Radar Observations of Mercury

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Talk Outline

• History of Radar Astronomy
• Basic Principles
• Observation Set-up
• Observation Runs
• Data Processing
• Results
• Discussion

History

• 1946: First radar reflection of the Moon
• 1961: First radar detection of Venus
• 1963: First radar detection of Mercury

Basic Principles

• The Radar Equation

\[ P_r = \frac{P_i G^2 \lambda^2 \sigma}{(4\pi)^3 R^4} \]

\[ P_r = kT\Delta f \sum (S / N) \]

Observation Set-up

• Tx = 2380 MHz
• Tx time = 783 sec
• Tx Power = 400 kW
• Mercury distance = 0.784 AU
• Pulse Period = 10 µs
• Mercury declination = 15 degrees
• Mercury transit time ~ 2 hours

Observation Runs

• 3 runs with CW transmission
• 3 runs with Long-code Delay-Doppler
Data Processing

- Analysis Software
  - Decode and Fourier transform returns from each range bin
  - Map power from the target into time delay and frequency space bins
- Display Software
  - Take 2-D Delay/Frequency Space Array and project onto Mercury lat/long coordinates

Results

- For each run OC and SC polarization returns received and sampled
- Image maps created for each polarization

Run 1 OC weak echoes

Run 1 SC weak echoes

Run 1 SC and OC weak echoes

Run 1 OC strong echoes
Mariner 10 vs Radar Imagery

Mercury Radar Cross Section

- \( \sigma_{OC} = 1.1 \times 10^{12} \text{ m}^2 \Rightarrow \text{Albedo} = 0.06 \)
  - Expected value of Albedo: 7%

- \( \sigma_{SC} = 7.8 \times 10^{10} \text{ m}^2 \Rightarrow \text{Albedo} = 0.004 \)
  - Expected value of Albedo: 0.5%

Discussion

- Ice features in the North Pole
  - Possible origins
  - Implications