Little green men and cosmic lighthouses

Hannah Middleton

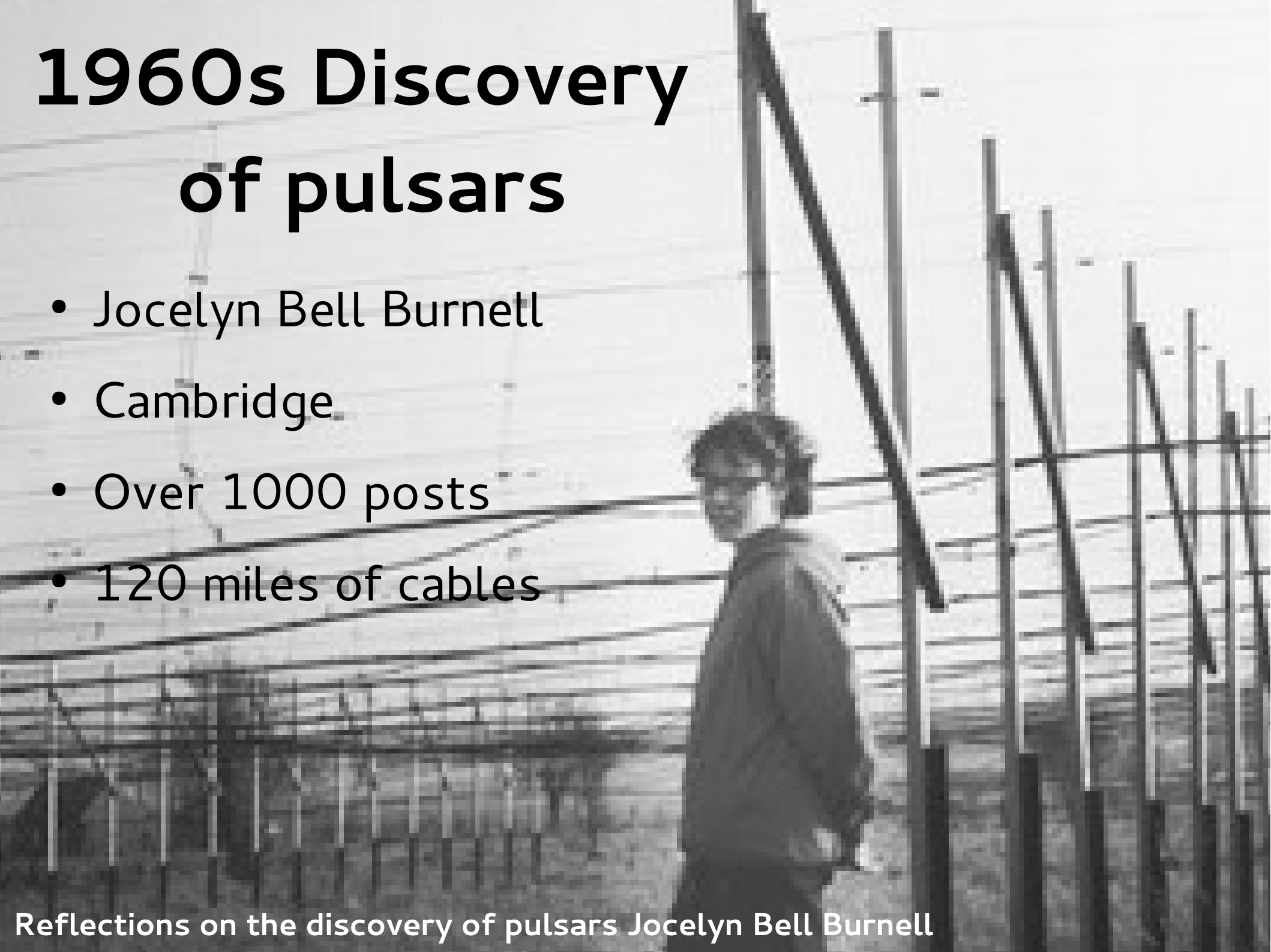
19 October 2016

Pulsars

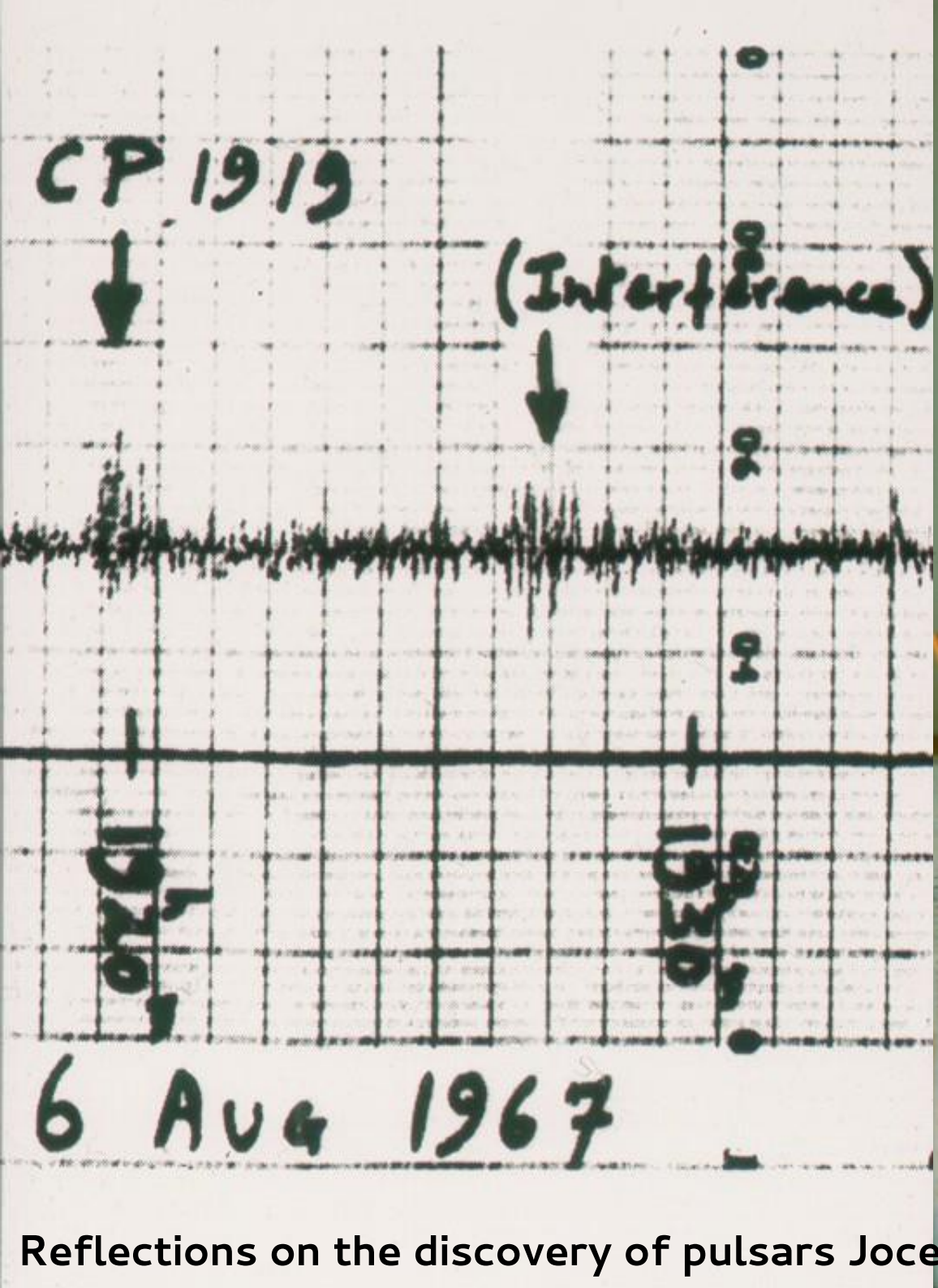
- Discovery
- What are pulsars?
- What can we use them for?
  - Binary pulsar
  - Double pulsar
  - Pulsar timing arrays

1960s Discovery of pulsars

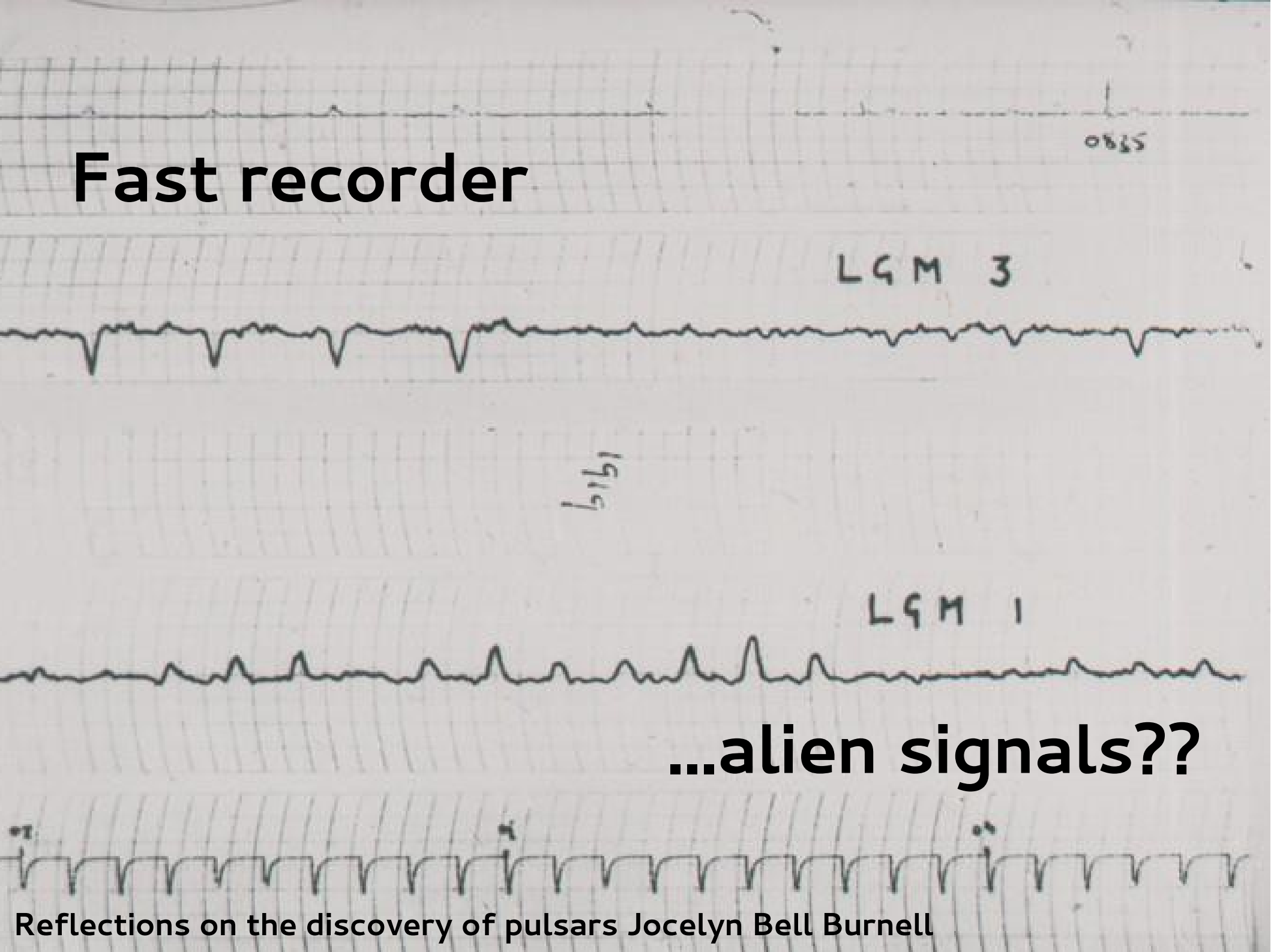
- Jocelyn Bell Burnell
- Cambridge
- Over 1000 posts
- 120 miles of cables



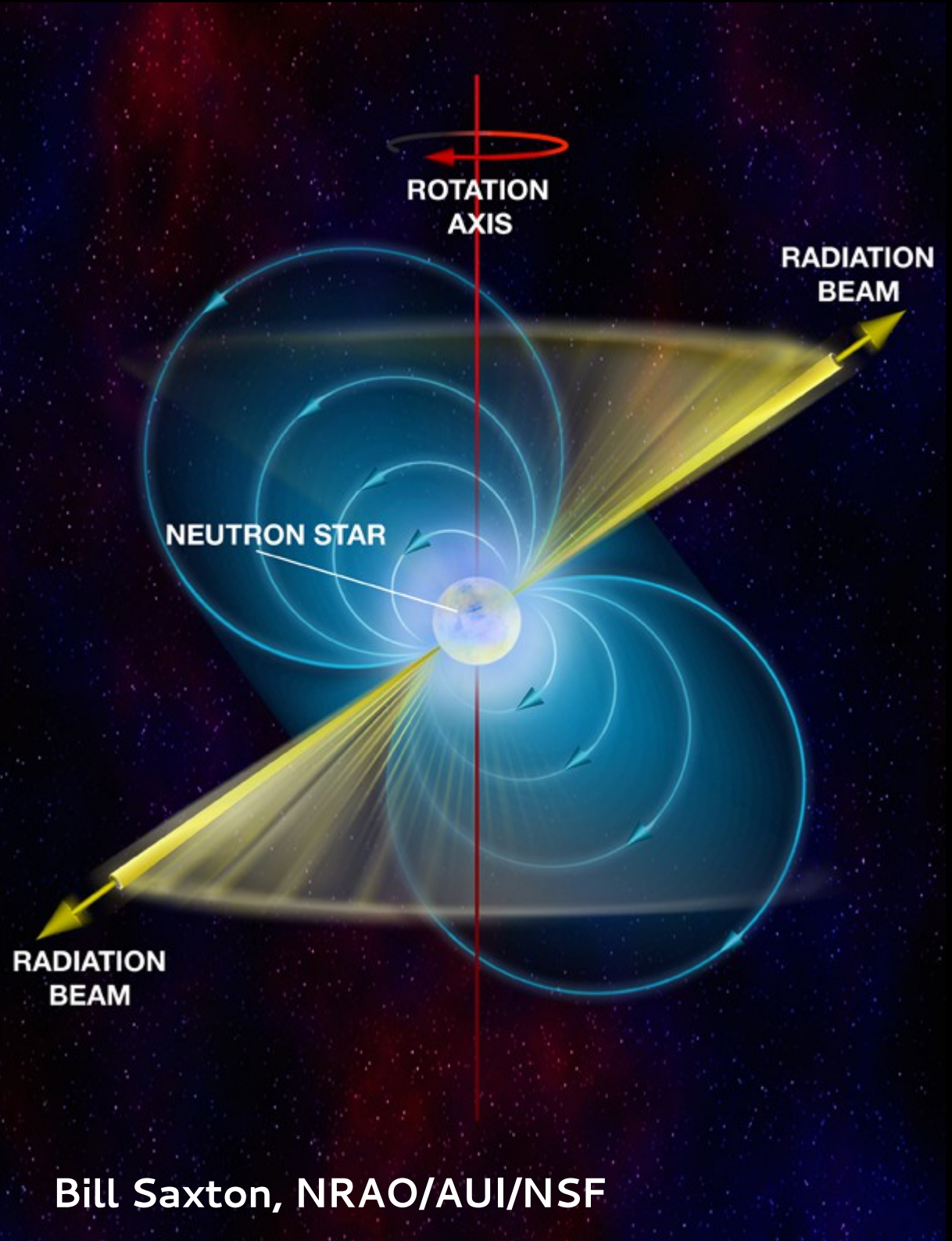
Reflections on the discovery of pulsars Jocelyn Bell Burnell



Reflections on the discovery of pulsars Jocelyn Bell Burnell



Reflections on the discovery of pulsars Jocelyn Bell Burnell



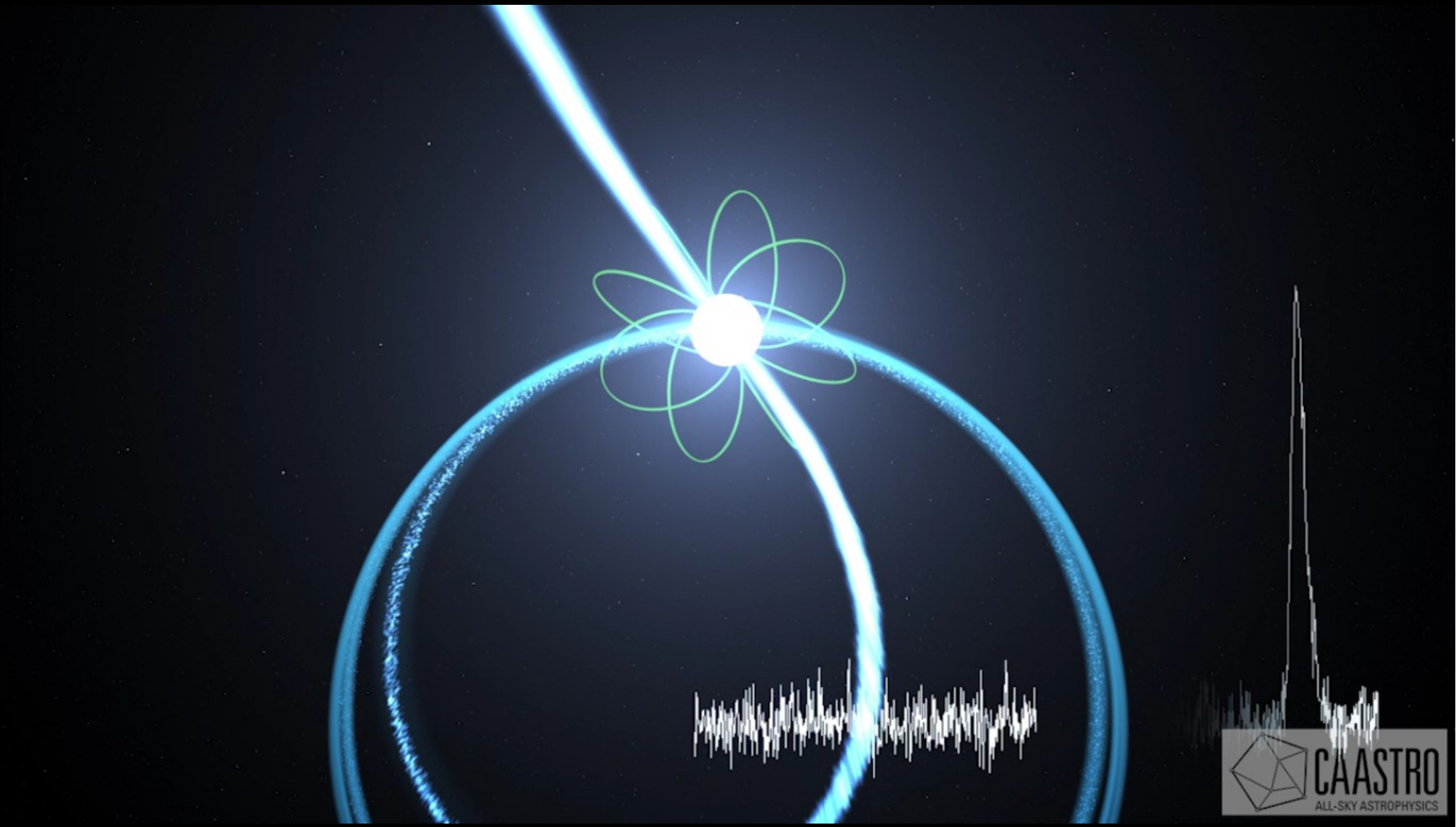
Pulsars

- Neutron stars
- About 1.4 times the mass of our Sun
- About 15km
- Rotating
- Magnetic field

Cosmic lighthouses

theneedles.co.uk

Nature's clocks

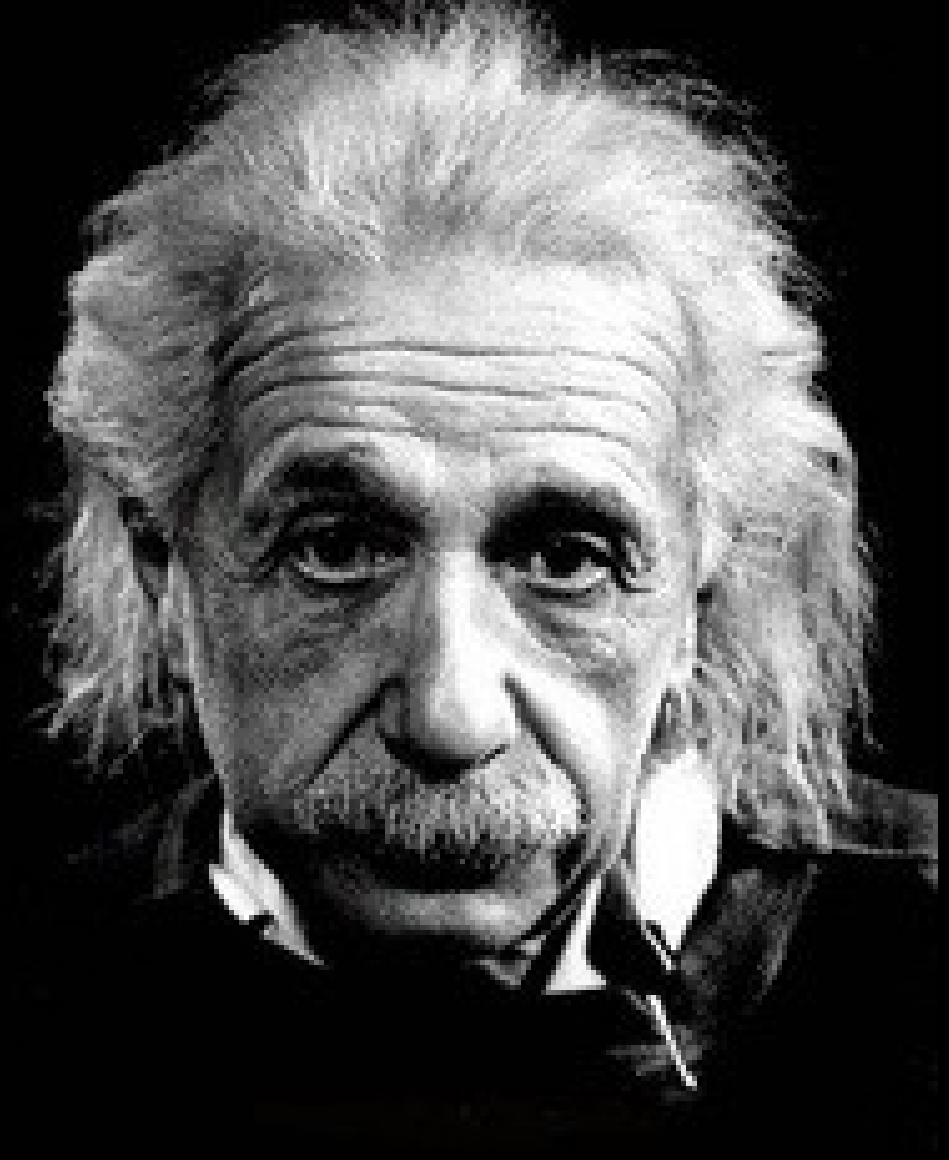


Swinburne Astronomy Productions

For full move see: http://www.astronomy.swin.edu.au/production/medialibrary/

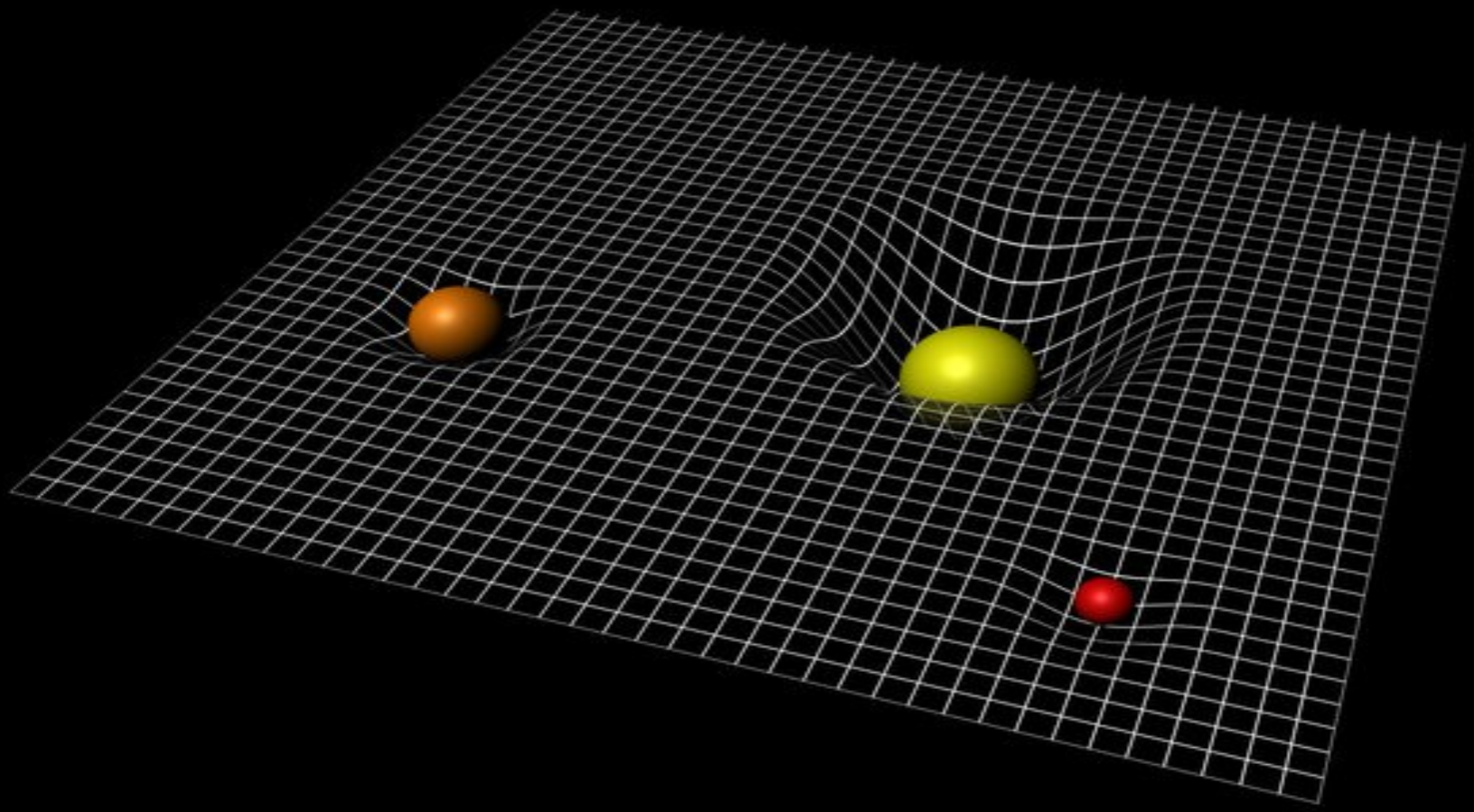
Pulsar Timing Telescopes

A.Holloway, University of Manchester,
H. Schweiker/WIYN and NOAO/AURA/NSF



Putting Einstein to the test

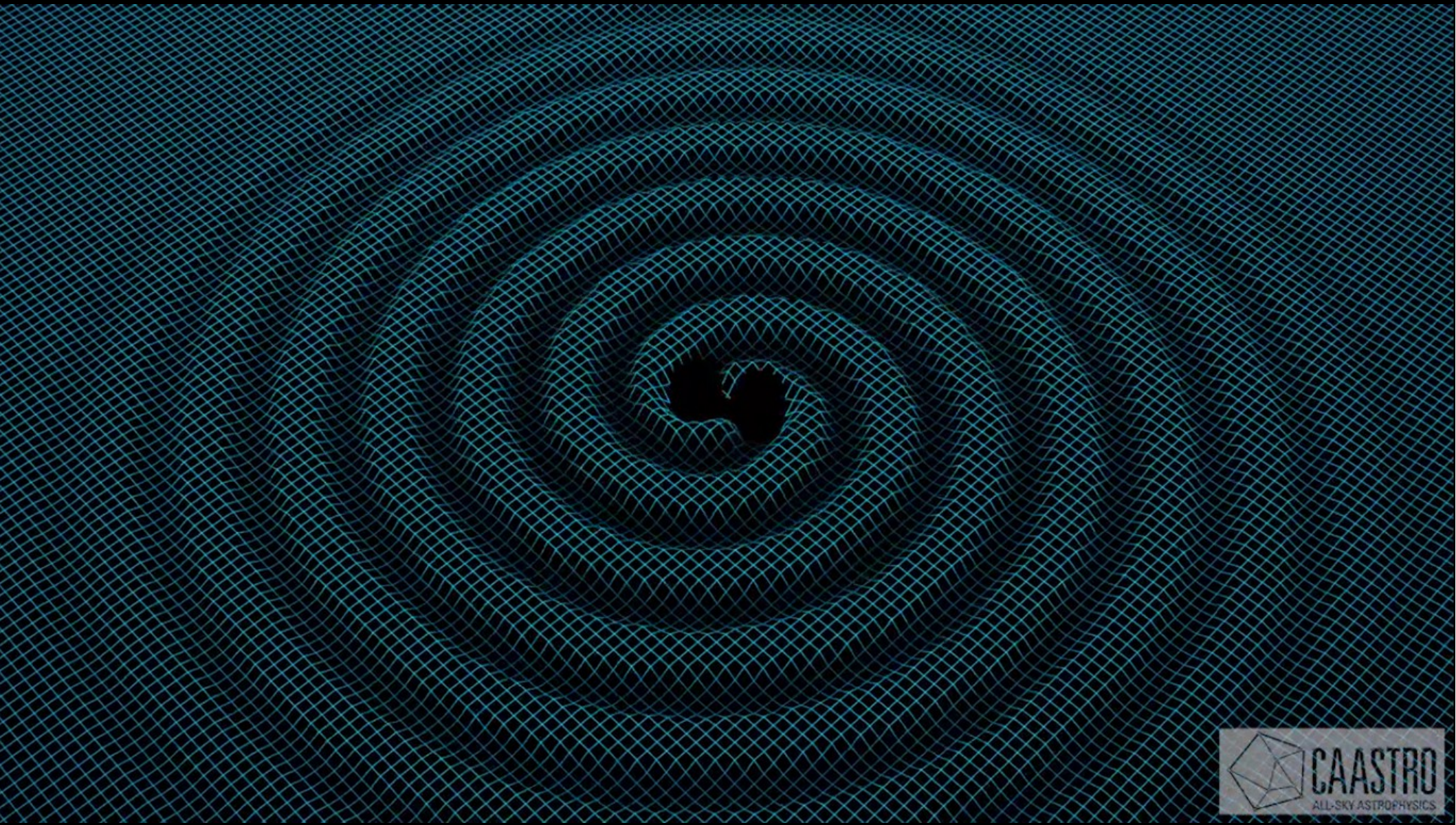
General relativity



ESA–C.Carreau


Gravitational waves
First detected
14 September 2015

Gravitational Waves



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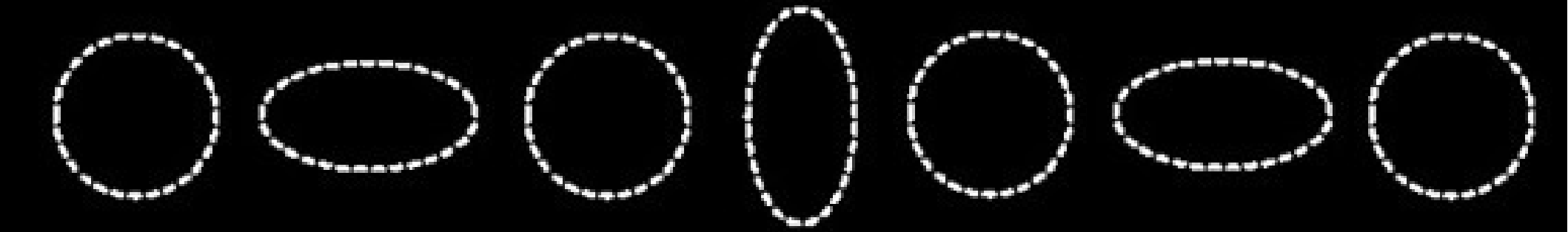
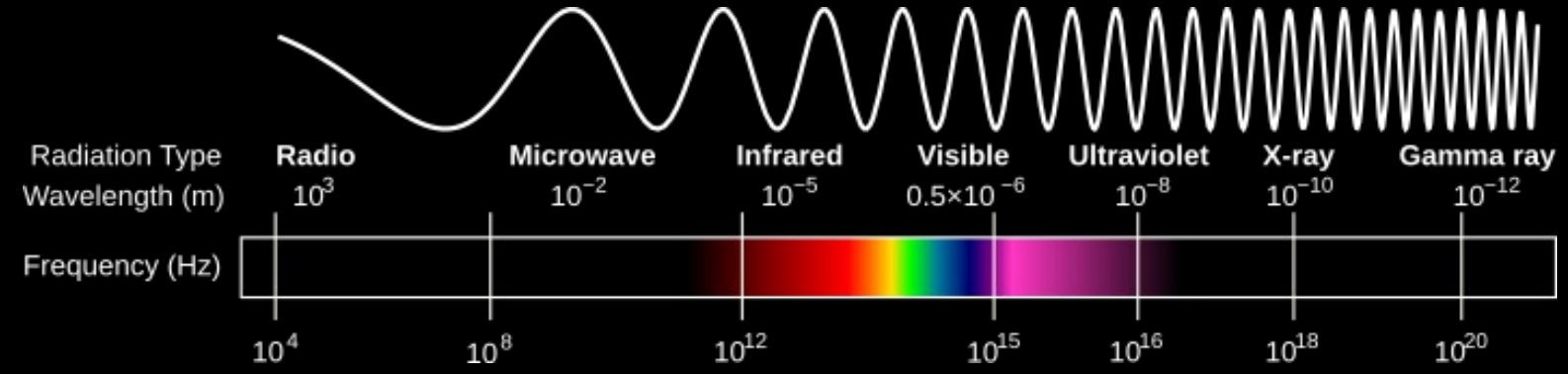
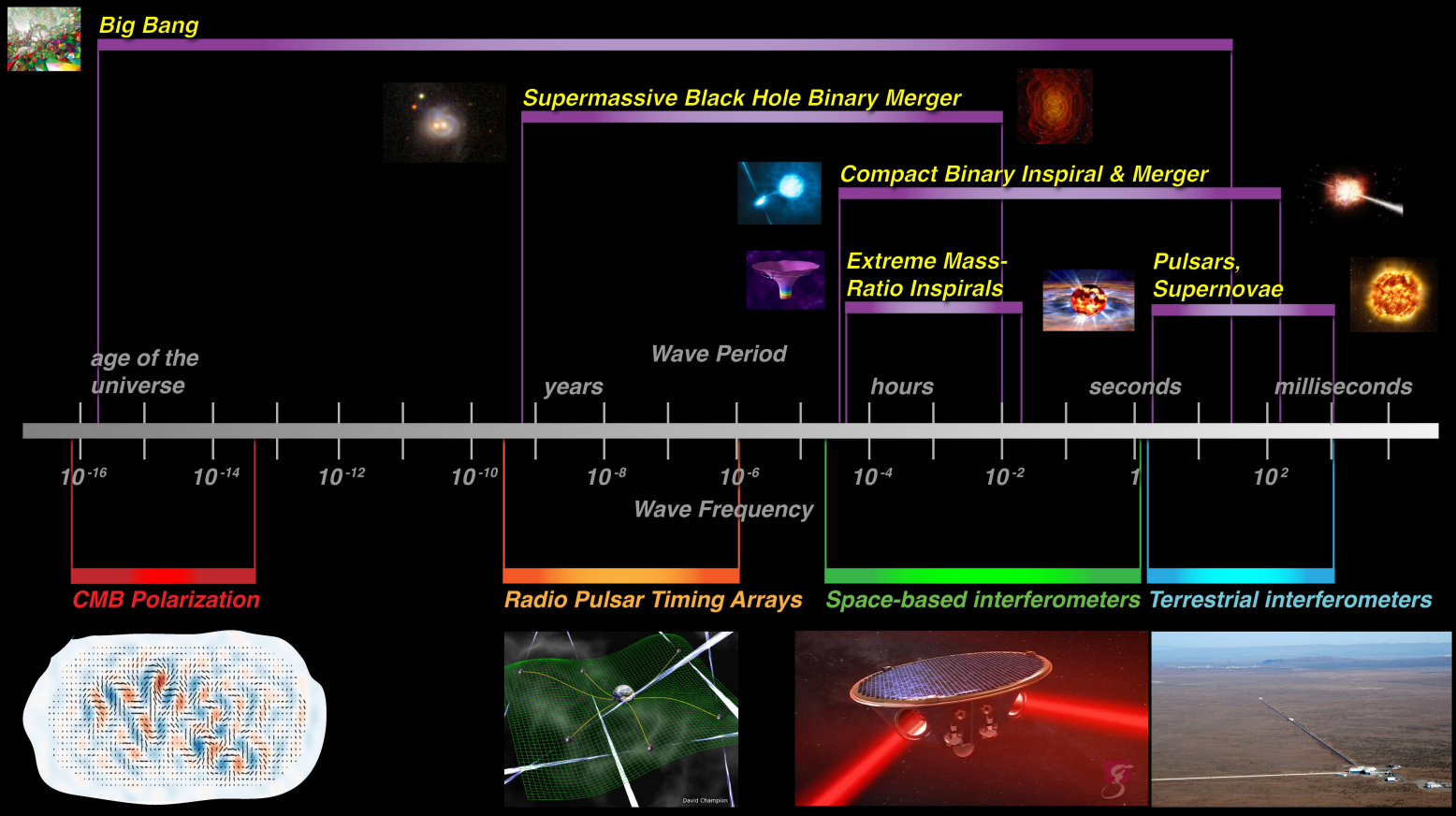
For full move see: http://www.astronomy.swin.edu.au/production/medialibrary/

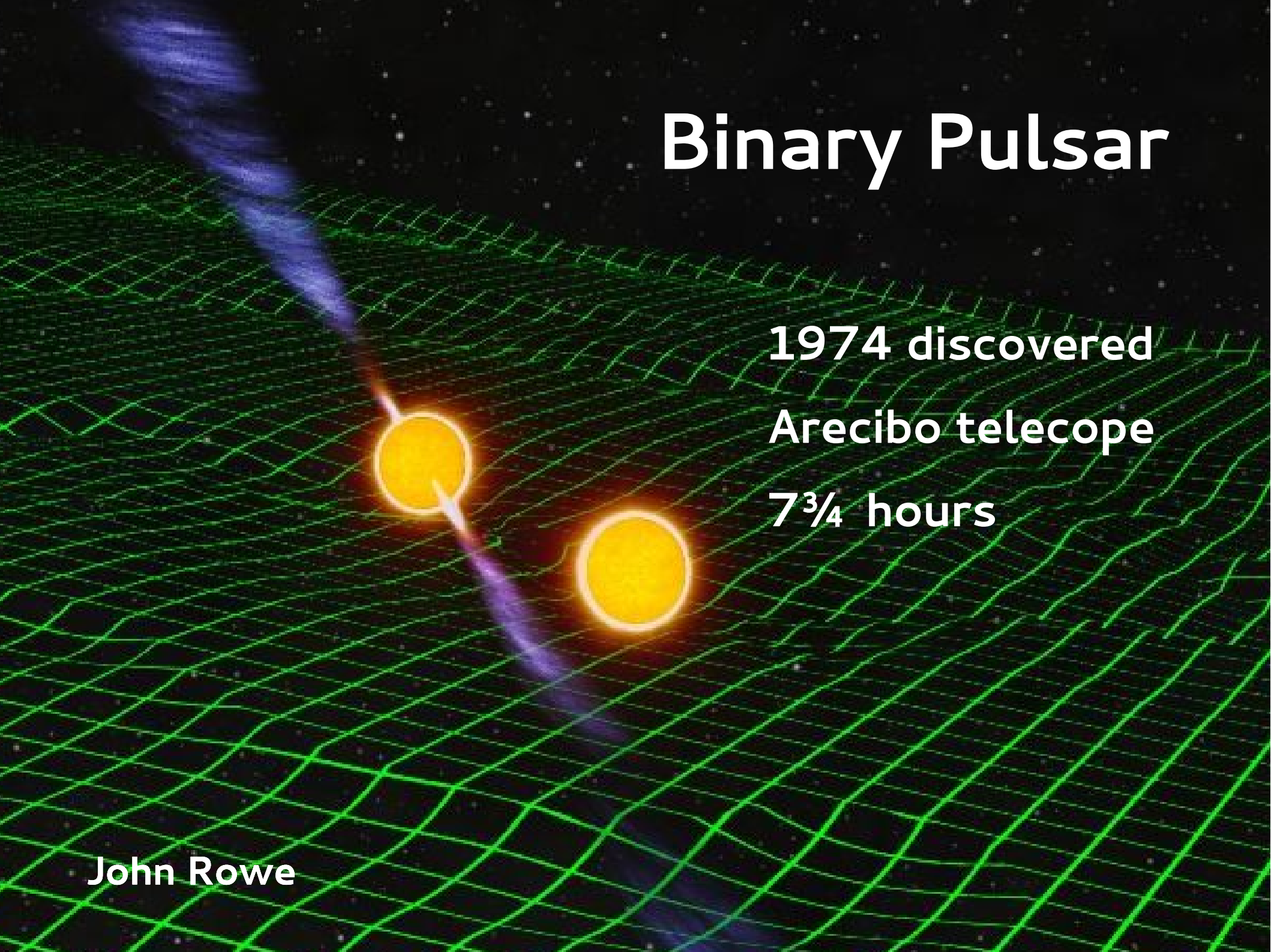
Stretch and Squash



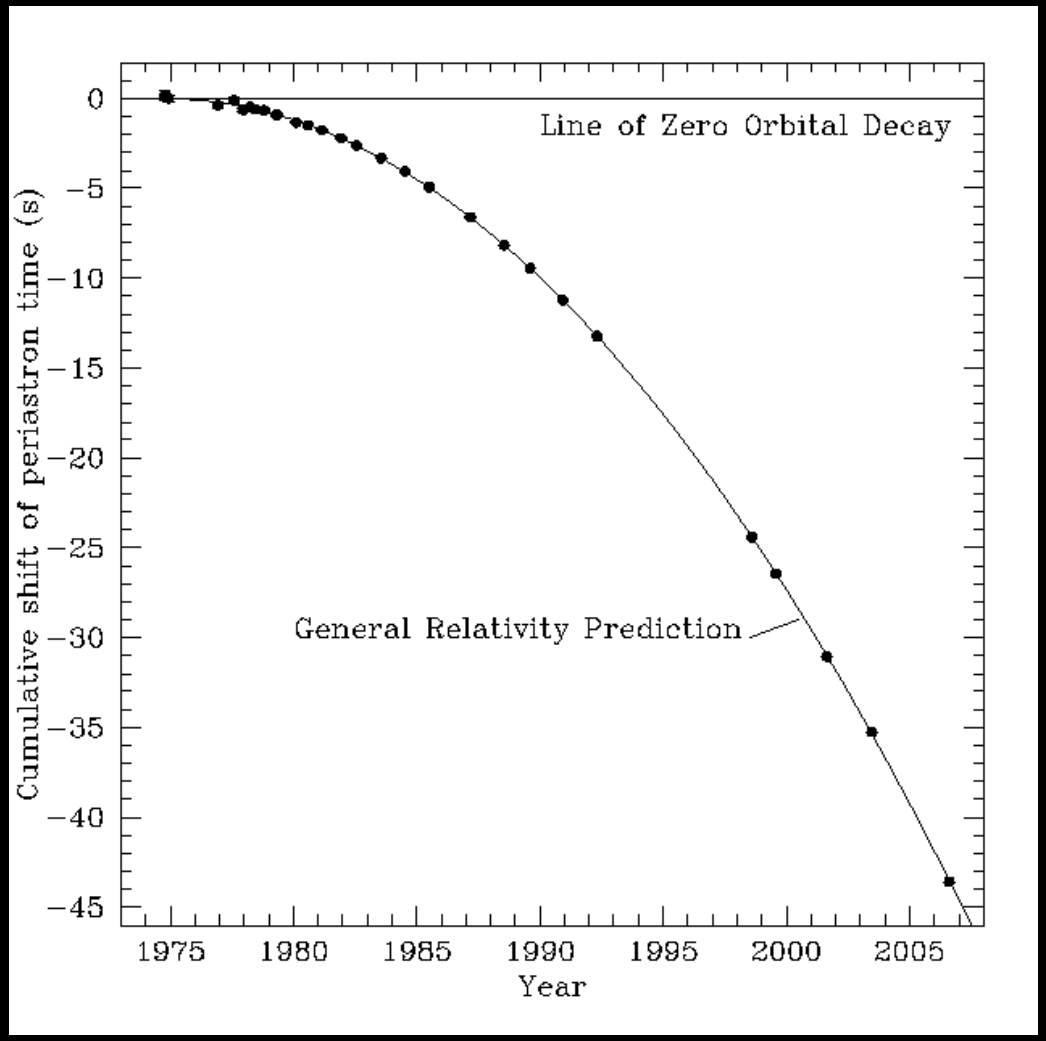




NASA, NASA/J. I.Thorpe


Binary Pulsar
1974 discovered
Arecibo telecope
7¾ hours
John Rowe

Binary Pulsar and Gravitational Waves

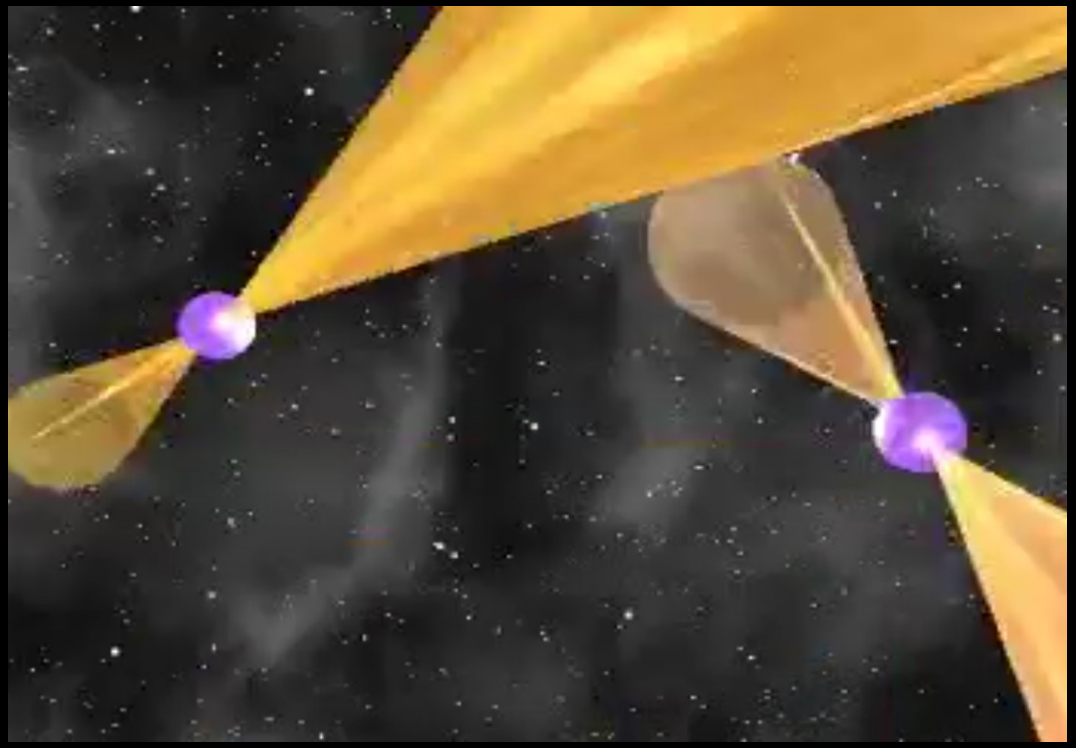


Weisberg and Taylor (2004)

Hulse and Taylor
1993 Nobel Prize

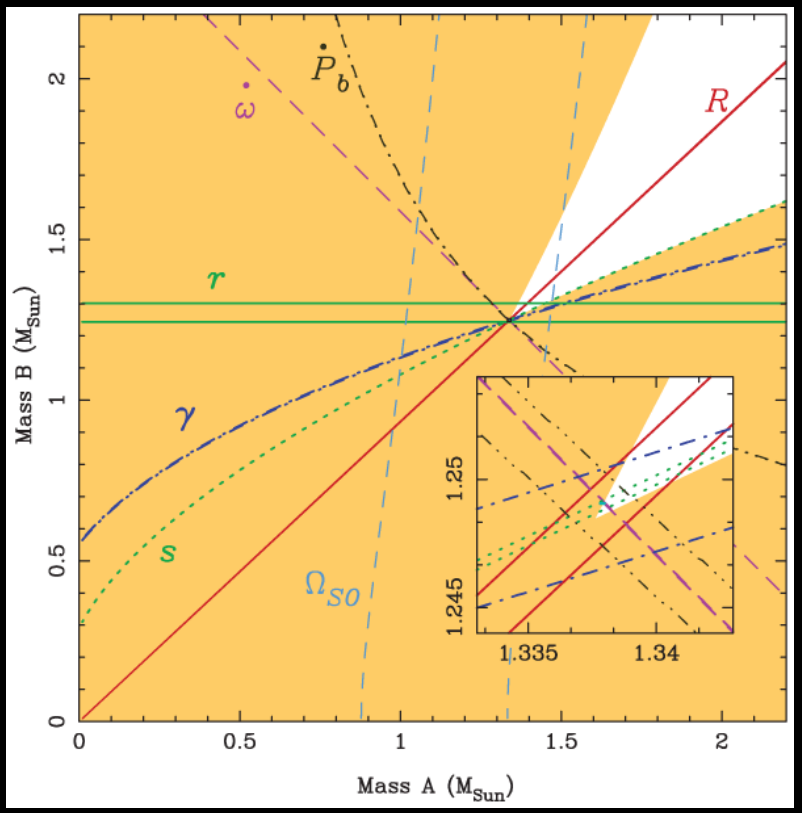
Image: University of Frankfurt

Two for one!

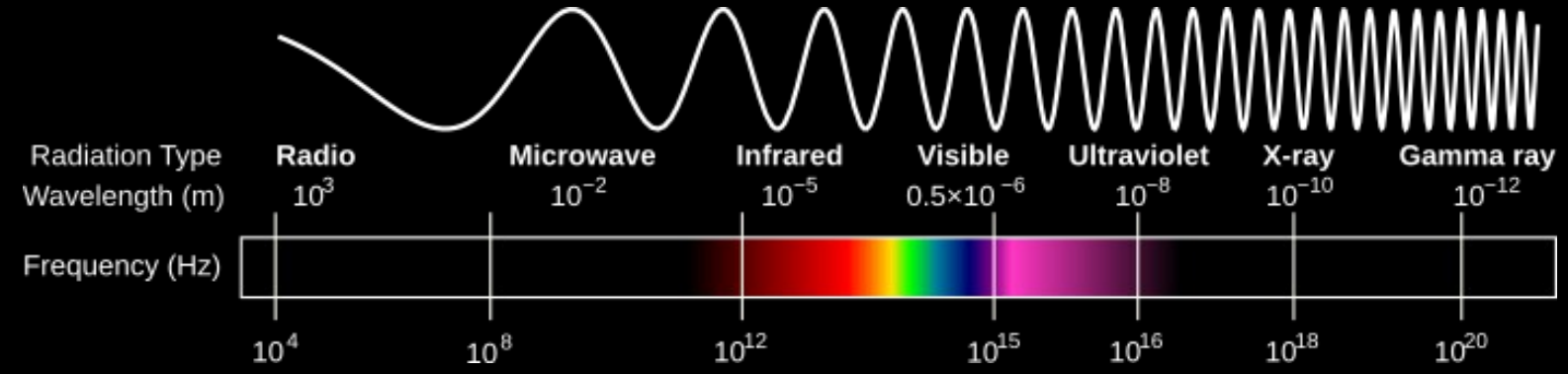


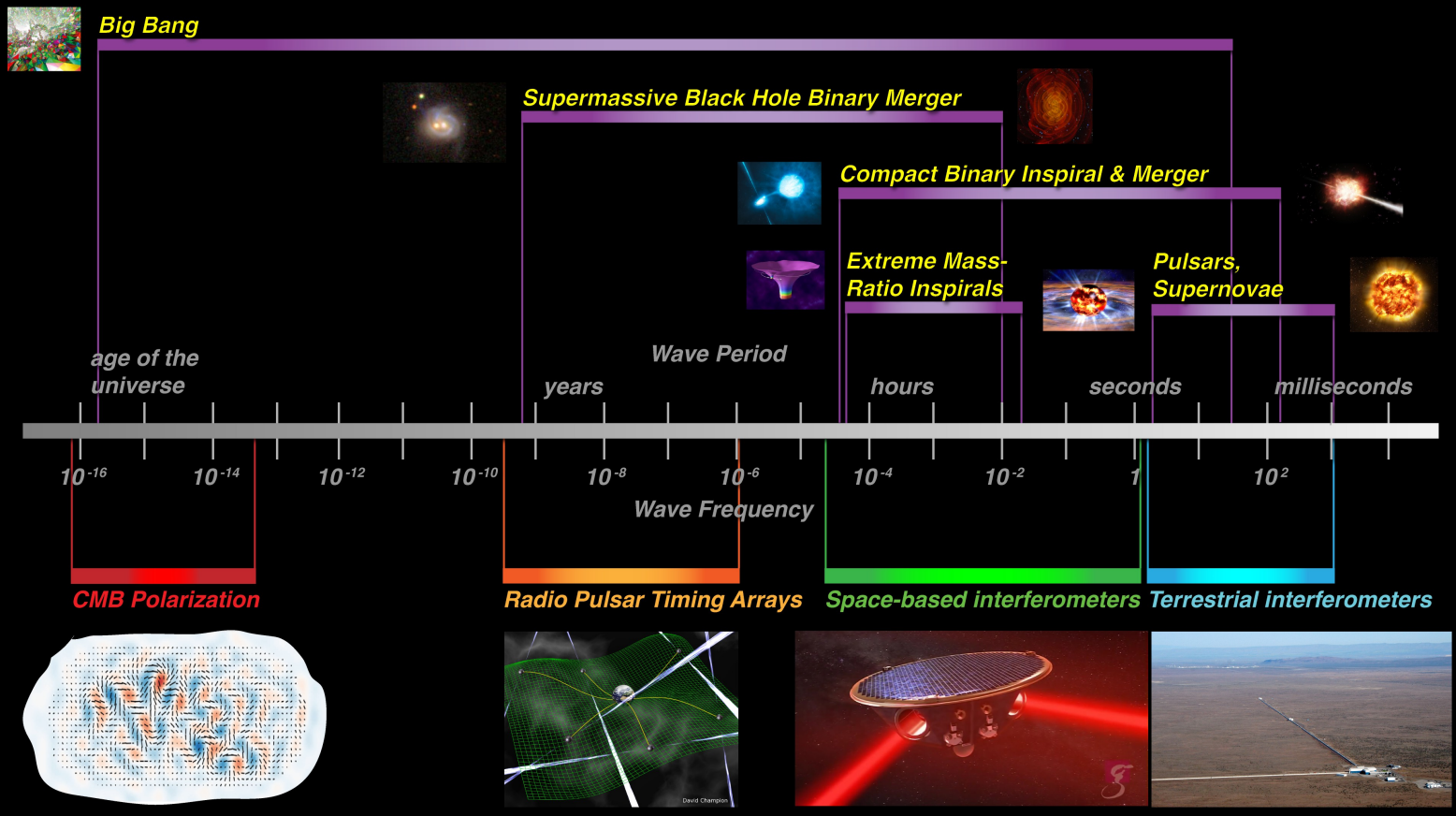
John Rowe Animation /Australia Telescope National Facility, CSIRO

For full movie see:
http://www.atnf.csiro.au/research/pulsar/array/gallery.html



J0737−3039A,B Kramer et al

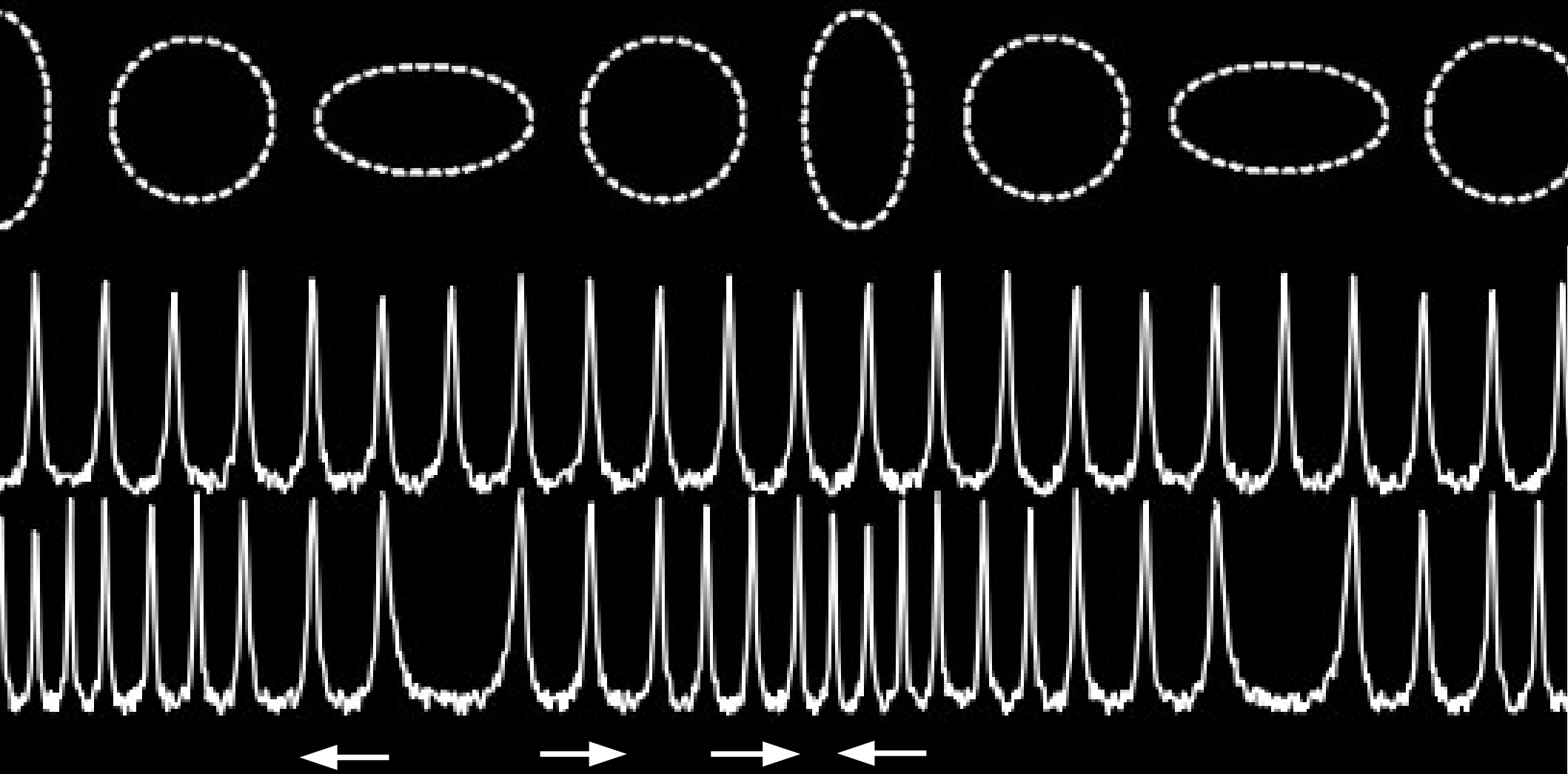




NASA, NASA/J. I.Thorpe

Merging galaxies

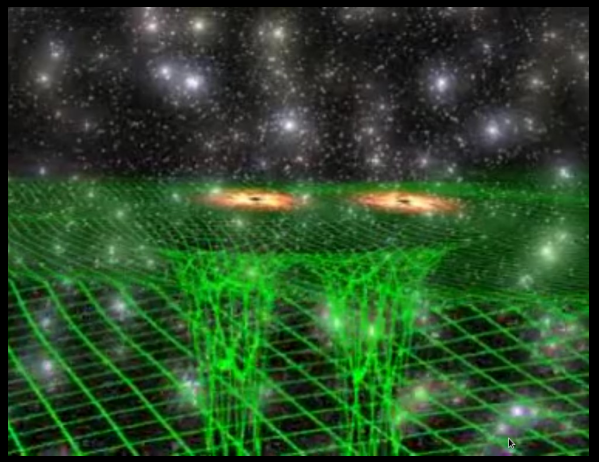
Stretch and Squash



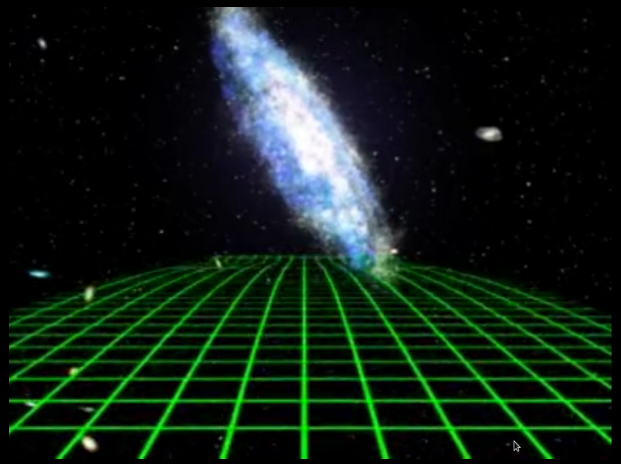
Pulsars act as clocks

Using pulsars to search for gravitational waves

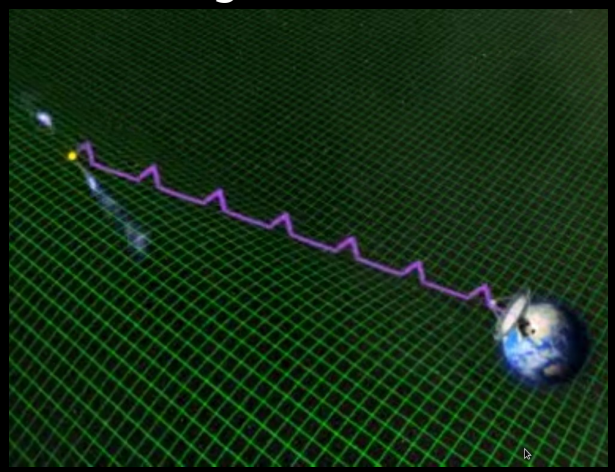
1. Two galaxies merge together.



2. The black holes from the centres of each galaxy orbit each other and emit gravitational waves.



3. Gravitational waves from many mergers like this spread out across the Universe and reach our own galaxy.



4. The gravitational waves 'stretch and squash the distance between the Earth and the pulsars, changing the time that the pulses arrive.

John Rowe Animation /Australia Telescope National Facility, CSIRO
For full movie see:
http://www.atnf.csiro.au/research/pulsar/array/gallery.html

What could we learn?

- Do super massive black holes merge?
- How many are merging?
- How massive are they?
- How far away are they?
- Learn about galaxies

The future

- Square Kilometer Array
- South Africa and Australia

The data collected by the SKA in a single day would take nearly two million years to playback on an ipod!

Not aliens after all!

- Nature's lighthouses / clocks
- Neutron stars
- Useful tools to learn about the Universe:
  - Testing Einstein's theories
  - Searching for gravitational waves
  - Learn about super massive black holes