Reflections on the discovery of pulsars and lessons for today

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And

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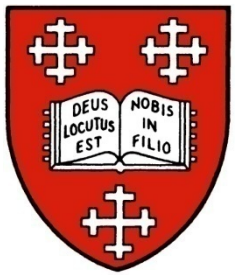


Topics

- A story from radio astronomy – the discovery of pulsating radio stars (pulsars)
- Reflection on the factors that led to the discovery
- (Not going to discuss the near-misses - when pulsars were *almost* discovered).

First build your radio telescope (through hail, rain and sunshine)

Typical working conditions for a PhD student?

2048 81.5MHz λ/2 antennae (16 E-W rows of 64 + 64), 1000+ wooden posts, 120 miles/192 km wire and cable, area 57 tennis courts. Grant £12k. 6 people for 2 years.

The 4.5 acre* radio telescope (*1.8 hectares), looking W

- Interferometric array; phased with delay cables; operated with 4 beams. Valve phase-switching receiver!

Discovery of pulsars

- Repeated mapping of the sky to identify quasars (and measure their angular diameter) using interplanetary scintillation
- Short time constant (short integration time) to study rapidly varying phenomenon (interplanetary scintillation). $\tau = 0.1$ s.
- 6 months' observing, starting July 1967

Data analysis

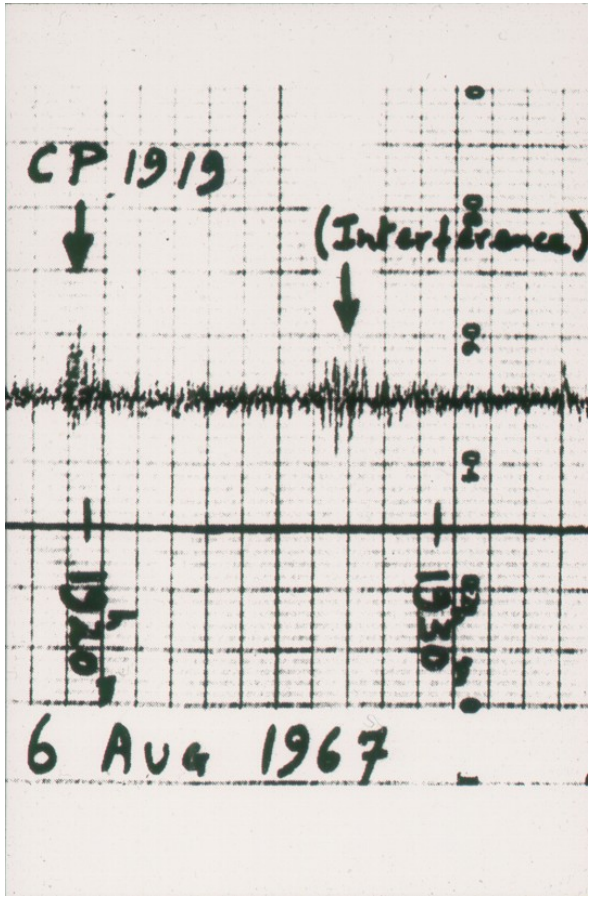
No computer!

3-pen chart paper

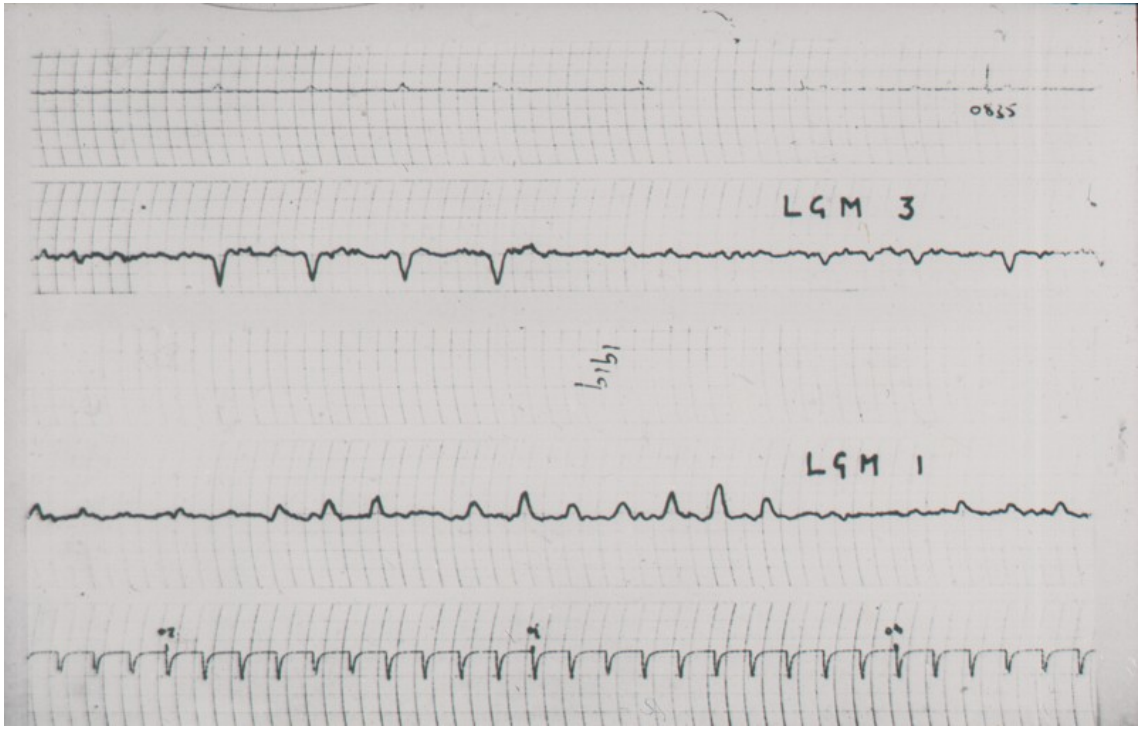
- 100’ (30m) / day
- 400’ (120m)/sky scan
- 3.3 miles (5.3km) total

Discovery of pulsars II

- Occasionally ¼” (0.5 cm) in the 400’ (120 m) showed an unusual signal.
- ‘Occasionally’ = 20% of the occasions that part of sky observed
- This signal occupied 0.5cm in 120m of chart paper on 20% of occasions (approx 1 in $10^{5)}$!
- Note RA - night sky



High-speed recording



Centre trace shows pulsed nature of emission

What is it?

- Local radio interference? *No – keeps sidereal time.*
- Faulty equipment? *No – seen by a separate telescope and receiver.*
- Small (short pulses) and big (maintains pulse period accurately). *???????*

What is it (contd)?

- Dispersion measurement showed it was 200 light years away (i.e. beyond the Solar System, but nearby in the Milky Way)
- Little Green Men? They'd be on a planet orbiting their Sun; *no Doppler effect*
- Finding second, third and fourth (1133, 0833, 0950)

Publication

- Nature turned the paper round in 2 weeks!
- Tony Hewish did a colloquium in Cambridge a few days before paper appeared…….Hoyle in audience

The naming of pulsars

- Interviewed by Science Correspondent of The Daily Telegraph – Anthony Michaelis – shortly after the discovery
- What were we going to call them?
- He suggested *pulsar* – cf quasar

The Daily Telegraph

Factors that lead to discovery

Key factors in the discovery

- One of the first observations with a short time constant (*new area of phase space*)
- In a relatively new subject (radio astronomy)
- 81.5MHz not an optimum frequency for studying pulsars, but large collecting area swung it
- Our own telescope and receivers – I understood the behaviour

Key Factors 2

- As a grad student I had time/space to follow up anomalies
- "Imposter syndrome" - from north and west fringes of UK to Cambridge
- Really understand your trash – is it trash?

Jackson Pollock
Dipper

Key factors 3

- Colleagues provided lots of healthy scepticism, and creative attempts to find alternative explanations!
- We had a good address – a reputable laboratory – essential to get published!
- This was not one of the objectives, or targets of the programme
- If we had computerised the search, would the pulsars have been discovered?

The thesis

- I found about 100 more QSRs, markedly increasing the data pool. No angular diameter measurements - all unresolved.
- Also found a co-rotating streams in IPM – enhanced scintillation at 27 day intervals.
- ‘Too late to change the thesis title’ – PSRs went in an appendix
- One of very few Cambridge radio astronomy grad students to finish in 3 years!

Questions?