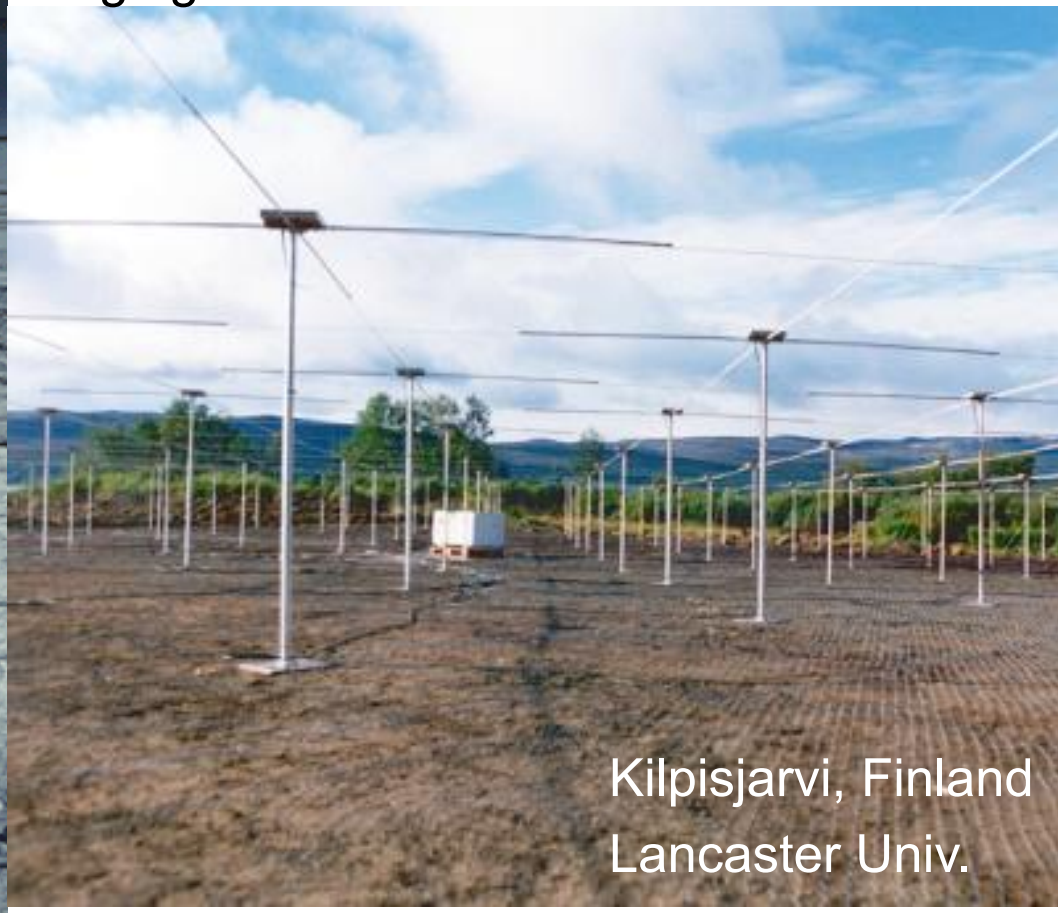
Radio Telescopes Around the World

- What is an imaging riometer?
  - relative ionospheric opacity …
  - low frequency array
    - 20, 30, 38 MHz
  - measures apparent changes in galactic emission due to plasma variability
  - obtain ‘quiet day’ data (a map of the galaxy) and subtract it
    - aeronomy pursues the residual
  - a curiosity from our perspective (*perhaps)*
    - angular resolution O(1-10°)
    - ≪300 kHz bandwidth

Radio Telescopes Around the World

Imaging Riometers





Radio Telescopes Around the World

LWA (10-88 MHz)

Radio Telescopes Around the World

PAPER @ 25%

Radio Telescopes Around the World

MWA 25% prototype

Radio Telescopes Around the World

Hypothetical Large-N Configuration

Summary

- How many are there?
  - over 100
  - amazing
- space, ground
- mid-latitude, polar
- individual dishes, interferometers