

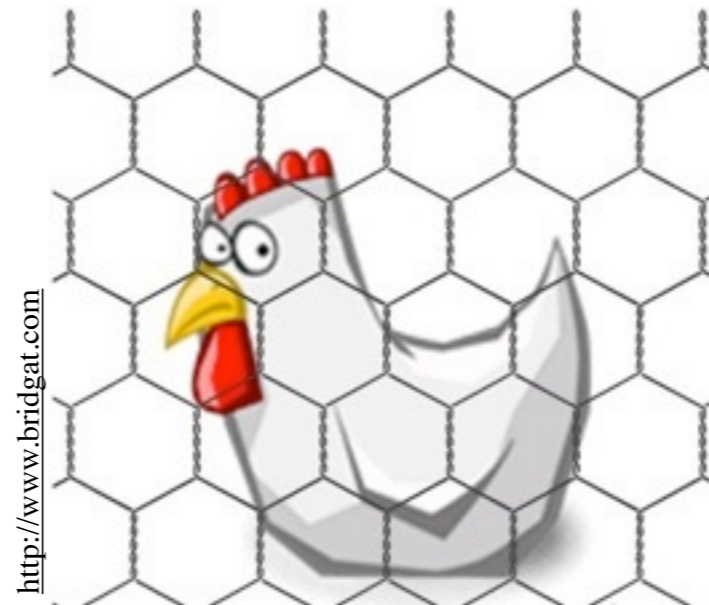
# What is Radio Astronomy?



**Dr. Greg Madsen**  
Senior Research Fellow  
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# Science with Dishes, Chicken Wire, and Supercomputers



iVEC @ Murdoch Univ



**Dr. Greg Madsen**  
Senior Research Fellow  
Univ. of Sydney



- School in Chicago, Illinois
- Uni degrees in Physics & Maths
- PhD in Astrophysics in Wisconsin
- Researcher at Australian Astronomical Observatory
- Senior researcher and lecturer at University of Sydney
  - Use telescopes, make computer programs, write research papers, go to conferences
- Free time: scuba diving, rock climbing, skydiving, ice hockey



Chicago



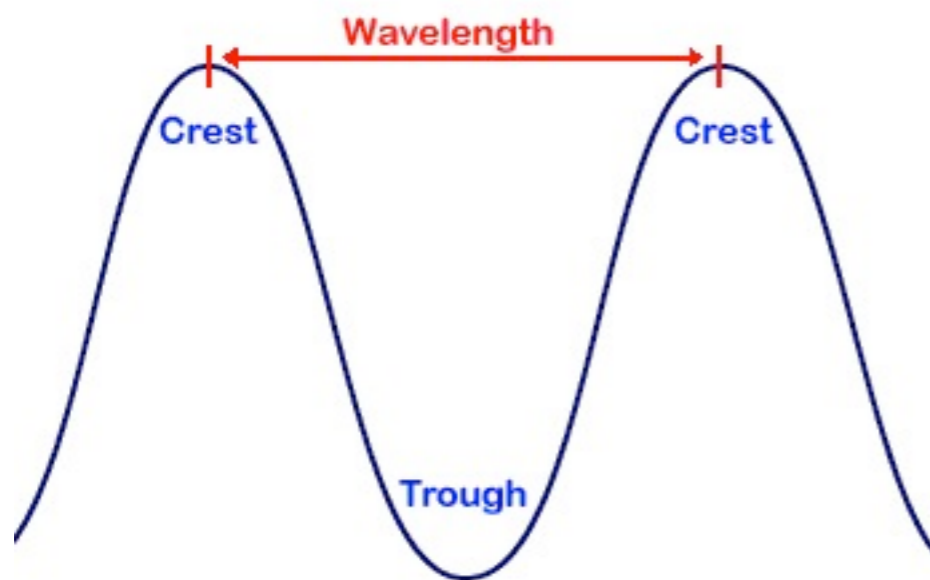
Me



# What are Radio Waves?

- *All* forms of light can be thought of as waves
  - waves move through space at speed of light (300,000 km/s)
- Type of wave depends on its *wavelength*
  - visible, ultraviolet, infrared, radio, microwave, X-rays, ...

<http://science.hq.nasa.gov/>



**Blue** light: 0.00004 cm

**Red** light: 0.00007 cm

Radio light: 0.1 cm to 100,000 cm

Mobile Phone: 333 cm

Triple J: 280 cm



Two basic methods for detecting radio waves:

## 1. Dishes

- radio waves bounce off a large curved surface
- focused onto a detector



© CSIRO

Parkes, NSW  
64 meter diameter



© SRI International

Arecibo, Puerto Rico  
305 meter diameter

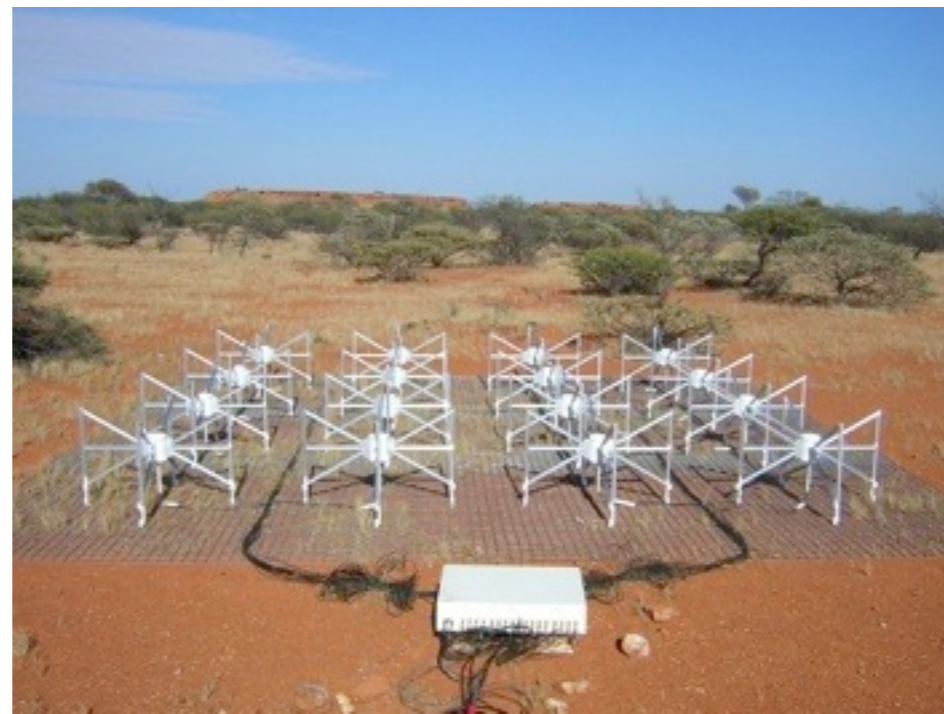
## 2. Antennas

- radio waves hit a metallic object
- they cause “electrons” in the metal to vibrate
- use electronic devices to measure the vibrations



Wikipedia

TV Antenna



“Droopy Dipoles”  
Murchison, WA

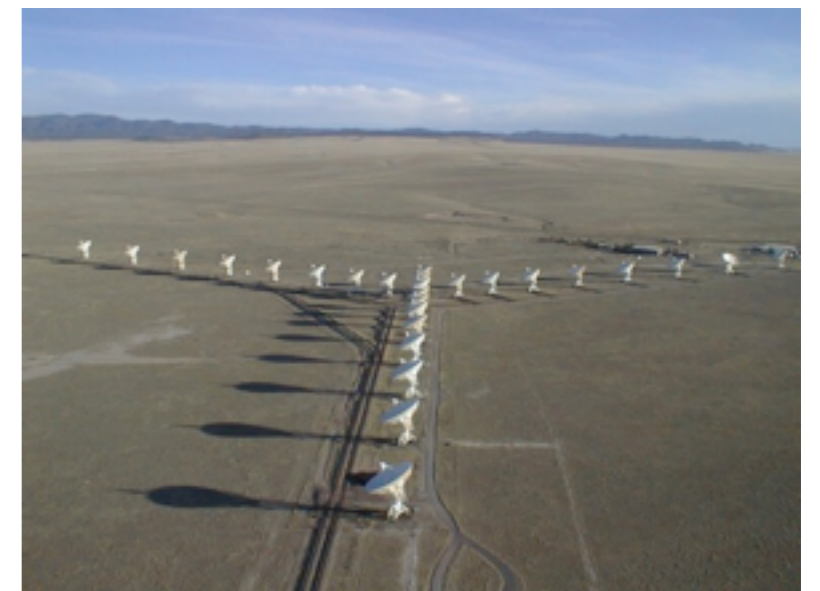


“Low Frequency Array”  
Chilbolton, UK

- Optical astronomy
  - large, high-quality mirrors very expensive
  - can only observe on clear nights
  - ability to resolve objects:
    - limited by ‘twinkling’
    - depends on size of mirror
- Radio astronomy
  - observe during day, through clouds & rain
  - dishes & antennas relatively cheap
  - ability to resolve objects:
    - unlimited (almost)
    - use a special trick: “interferometry”



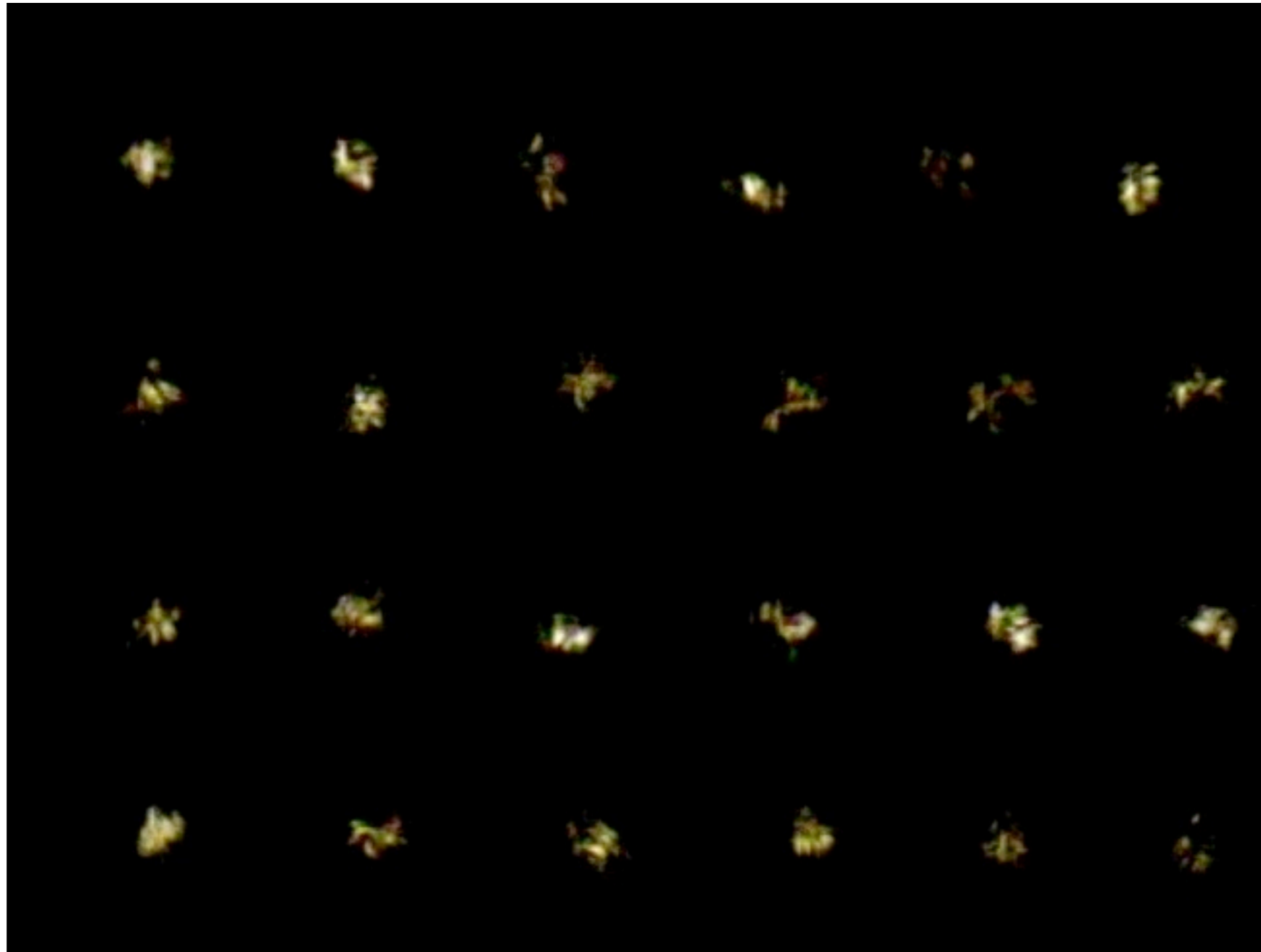
“VLT” in Chile



“VLA” in USA



# Twinkle, Twinkle.....



<http://www.astr.ua.edu>

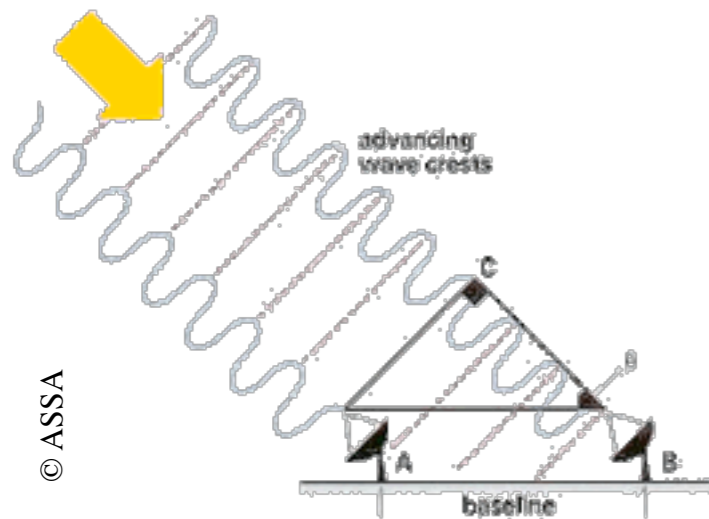
Time lapse optical images of a bright star  
Exposure time: 0.01 sec per frame





# Interferometry

- Radio telescopes can record the arrival of radio waves very accurately
- Build several radio telescopes next to each other
- Combine the signals to get a crisp image!



© ASSA



© CSIRO

ATCA  
Narrabri, NSW



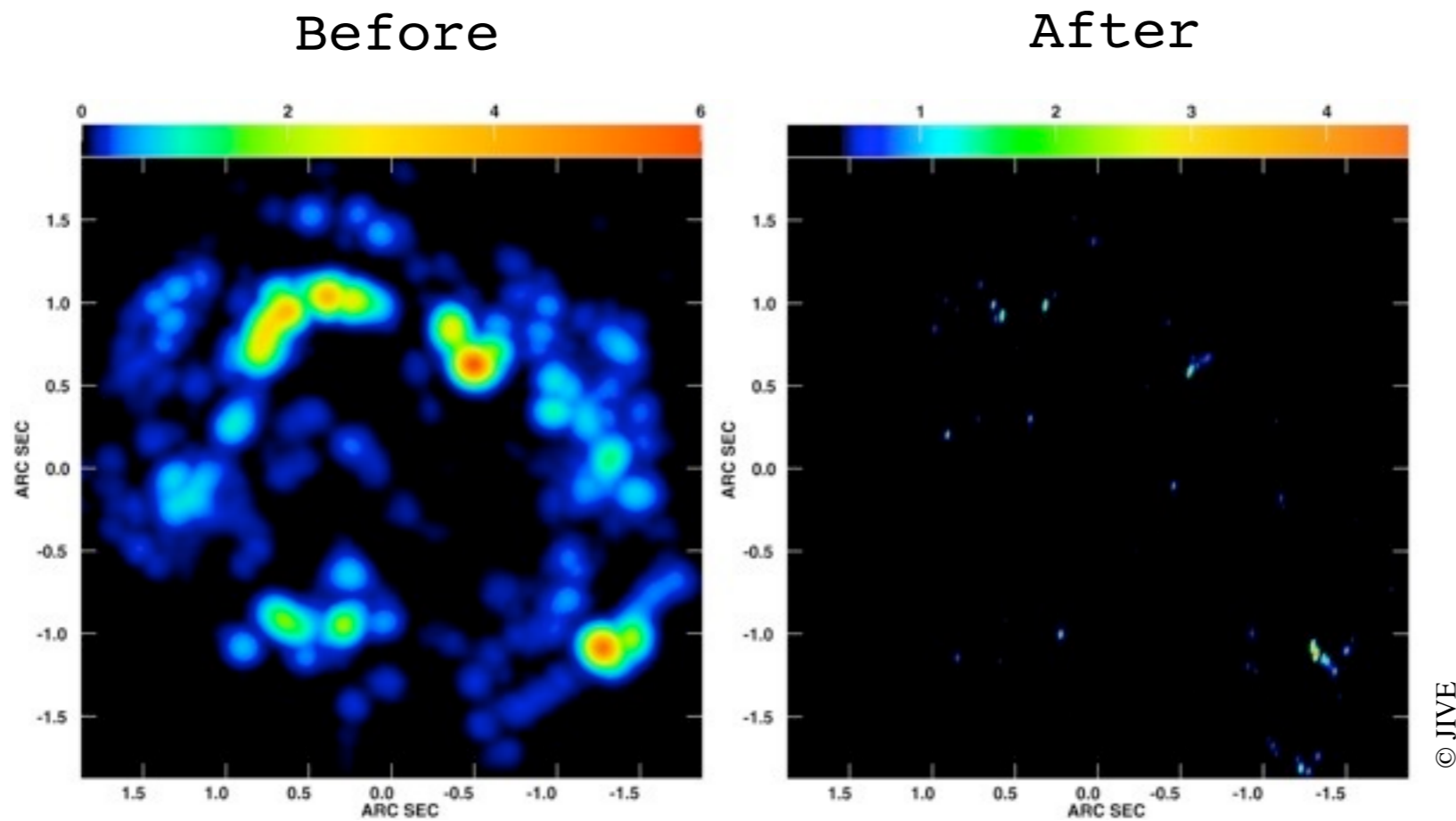
© NCRA

GMRT  
Pune, India



# Interferometry

- The bigger the separation of telescopes, the crisper the image
- Combine signals from arrays of telescopes around the world (or from space!)



Radio Image of the Wind of Dying Star

- Building a lot of dishes & antennas is cheap
- Combining the signals is hard!
- Example: “[SKA Molonglo Pathfinder](#)”
  - array of 384 antennas near Canberra
  - signal from each antenna split into 12,480 “colours”
  - combine signals from 67,528 unique pairs of antennas
  - spits out enough data to fill a DVD *every 30 seconds*



SKAMP Telescope



SKAMP Computers



## **BIG UNANSWERED QUESTIONS**

- How are stars made?
- How are disks & jets made?
- Where does the gas in galaxies come from?
- Where do cosmic magnetic fields come from?
- What are the objects that flicker, brighten, or disappear?
- ...

Use observations of radio waves to answer these questions !

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# Square Kilometre Array





- Radio waves
    - light with very long wavelengths
    - detected by dishes and/or antennas
    - signals combined to create very crisp images of sky
  - Radio astronomy seeks to answer fundamental questions about the Universe
  - Square Kilometre Array is the future of radio astronomy
    - to be built in Western Australia, ready by ~2025
    - just in time to be used by you!
-