Are We Alone in the Universe?

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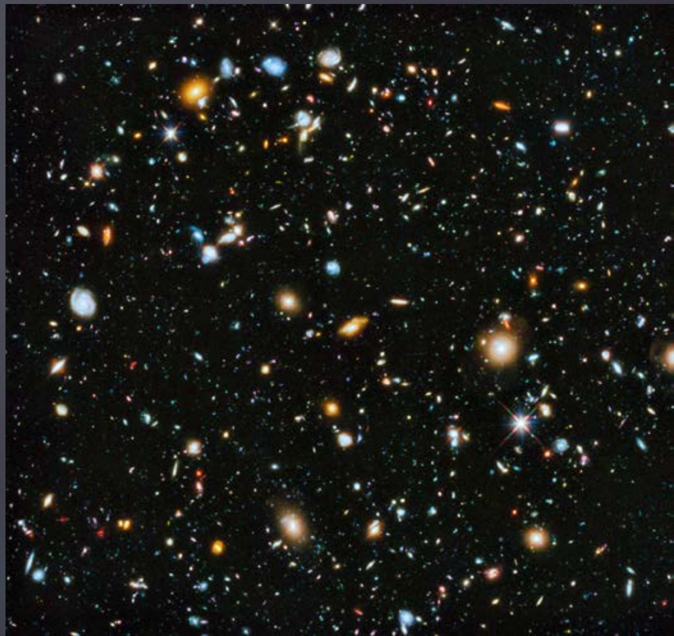
I: LIFE ON EARTH: COULD IT HAPPEN ELSEWHERE?

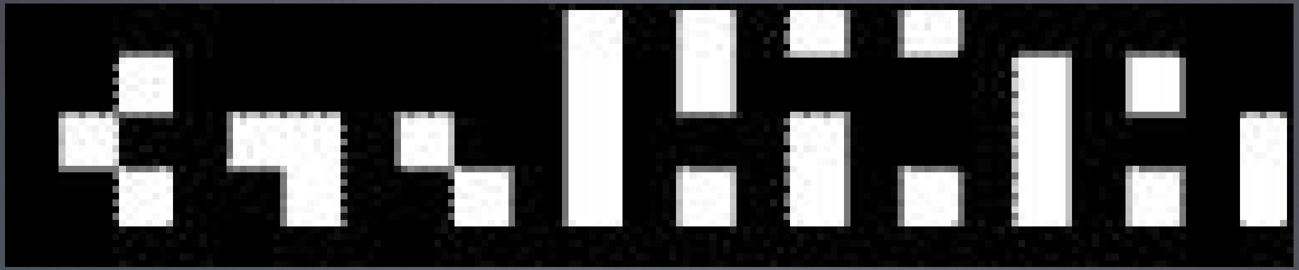
II: MAKING ALIENS

III: TALKING WITH ALIENS

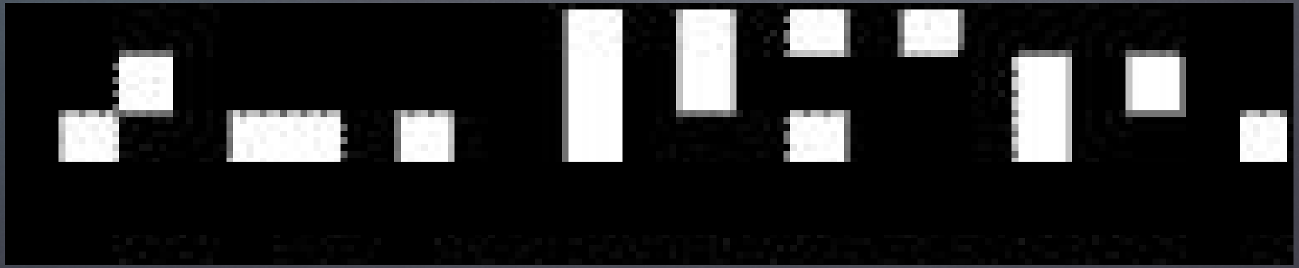


First Radio Signal

- Start at the top…
- Seems to be a dot at the bottom of various binary numbers

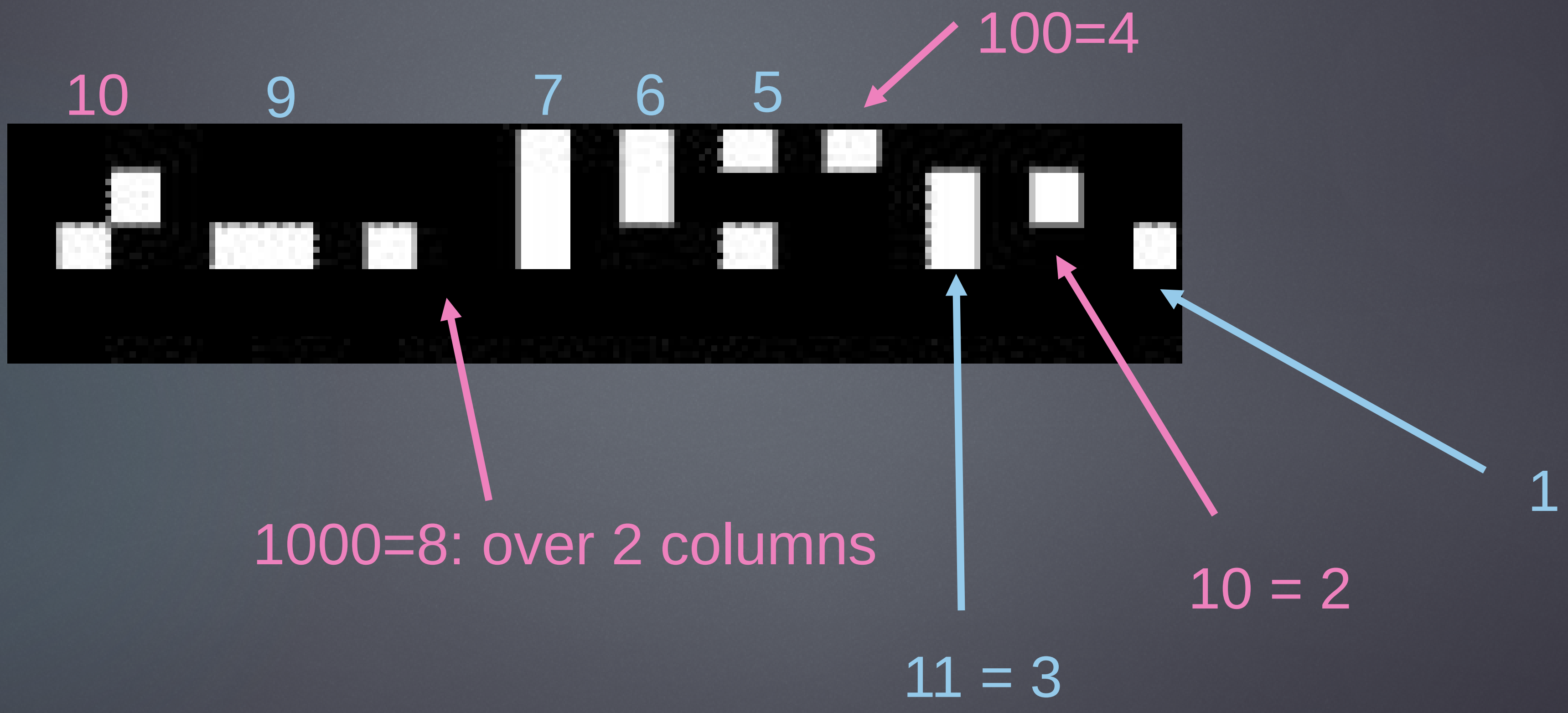


- Remove the dot beneath the numbers:



First Radio Signal

A white square = 1….a black space = 0



Number systems: Decimal or base 10

- Hopefully, you are familiar with this system!
- We have 9 digits: 1, 2, 3, 4, 5, 6, 7, 8, and 9
- Plus a zero: 0
- Note that there is NO DIGIT for the number ten!
- Instead we use a 1 and a 0 but the POSITION is crucial.
- For example 132 means:

$$132 = (1 \times 100) + (3 \times 10) + (2 \times 1)$$
$$= (1 \times 10^2) + (3 \times 10^1) + (2 \times 10^0)$$

- The digit tells you how many multiples you have for each POWER OF TEN

Number systems: Decimal or base 10

- We use the same system for numbers that are less than one.
- Here we use a decimal point to separate NEGATIVE powers of ten from POSITIVE powers

$$1.52 = (1 \times 1) + (5 \times 0.1) + (2 \times 0.01)$$
$$= (1 \times 10^0) + (5 \times 10^{-1}) + (2 \times 10^{-2})$$

- Another example:

$$254.17 = (2 \times 100) + (5 \times 10) + (4 \times 1) + (1 \times 0.1) + (7 \times 0.01)$$
$$= (2 \times 10^2) + (5 \times 10^1) + (4 \times 10^0) + (1 \times 10^0) + (7 \times 10^{-1})$$

Other bases?

- But there is no reason why we need to use base 10.
- It probably arose as a result of our ten fingers.
- But there is nothing special about that.
- Lets see what base FIVE looks like.

- Well there are 4 digits: 1, 2, 3 and 4
- And a zero:0
- BUT NO SYMBOL FOR FIVE…just as there is no symbol for TEN in base 10!
- The number FIVE is now written as 10 = 1 x 5 + 0 x 1

$$= (1 \times 5^1) + (0 \times 5^0)$$

Number systems: Base 5

Counting

Base 5: 1, 2, 3, 4, 10, 11, 12, 13, 14, 20, 21…

Decimal: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11…

132 $= (1 \times 5^2) + (3 \times 5^1) + (2 \times 5^0)$

$= (1 \times 25) + (3 \times 5) + (2 \times 1)$

$= 25 + 15 + 2$

$= 42$ in decimal

1.42 $= (1 \times 5^0) + (4 \times 5^{-1}) + (2 \times 5^{-2})$

$= (1 \times 1) + (4 \times 1/5) + (2 \times 1/25)$

$= 1 + 0.8 + 0.08$ in decimal

$= 1.88$ in decimal

Number systems: Base 5

$$132 = (1 \times 5^2) + (3 \times 5^1) + (2 \times 5^0)$$
$$= (1 \times 25) + (3 \times 5) + (2 \times 1)$$
$$= 25 + 15 + 2$$
$$= 42 \text{ in decimal}$$

$$1.42 = (1 \times 5^0) + (4 \times 5^{-1}) + (2 \times 5^{-2})$$
$$= (1 \times 1) + (4 \times 1/5) + (2 \times 1/25)$$
$$= 1 + 0.8 + 0.08 \text{ in decimal}$$
$$= 1.88 \text{ in decimal}$$

Base 16: Hexadecimal

- We can have bases greater than 10, of course
- But we will need more symbols!
- Hexadecimal, or base 16, is often used in computing.
- So we need 15 symbols. Sixteen will be represented as 10 = (1 x 16) + (0 x 1)
- The symbols used are 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- Note that in hexadecimal A represents ten

  B represents eleven

  C represents twelve

  D represents thirteen

  E represents fourteen

  F represents fifteen

Base 16: Hexadecimal

- So how would we represent the number one hundred in hexadecimal?
- Well the digits will represent multiples of 16.
- The first to the left of the decimal point (hexadecimal point?) tells us how many multiples of 16^0 there are. 16^0 is just one of course.
- The second digit to the left tells us how many multiples of 16^1 are needed.
- The third digit tells us how many multiples of 16^2 = two hundred and fifty six are required.

- So for one hundred we need (6 x 16) + (4 x 1) so the hex number for one hundred is 64
- What about two hundred? Now we need twelve x 16 plus 8: ie C8
- One thousand would be 3E8 (check it!)

Base 16: Hexadecimal

- What does this hex number represent?
- E3.A4

E3.A4 = E (ie fourteen) times 16^1 + 3 x 16^0 + A (ie ten) times 16^{-1} + 4 times 16^{-2}

In decimal form this is: (14 x 16) + (3 x 1) + (10 x 0.0625) + (4 x 0.00390625)

So E3.A4 = 227.640625

Number systems: Binary or Base 2

- Now to the simplest – base 2!
- Here we have ONE symbol…the 1
- Plus of course the zero.
- As usual, there is no symbol for TWO in a base TWO system!
- Two is represented by 10 = 1 x 2 + 0 x 1

Counting

Base 2:	1,	10,	11,	100,	101,	110,	111,	1000…
Base 10:	1,	2,	3,	4,	5,	6,	7,	8…

Number systems: Binary or Base 2

And we do fractions just as before:

$$1.01 = (1 \times 2^0) + (0 \times 2^{-1}) + (1 \times 2^{-2})$$
$$= (1 \times 1) + (0 \times 1/2) + (1 \times 1/4)$$
$$= 1 + 0.25 \text{ in decimal}$$
$$= 1.25 \text{ in decimal}$$

One more example:

$$101.101 = (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3})$$
$$= (1 \times 4) + (0 \times 2) + (1 \times 1) + (1 \times 1/2) + (0 \times 1/4) + (1 \times 1/8)$$
$$= 4 + 0 + 1 + 0.5 + 0.0 + 0.125$$
$$= 5.625$$