

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

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

Very Large Array (VLA)



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

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

(NOT $\pi \times 1.42$ GHz, as the movie suggests!)

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

Word of the Day: sidereal

- From Latin sidere
- Belonging to the stars
- “Moving sidereally” (pg. 66)
- Having the apparent motion of the stars
- Which is really caused by the motion of the Earth (rotation and orbit)

The Signal

Not Terrestrial:

Moving Sidereally pg. 66

Vega:

Interferometric Position pg. 65

Proper Motion pg. 78

Doppler Corrected pg. 78

What were the 4 Levels of information?

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

Four Levels

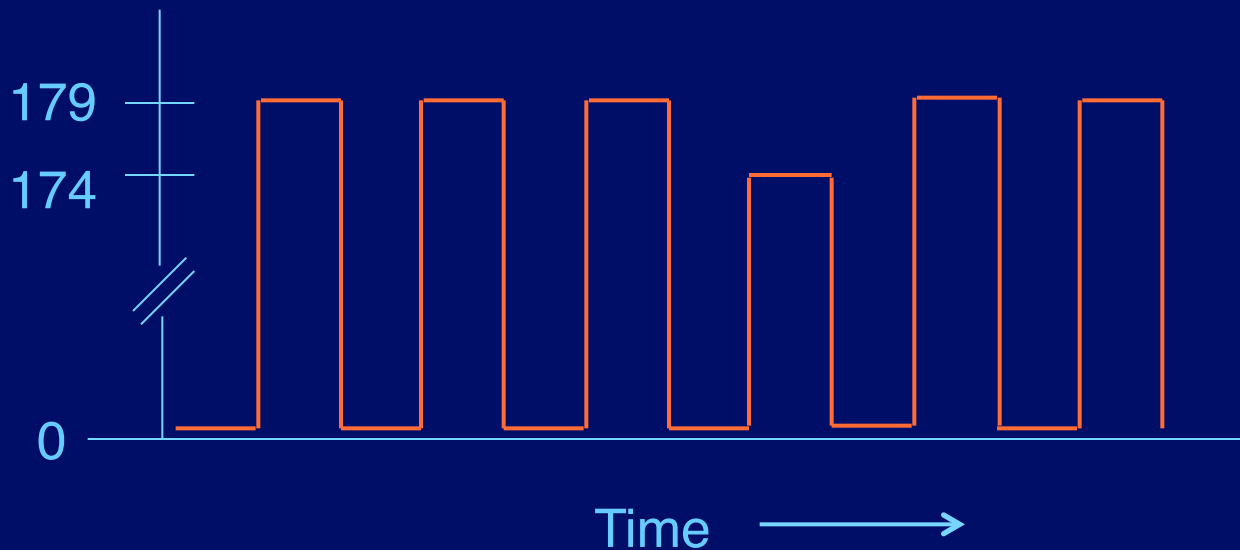
- Binary numbers
- Hitler movie
- Instructions for the machine
- The Primer

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

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

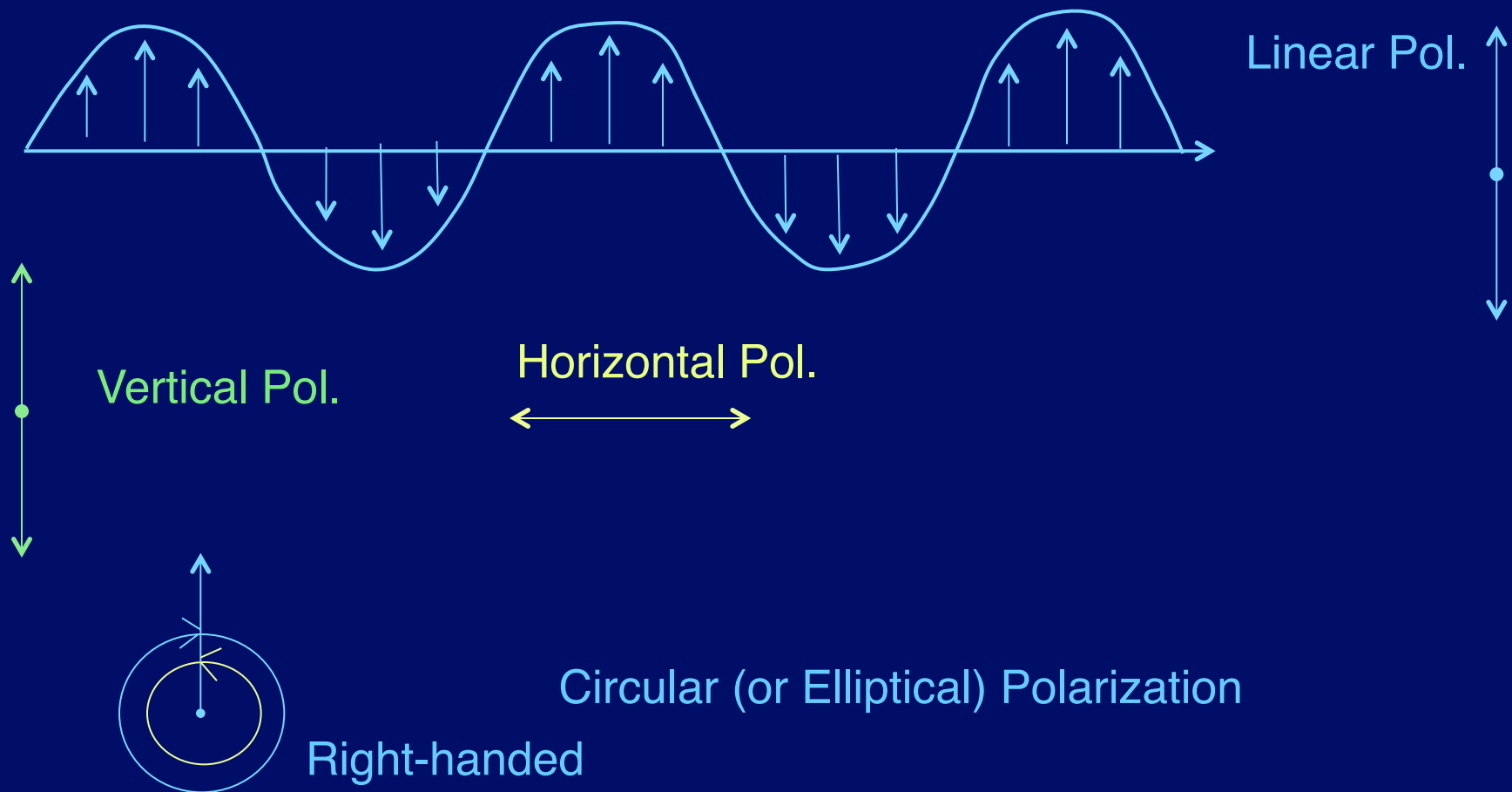
$32 + 16 + 8 + 0 + 2 + 1 = 59$ (pg. 68)

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?

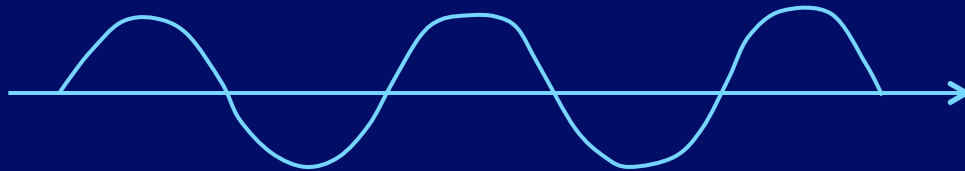
Five Suggestions (pg. 220)

- 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 O₂ blocks waves

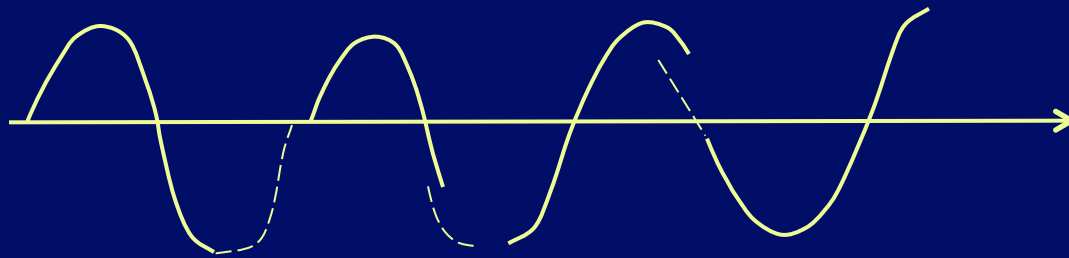
The Primer

Phase Modulation

- (“Timing is the Message”)

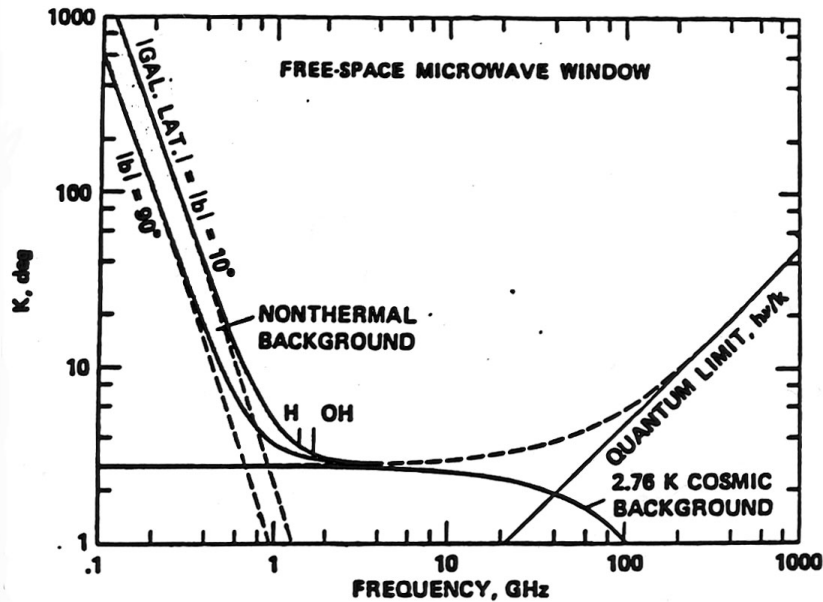


Steadily
Increasing
Phase

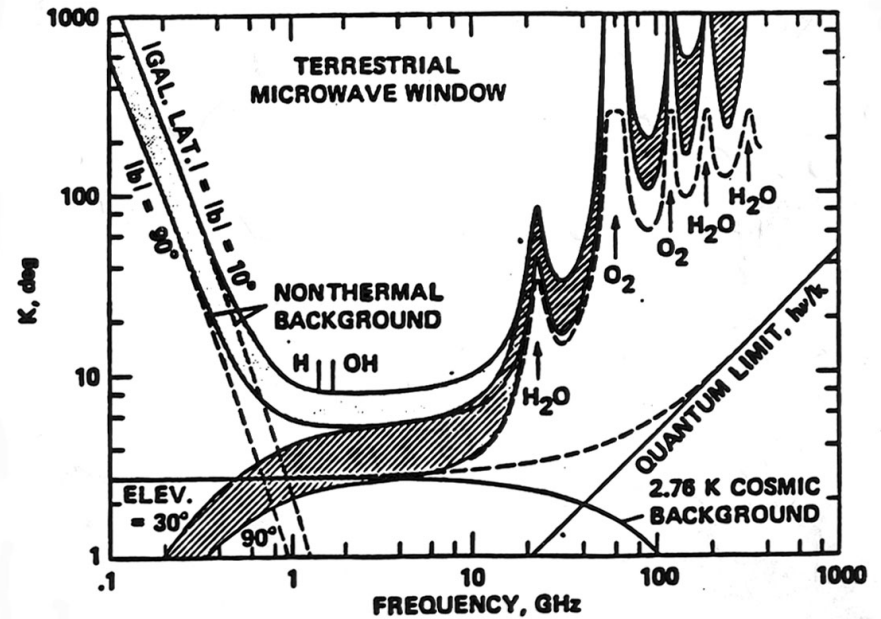


Rapid Changes
in Phase

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