History of Radioastronomy from 1800 to 2007

(a personal selection)

Steve Torchinsky
Observatoire de Paris

Herschel discovers invisible radiation

- 1800
- For the first time, it is understood that light has components that are invisible to the human eye

History of radio astronomy, Steve Torchinsky

Hertzian waves

- 1889
- First transmission and detection of radiowaves
- “no practical purpose”

Attempts to Detect the Sun

- 1900 – 1905 non detections
- Oliver Lodge
  - Not enough sensitivity
  - Solar minimum
- Nordmann
  - 175m long wire
  - galvonometre

Karl Jansky

- 1932 (published in 1935)
- λ 15m
- Detected galactic centre

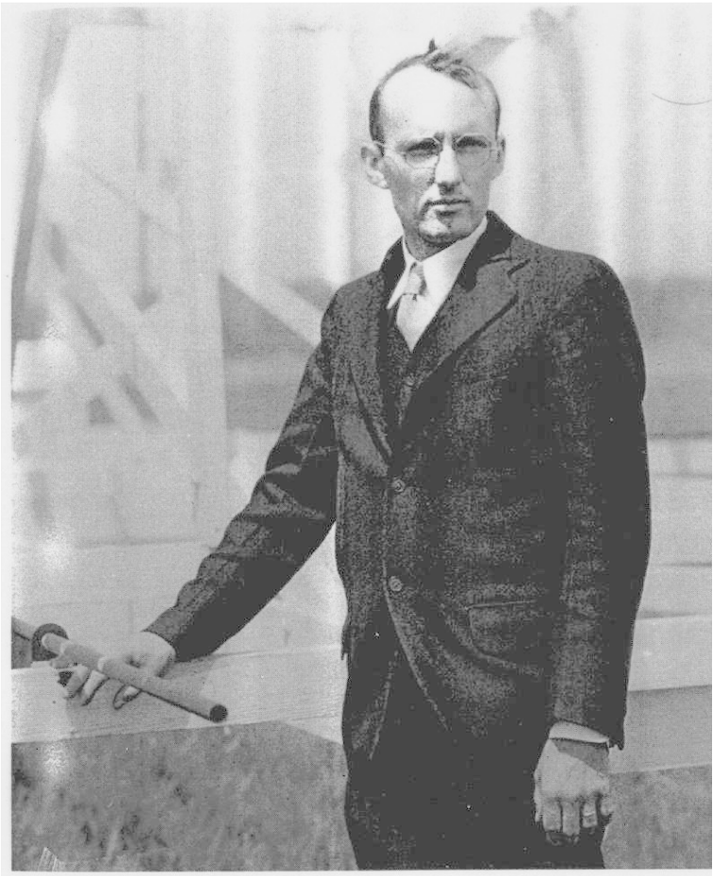


FIG. 1—Karl Guthe Jansky, about 1933.

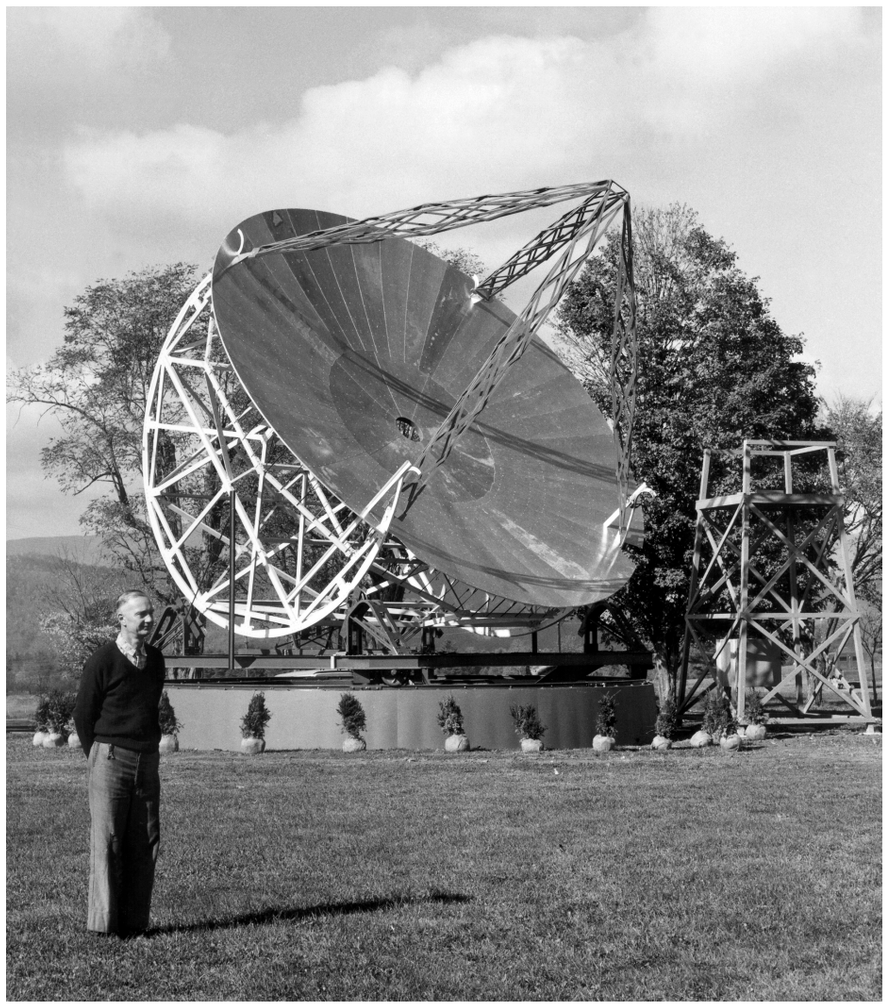
Radio static from the Sun

- 1936
  - Solar maximum
  - Static on radio receivers
  - No one realised they had detected the Sun!

Detection of the Sun

- 1942
  - J.S. Hey in England
  - λ ~ 1m
  - correlation with sunspots
  - not published until 1946 (after the war)
- 1944
  - Grote Reber detects the Sun and publishes the result
- 1945
  - Sourthworth in USA
  - λ ~ O(1) cm
  - thermal emission from the Sun

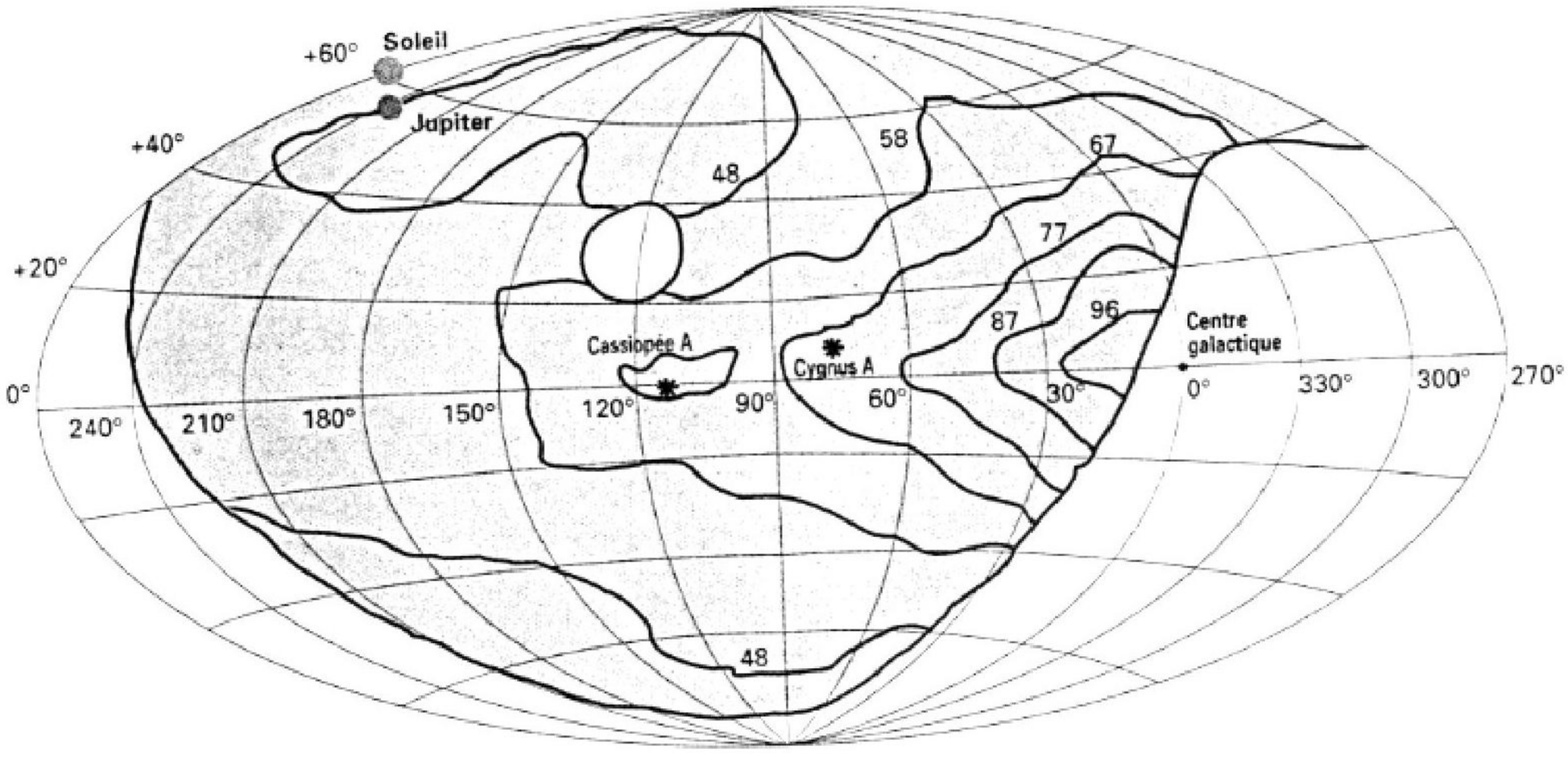
Grote Reber
The Father of Radio Astronomy



- For ~10 years no one followed up Jansky's discovery
- 1944
  - λ 2m, 310ft reflector (huge!)
  - Several maxima including Cygnus
  - Continuum emission along galactic plane
  - the first radio map of the sky

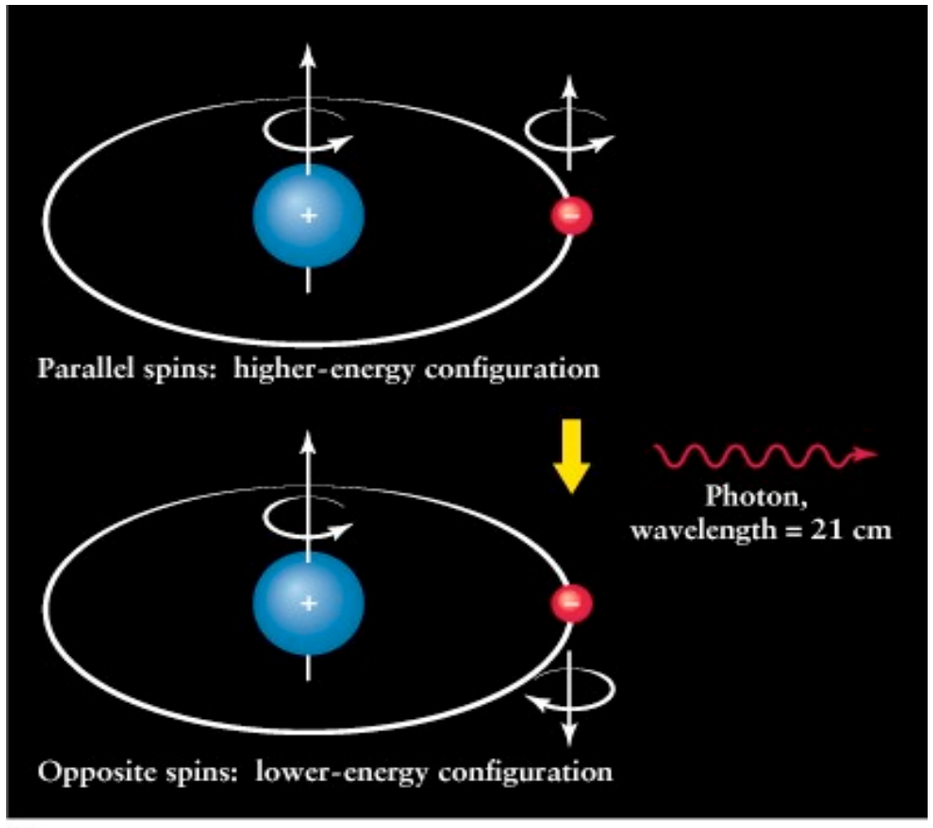
The first radio map of the sky

- Grote Reber



Neutral Hydrogen

- 1945
  - van de Hulst suggests spin-flip transition of neutral hydrogen
  - first time line emission is proposed as a possibility in radio astronomy
  - expected to be weak, but van de Hulst expects the abundance of HI to be very high (primordial material)



b

RADAR Astronomy

- 1947
  - Hey and Stewart
  - bouncing RADAR of the ionised tails of meteorites
  - detection of daytime meteor showers
  - first RADAR astronomy

Discrete Sources

- 1946
  - Hey, Parsons, and Phillips
  - Short period irregular fluctuations
  - 2° angular resolution
- 1948
  - Bolton and Stanley
  - 8’’ angular resolution

HI Detected

- 1951
  - Ewen and Purcell in USA
- HI is the most abundance element in the universe
- radio astronomy really takes off

Radio Observatories in the 50's and 60's

- Cambridge
- Jodrell Bank
- Westerbork
- Parkes
- Greenbank
- Nançay
- Arecibo
- …

Galactic structure

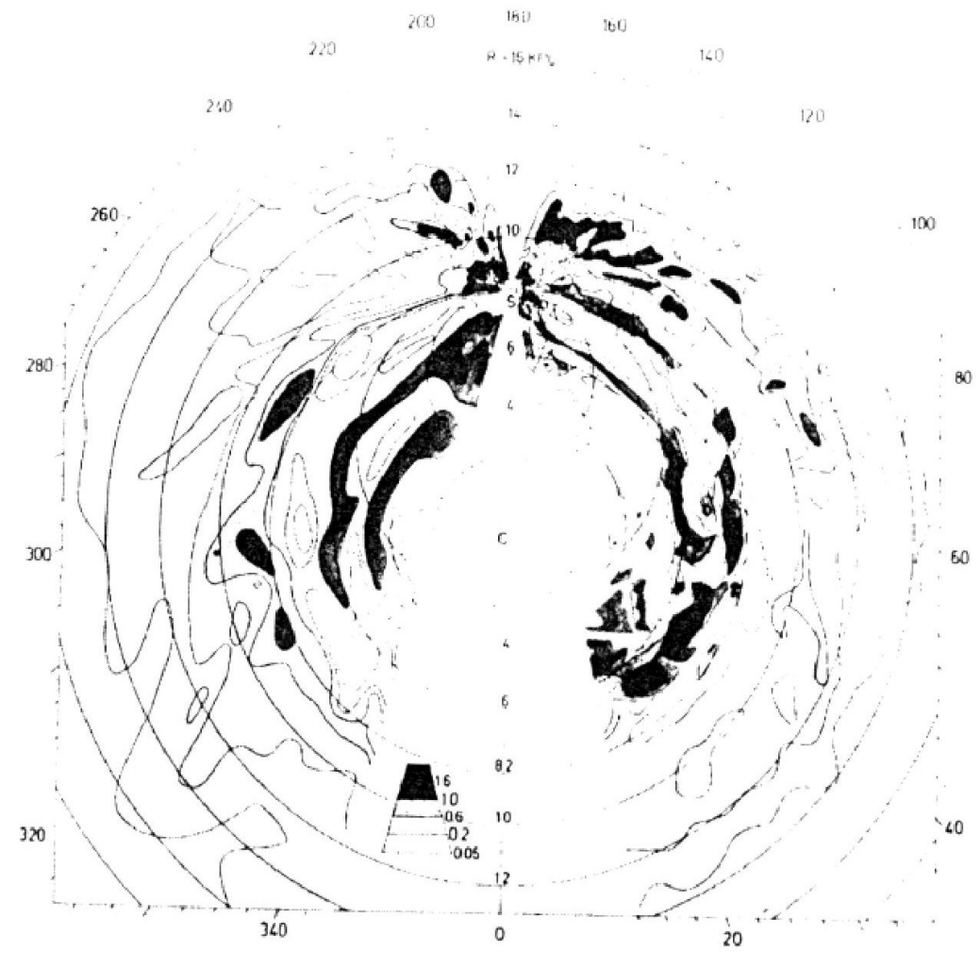


Figure 6.1 The "Leiden-Sydney" 21 cm map of neutral hydrogen in the Galaxy.

- 1950's early 60's
  - Oort
  - using HI

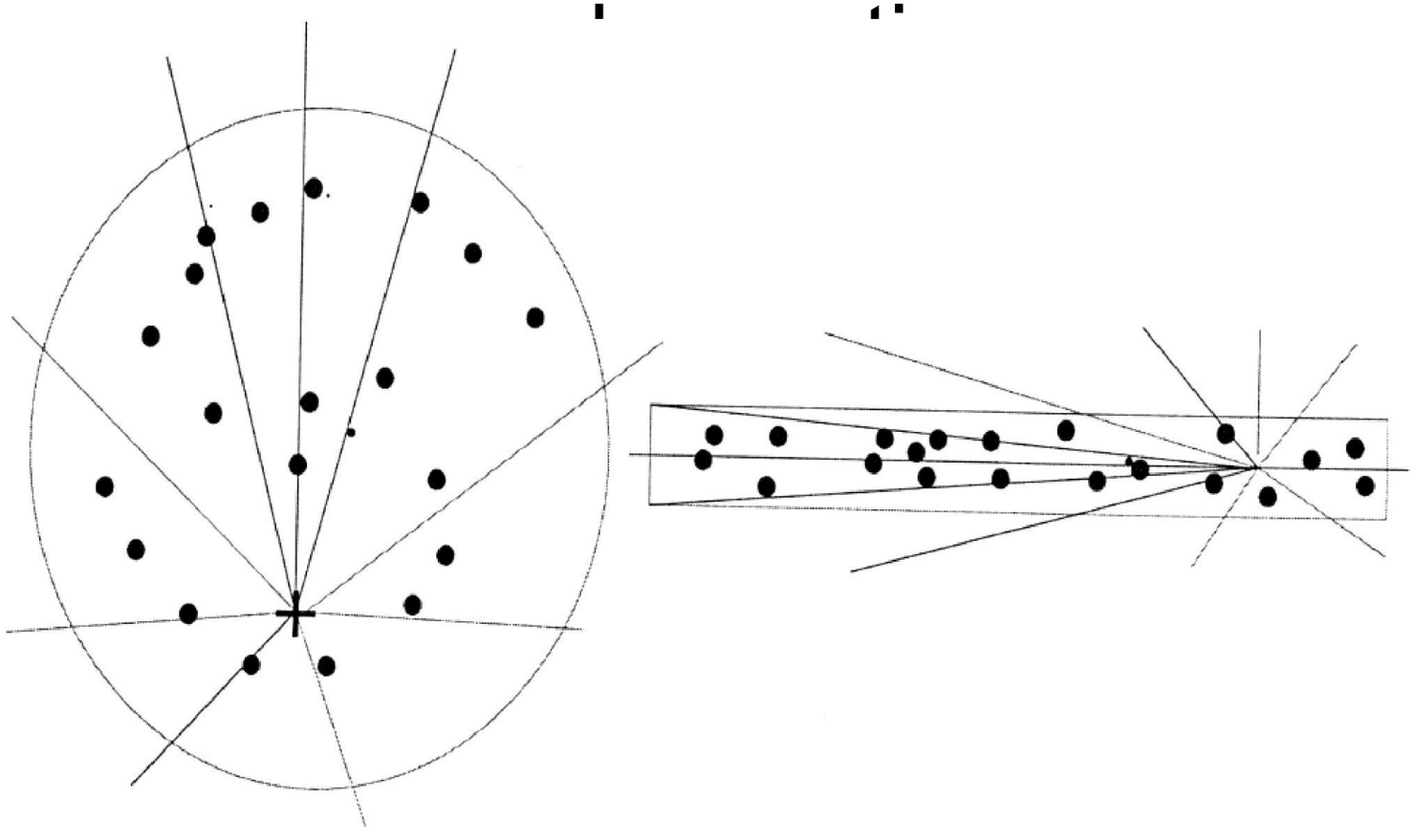


Figure 4. A schematic view of our location relative to HII regions in the Galaxy. The left figure shows the face-on view while the edge-on view is shown on the right. Line segments indicate lines of sight relative to the observer situated at the convergence point of the line segments.

Radio emissions from Jupiter

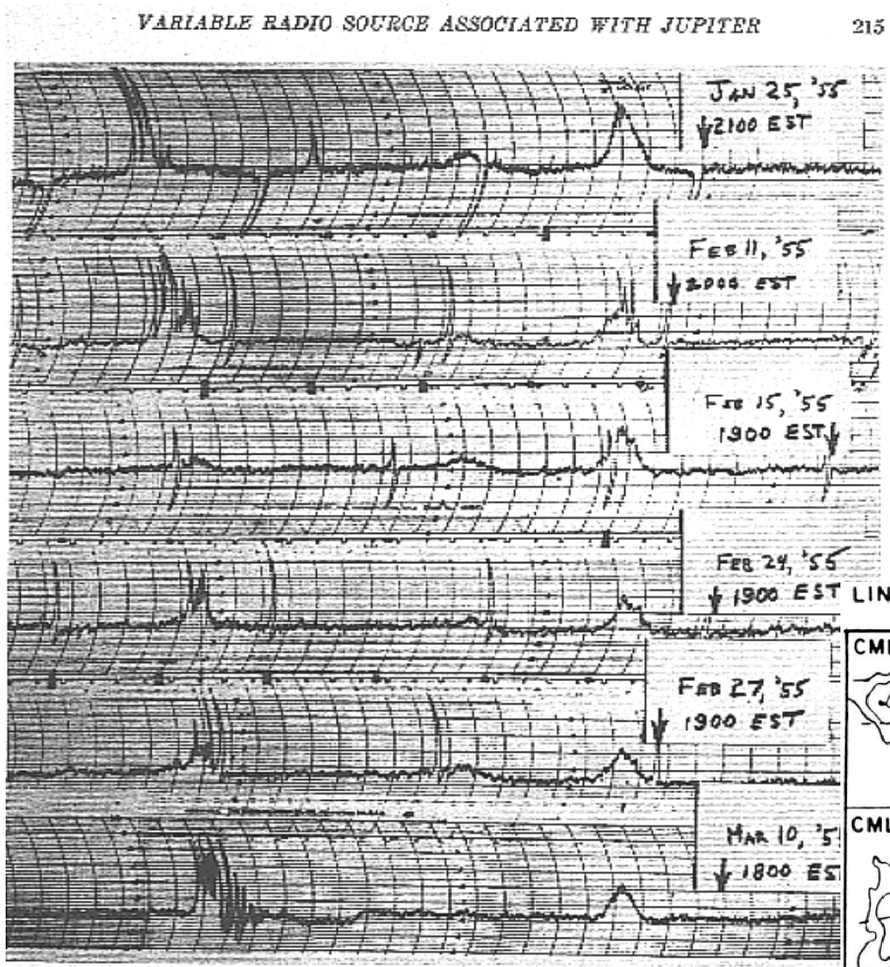


FIG. 2—Phase-switching records showing the appearance of the variable source

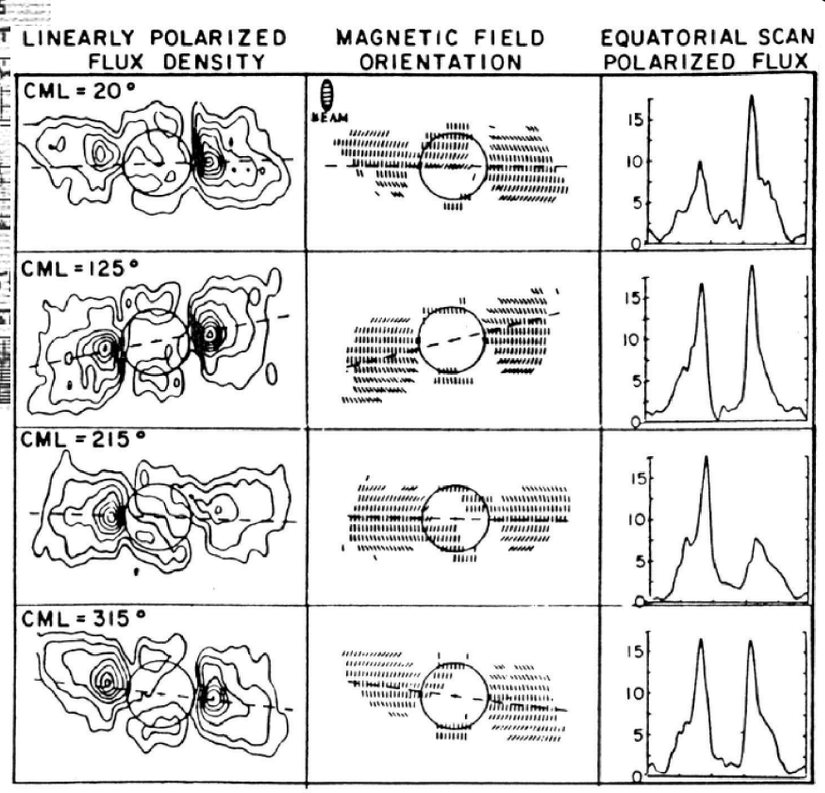


Fig. 7.9. Maps of the linearly polarized flux density at 6 cm wavelength (left-hand panels), magnetic field orientation (center panels) and polarized flux density scans (in Jy) across the magnetic equator. The value of the CML is given in the upper left-hand corner of the first panel for each of the four rows of maps. The projected average magnetic field directions are drawn perpendicular to the measured orientation of the linearly polarized component of the radio emission. Adapted from de Pater [1981].

- 1955
  - Burke & Franklin
  - 22MHz
- 1958
  - Sloanaker
  - 3GHz

Rotation of Mercury

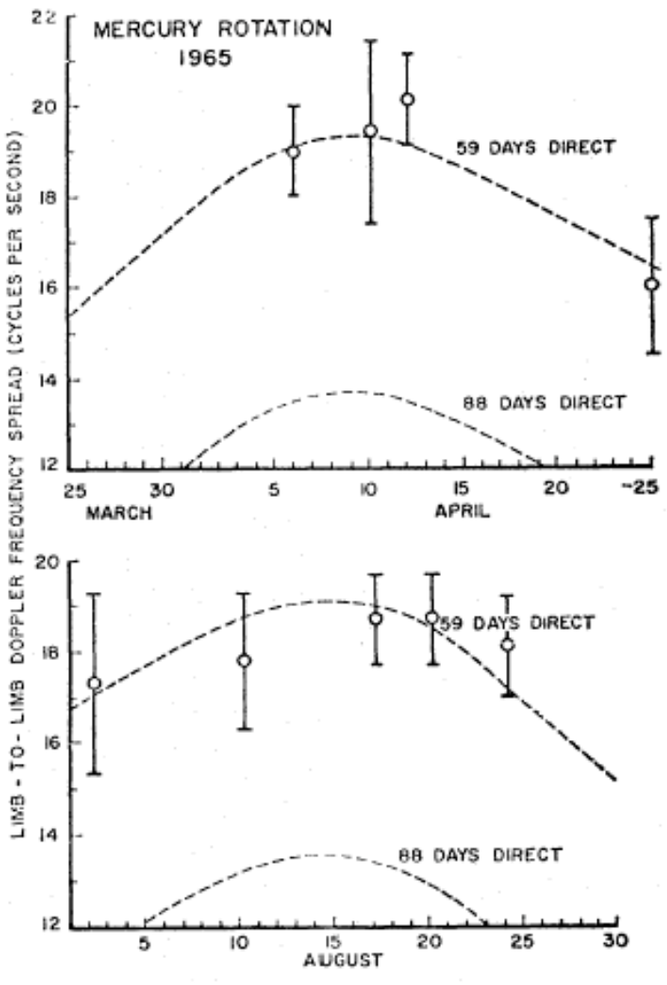


FIG. 4. Inferred limb-to-limb Doppler spread vs date for observations of Mercury taken at the Arecibo Ionospheric Observatory during 1965. The dotted curves show the theoretical variation for direct sidereal periods of rotation of 59 and 88 days, under the assumption that the axis of rotation is normal to the orbital plane of Mercury.

Arecibo Radar echo shows the rotation rate of Mercury to be 59 days, and not 88 days

Pettengill & Dyce, 1965, Nature, 206, 1240

The Cosmic Microwave Background

The Nobel Prize in Physics 1978

"for their discovery of cosmic microwave background radiation"

Arno Allan Penzias

1/4 of the prize

USA

Bell Laboratories
Holmdel, NJ, USA

b. 1933
(in Munich, Germany)

Robert Woodrow Wilson

1/4 of the prize

USA

Bell Laboratories
Holmdel, NJ, USA

b. 1936

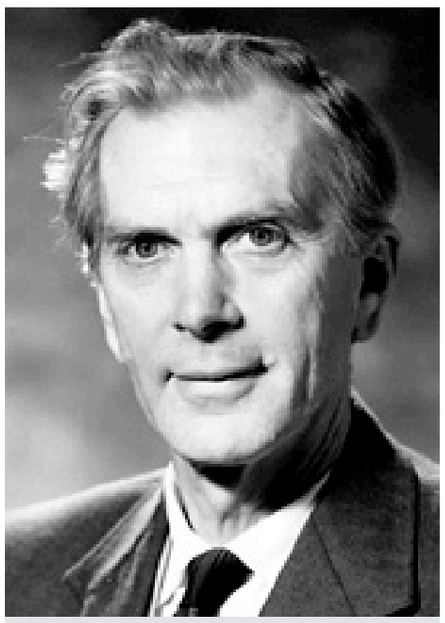
1965

- Penzias and Wilson
- Nobel Prize 1978

Aperture Synthesis

The Nobel Prize in Physics 1974

"for their pioneering research in radio astrophysics: Ryle for his observations and inventions, in particular of the aperture synthesis technique, and Hewish for his decisive role in the discovery of pulsars"



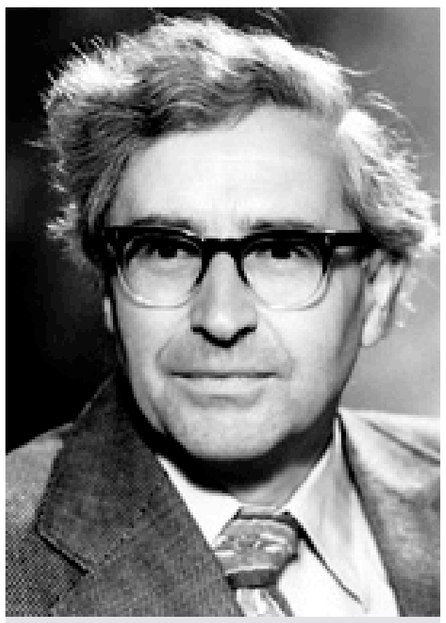
Sir Martin Ryle

1/2 of the prize

United Kingdom

University of Cambridge
Cambridge, United Kingdom

b. 1918
d. 1984



Antony Hewish

1/2 of the prize

United Kingdom

University of Cambridge
Cambridge, United Kingdom

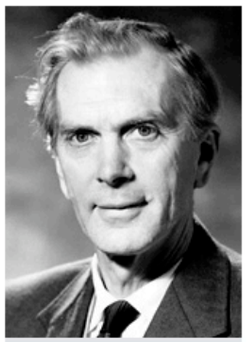
b. 1924

- Martin Ryle at Cambridge
- using Earth rotation to fill the u-v plane
- Nobel Prize 1974

Discovery of Pulsars

The Nobel Prize in Physics 1974

"for their pioneering research in radio astrophysics: Ryle for his observations and inventions, in particular of the aperture synthesis technique, and Hewish for his decisive role in the discovery of pulsars"



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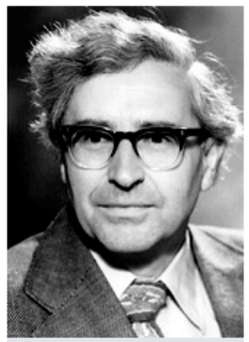

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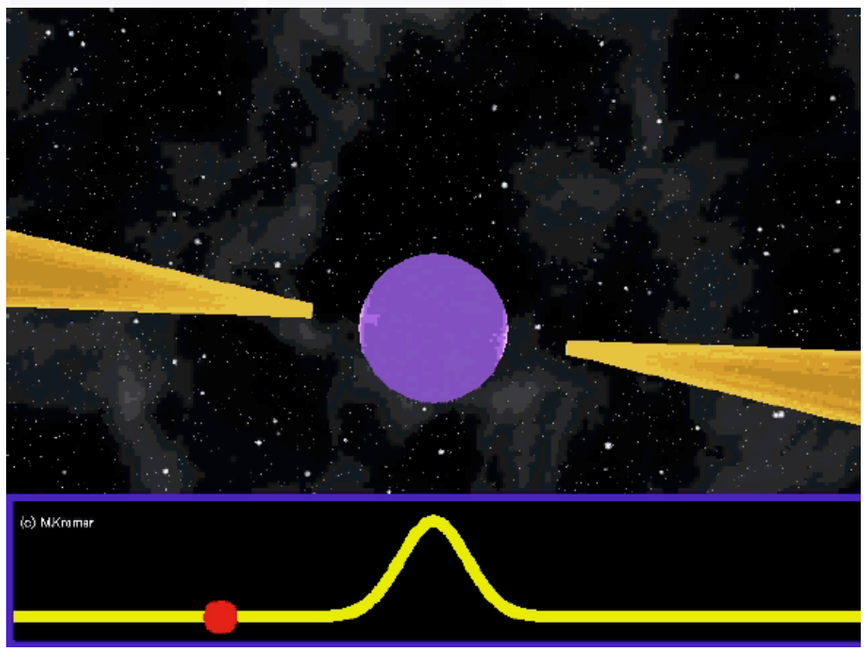


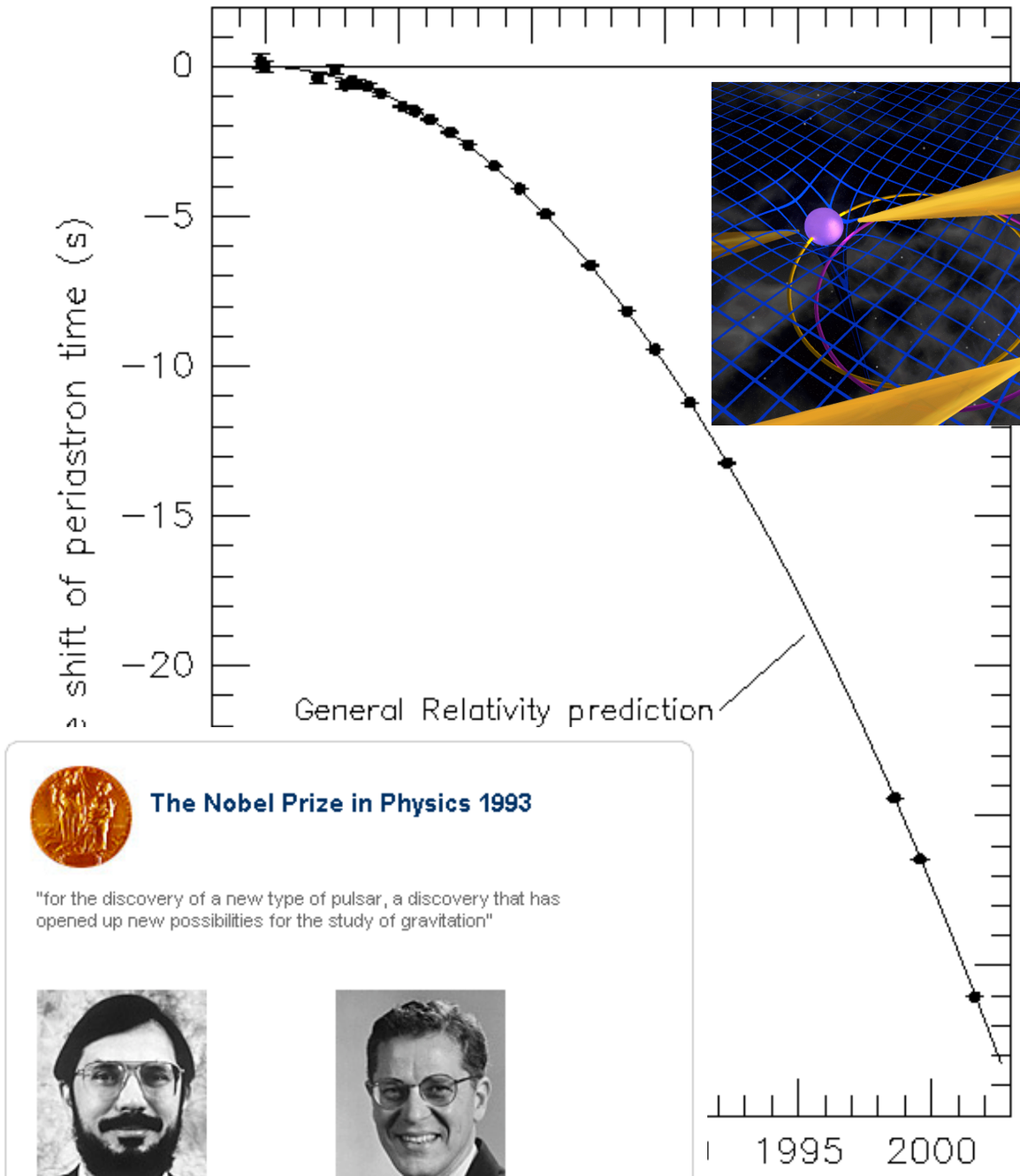
History of radio astronomy, Steve Torchinsky

- 1967
  - Jocelyn Bell
    - “Little Green Men”
    - demonstrates it’s extraterrestrial (not RFI)
    - perseveres!

Very Long Baseline Interferometry

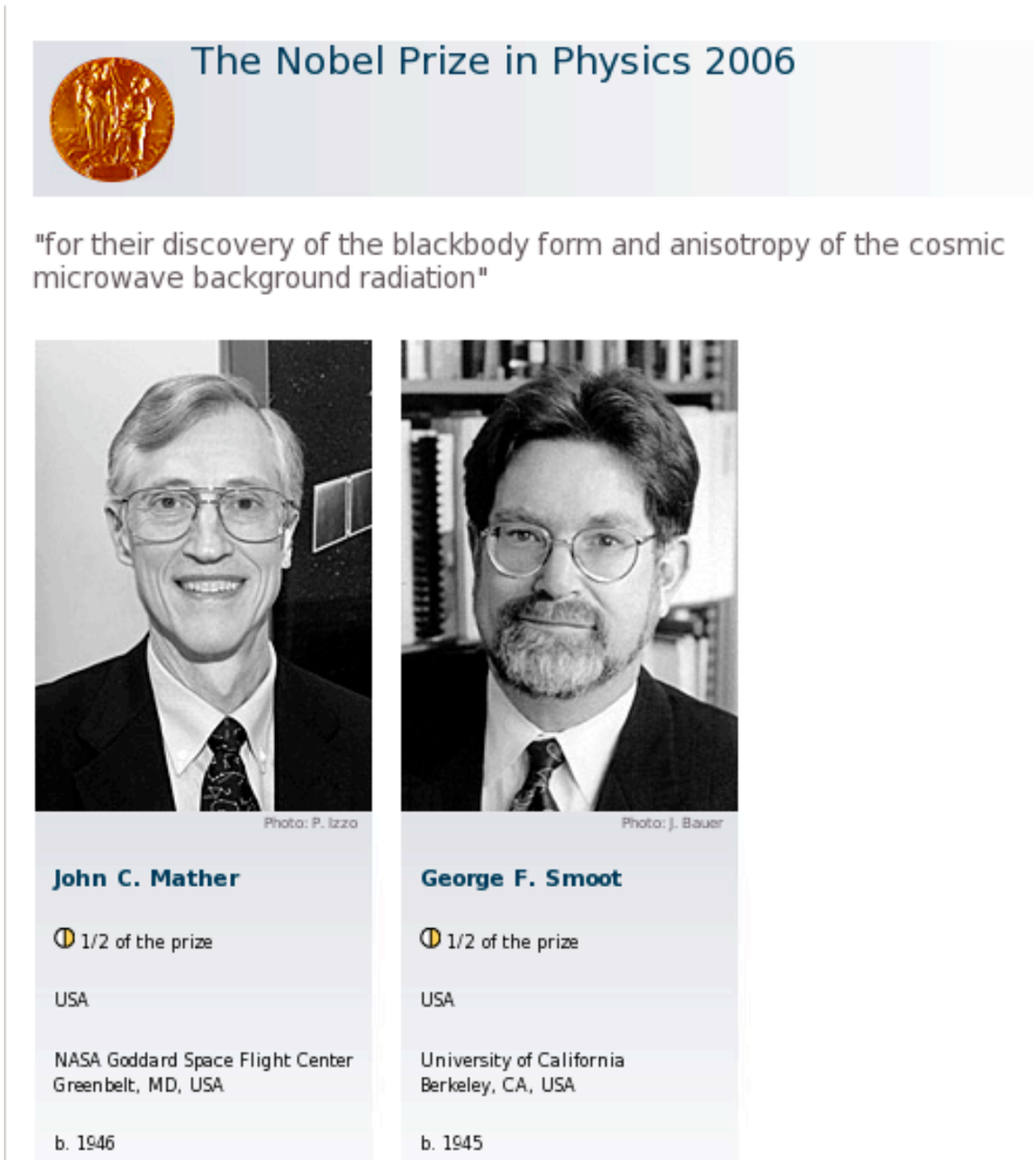
- 1971
  - Broten et al in Canada
  - et al in USA

Pulsar – Neutron star binary



- 1974 at Arecibo
- timing over the next ~20 years
- confirms gravitational wave radiation
- Hulse and Taylor Nobel Prize 1993

The Cosmic Microwave Background



- 1990
  - COBE satellite
  - first measure of complete Planck black-body spectrum for the CMB
  - first measure of anisotropy
  - 2006 Nobel Prize: Mather and Smoot

First extra solar planet

- 1992 at Arecibo
  - Wolszczan & Frail "A Planetary System around the Millisecond Pulsar PSR 1257+12" 1992, *Nature*, 355, 145

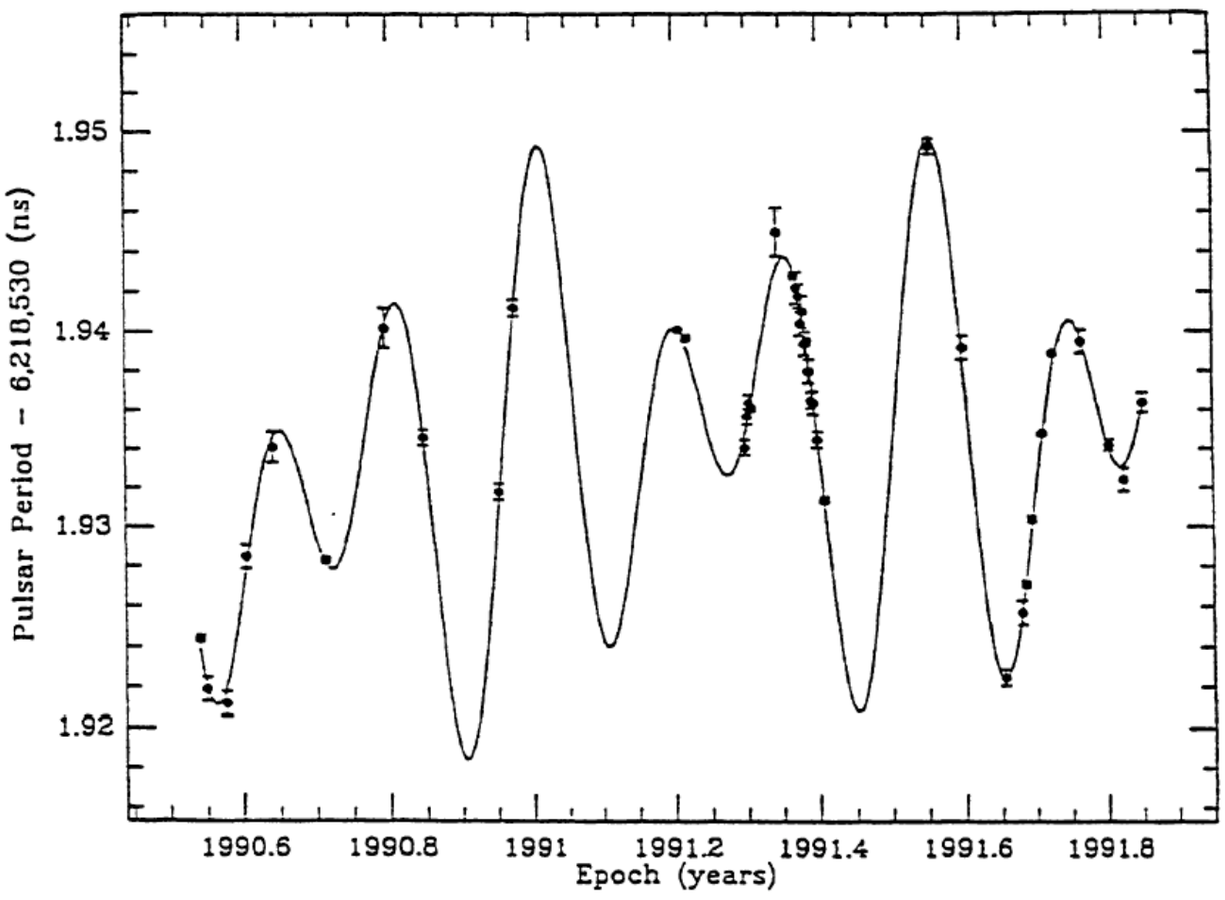


Figure 2. A comparison of period variations of PSR1257+12 (*filled circles*) with a two-planet model prediction (*solid line*).

Radio Schmidt and SKA

- 1990's
  - proposal for a wide field of view high sensitivity radio telescope
  - more on Wednesday!