Are We Alone in the Universe?

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Thanks!

1) Honors Carolina
2) Morehead-Cain Scholars Program
3) UNC Department of Physics and Astronomy

for inviting me to serve as the 2018 Morehead-Cain Alumni Visiting Distinguished Honors Professor
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

1000=8: over 2 columns
10 = 2
11 = 3
100=4
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.
- Let's 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 $10 = 1 \times 5 + 0 \times 1$
  
  $= (1 \times 5^1) + (0 \times 5^0)$
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 x 5²) + (3 x 5¹) + (2 x 5⁰)
= (1 x 25) + (3 x 5) + (2 x 1)
= 25 + 15 + 2
= 42 in decimal

1.42 = (1 x 5⁰) + (4 x 5⁻¹) + (2 x 5⁻²)
= (1 x 1) + (4 x 1/5) + (2 x 1/25)
= 1 + 0.8 + 0.08 in decimal
= 1.88 in decimal
Number systems: Base 5

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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 $10 = (1 \times 16) + (0 \times 1)$
- 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 $16^2 = \text{two hundred and fifty six}$ are required.

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

E3.A4

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

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

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 $10 = 1 \times 2 + 0 \times 1$

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:

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