

Contact

# The Argus System in **Contact**

- How many telescopes?
- How many channels?
- Channel Width?
- Sensitivity?

# ARGUS

131 telescopes pg. 63

Built by expanding the VLA

if similar antennas:  $\frac{131}{27} \sim 5 \times$  the area

Coverage:  $10^9$  channels pg. 56, 62  
channel width  $< 1$  Hz pg. 56

$\Rightarrow \sim 10^9$  Hz if width = 1 Hz

Sensitivity: if assume better than VLA by 5,

5 Jy in 1 sec

$5 \times 10^{-26} \text{ W m}^{-2} \text{ Hz}^{-1}$

# The Signal

- Frequency at which it was first detected?
- Bandwidth?
- Polarization?
- Other frequencies?
- Strength of the signal?

# The Signal

First detected near 9 GHz      pg. 66

$$\nu = 9.24176684$$

$$\Delta\nu = 430 \text{ Hz}$$



pg. 72

Linearly polarized

pg. 66

Later found at 1.420 GHz      H      pg. 78

1.667 GHz      OH

Bimodal pulses 179 and 174 Jy      pg. 72

## Source of Signal

- How was terrestrial interference ruled out?
- How was it determined to come from Vega?
- How do we know it was intended for us?
  - Rather than omnidirectional
  - BEFORE the message decoded

# The Signal

Not Terrestrial:

Moving Sidereally                      pg. 66

Vega:

Interferometric Position              pg. 65

Proper Motion                              pg. 78

Doppler Corrected                        pg. 78

## Very Large Array (VLA)



26 telescopes each 25 meters in diameter  
Will work at wavelengths as short as 7 mm



## What were the 4 Levels of information?

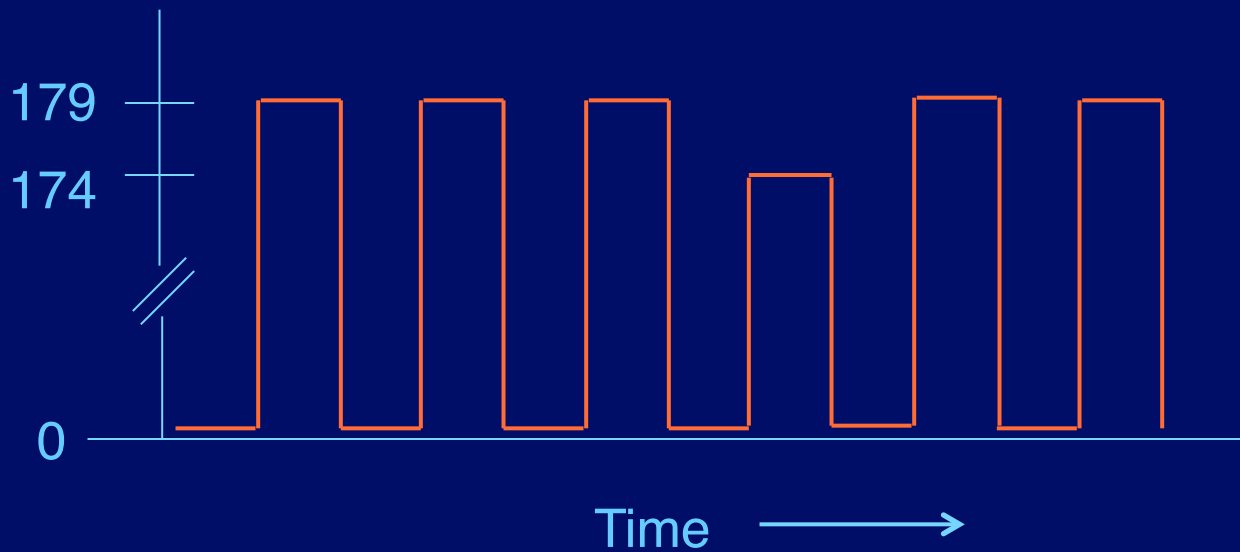
- How encoded (modulation method)?
- What was the purpose of each?

# The Prime Numbers

## Amplitude Modulation

- (“Strength is the Message”)

Bimodal amplitudes 174 & 179 Jy



Convention

179 = 1

174 = 0

1    1    1    0    1    1

$2^5 + 2^4 + 2^3 + 0 + 2^1 + 1$

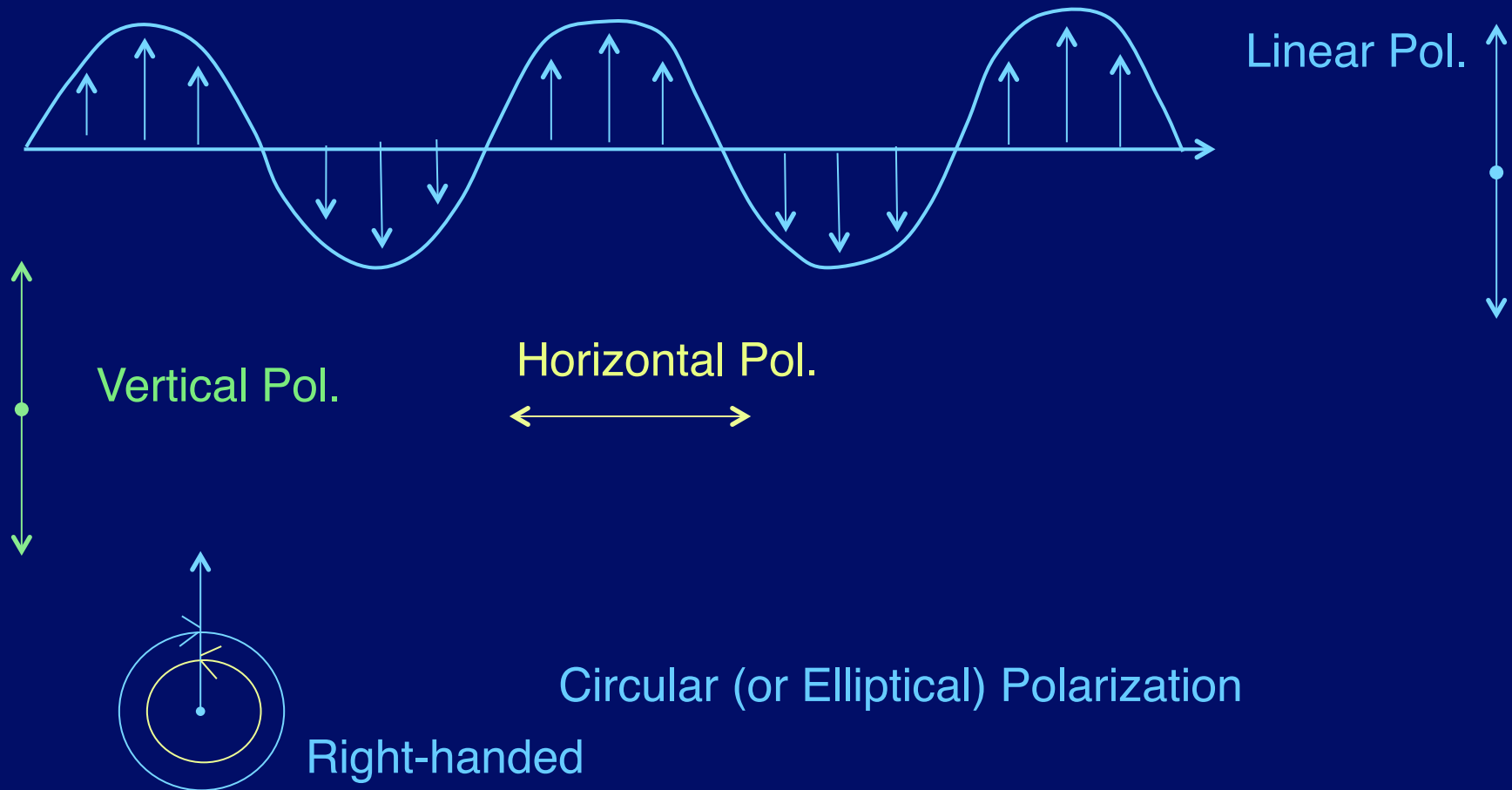
$32 + 16 + 8 + 0 + 2 + 1 = 59$  (pg. 68)

# The Movie (and the Instructions)

Polarization Modulation

(pg. 83)

- ("Direction is the Message")



# Decoding the Movie

- Repeating pattern
- Tens of billions of bits
- Product of 3 prime numbers
- Guess 2D image and time, so movie
- Purpose?

# Machine Instructions

- Palimpsest (pg. 100)
- Under the movie (pg. 185)
- Polarization modulation
- Purpose:

## Suggestions for the Primer

- Sol Hadden made 5 suggestions for finding it
- What were they?
- Which was right?

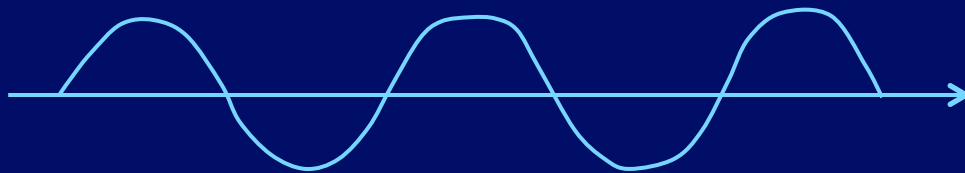
## Five Suggestions (pg. 220)

- Slower bit rate (e.g., 1 bit per hour)
- Faster bit rates (would require more BW)
- Occasional fast data dump
- Phase modulation
- Have to detect from space
  - e.g., around 5 mm, where O<sub>2</sub> blocks waves

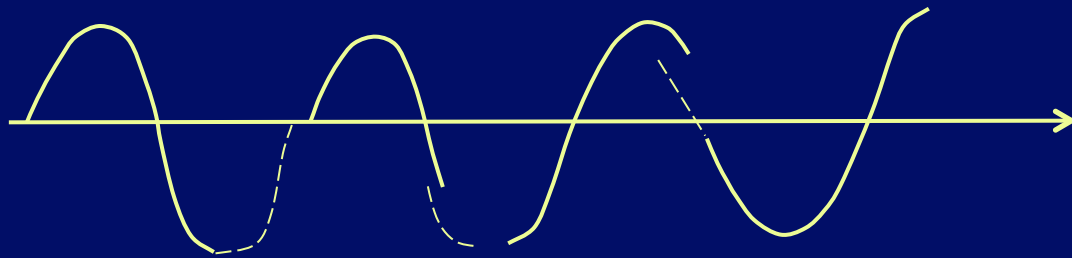
# The Primer

## Phase Modulation

- (“Timing is the Message”)



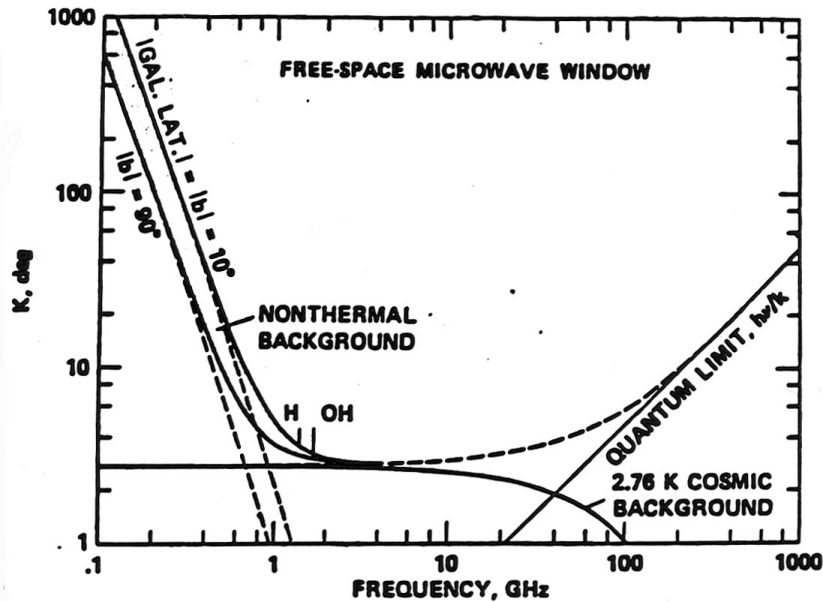
Steadily  
Increasing  
Phase



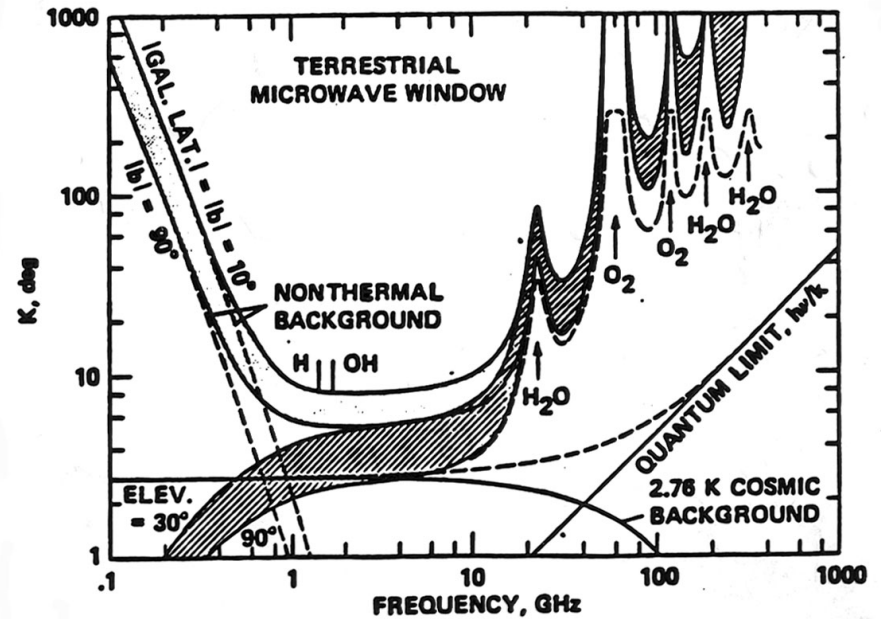
Rapid Changes  
in Phase



Figure 6.8



Free-space microwave window, in which the basic noises that limit radio communication over interstellar distances are least disruptive.



Terrestrial microwave window. Atmospheric water vapor and oxygen degrade the upper end of the microwave window for receivers on Earth's surface and raise the temperature in the lower portion of the window.

Note big noise at about 60 GHz. Oxygen molecules block our view of space at about 5 mm wavelength

# How The Primer Works

1 A 1 B 2 Z      1 + 1 = 2      TRUE

1 A 2 B 3 Z      1 + 2 = 3      TRUE

1 A 2 B 4 Y      1 + 2 = 4      FALSE

⇒      A is +

        B is =

        Z is TRUE

        Y is FALSE