

## Life in the Universe 1

- History of Life on Earth
- Hypotheses on the origin of life
  - panspermia vs. spontaneous generation
- Drake Equation
  - the number of civilizations in the Milky Way
- How should we search?
- Fermi's Paradox
  - why are they not here?

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### A little timeline:

- Oldest books ~2800 years ago
- first "people" ~10<sup>6</sup> years ago
- first animals, plants 6.5 x 10<sup>8</sup> years ago
- earth and sun form 4.6 x 10<sup>9</sup> years ago
- Milky Way forms ~1.2 x 10<sup>10</sup> years ago
- universe begins 1.37 x 10<sup>10</sup> years ago

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### If this were one day ...

- Now 12:00 midnight
- Old Testament 0.017 sec ago
- first people 11:59:54 PM
- first animals, plants 10:51 PM
- earth and sun form 3:56 PM
- Milky Way forms ~3:00 AM
- CMB radiation 12:00:02 AM
- universe begins 12:00 midnight

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### A Logarithmic Scale :

10<sup>10</sup> 10<sup>9</sup> 10<sup>8</sup> 10<sup>7</sup> 10<sup>6</sup> 10<sup>5</sup> 10<sup>4</sup> 10<sup>3</sup> 10<sup>2</sup> 10<sup>1</sup> years ago

Challenge: Can you fill in some interesting things that were happening right here in each interval?

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The Drake Equation for the number of civilizations in our Milky Way Galaxy

$$N = r f_p n_p f_l f_e L$$

where N = the number of civilizations

r = the star formation rate in the MW

f<sub>p</sub> = the fraction of stars that have planets

n<sub>p</sub> = the average number of planets

f<sub>l</sub> = the fraction of planets that develop life

f<sub>e</sub> = the fraction with life that evolve intelligence

L = the lifetime of the civilization the evolves

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## Fermi's Paradox

If we work out how rapidly civilizations could spread around the Galaxy once they get started, the time to fill the whole area is much less than the lifetime of the sun.

So why have alien civilizations not already come here?

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