Astronomy 330

This class (Lecture 14):

Life on Earth
Alesia Prakapenka
Anthony Salis

Next Class:

Origin of Life
MidTerm Due!
Sonja Bromann
Michelle Boehm

Music: *Bring Me to Life*– Evanescence

Take Home Midterm

- Emailed to everyone after class last Thursday.
  - 50%: 4 short (few paragraphs) essays
  - 50%: 1 large (~1 page) essay (with definition terms)
- Must be typed, not handwritten.
- Will cover material up to and including last Thursday.
- It is a closed notes exam (honor system!).
- You can make 1 page of notes that you use during the exam.

HW 2

- Carolyn Buesing
  http://www.ufos-aliens.co.uk/cosmicabduct.htm
- Maura Walsh
  http://aliensandchildren.org

Presentations

- Alesia Prakapenka
  Aliens in Religion
- Anthony Salis
  Alien Math

Outline

- What type of stars are good for life?
- Monomers and polymers
- Proteins and nucleic acid?
- Where did the monomers of life come from?

$$n_e = n_p \times f_s$$

n_p: number of planets suitable for life per planetary system

Class number is 1.3

http://nike.cecs.csulb.edu/~kjlivio/Wallpapers/Planets%2001.jpg

$$n_e = n_p \times f_s$$

n_p: number of planets suitable for life per planetary system

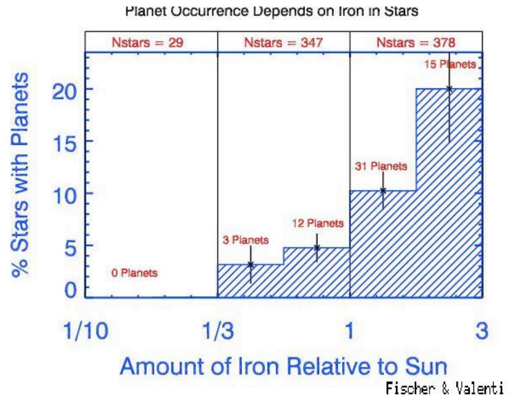
f_s: fraction of stars whose properties are suitable for life to develop on one of its planets

We can list 5 situations that will have an effect on f_s.

http://nike.cecs.csulb.edu/~kjlivio/Wallpapers/Planets%2001.jpg

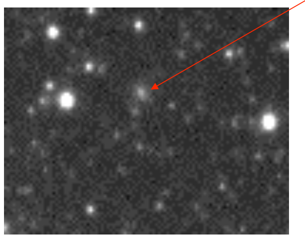
Differences of Stars to Life

1. **Metal rich stars**. Stars with heavy elements, probably more likely to have planets. Suggested in the current planet searches. About 90% of all stars have metals.



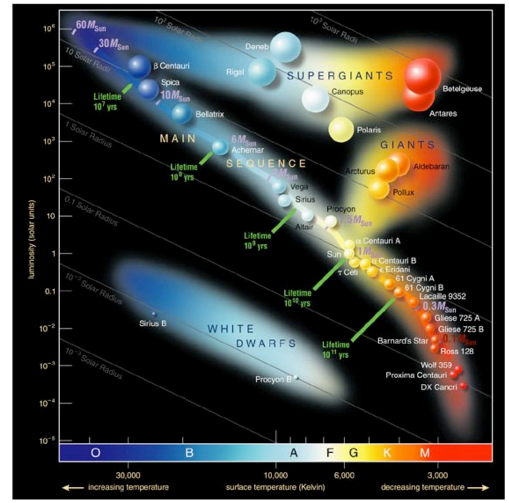
Differences of Stars to Life

2. **Main sequence stars**. Need the brightness to stay as constant as possible. Otherwise the temperature changes dramatically on the planets. This is 99% of all stars.



Differences of Stars to Life

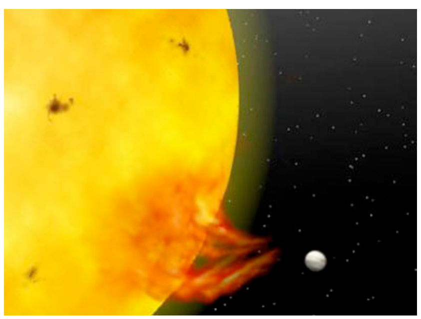
3. **Length of time on the main sequence**. We needed temperature stability for 5 billion years to get intelligence on Earth. This rules out stars more massive than 1.25 solar masses! 90% of all stars are less massive than that.



http://mjbs.org/hr.jpg

Differences of Stars to Life

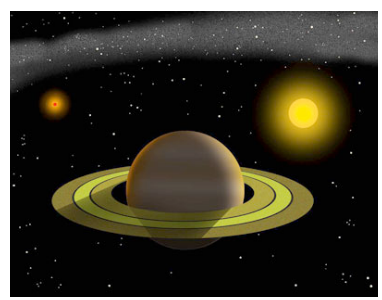
4. **Minimum mass of star**
For low-mass stars, any life bearing planetd would have to be closer to the star– and closer to stellar effects (e.g. tidal locking and more flares from low mass stars). That limits us to a minimum of 0.5 solar masses. 25% of all stars are more massive than that.

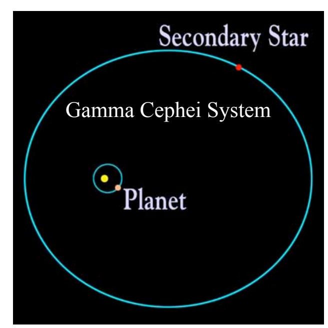


http://spaceflightnow.com/news/n0401/19planet/planet.jpg

Differences of Stars to Life

5. **Binarity**. Planets may form. But they may have odd orbits unless the 2 stars are far enough apart or the planet orbits the pair. Only 30% of all stars are single stars. 50% of all stars are single stars or wide binary stars.





http://spaceflightnow.com/news/n0210/11planet/

Adding it all up

Stellar Requirement	*Mass Limit*	*Fraction OK*	*Cumulative Fraction*
✓ Heavy Elements	…	0.9	0.9
✓ Main Sequence	…	0.99	0.891
Main Sequence Lifetime	$M < 1.25\ M_{sun}$	0.90	
Synchronous Rotation/ Flares	$M > 0.5\ M_{Sun}$	0.25	
✓ Not a Binary	…	0.30	0.267
Wide Binary Separation	…	0.50	

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f_s: fraction of stars that life can exist around

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Heavy Elements	…	0.9	
Main Sequence	…	0.99	
Main Sequence Lifetime	$M < 1.25\ M_{sun}$	0.90	
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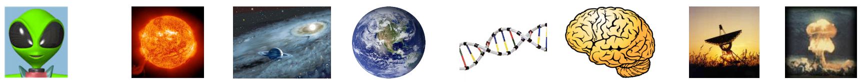
Not a Binary	…	0.30	
Wide Binary Separation	…	0.50	

Value can range from ~ 0.06 to ?

Drake Equation

That's 1.27 Life-liking systems/year

Frank Drake



$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

N	R_*	f_p	n_e	f_l	f_i	f_c	L
# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that commun-icate	Lifetime of advanced civilizations
	15 stars/ yr	0.65 systems/ star	1. 3 x 0.1 = 0.13 planets/ system	life/ planet	intel./ life	comm./ intel.	yrs/ comm.

Question

The best type of life sustaining stars are

a) Low mass stars (less than 0.5 solar masses), as life can exist nearer the star where more terrestrial planets are probably located.

b) Binary stars, as they double the chances of life.

c) Stars off the main sequence, as they have lived the longest, they are the best chance for finding intelligent life.

d) Middle mass stars (less than 1.25 and more than 0.5 solar masses), as they live longer and don't require the planets to be too close.

e) Massive stars (more than 2 solar masses), as they have more mass from which to form planets.

So Far, We have Studied

- The Universe
  - Big Bang
    - Creation of hydrogen, helium…
  - Galaxy formation
    - Swirls of elements embedded in self-gravitating cloud of dark matter
  - Star birth
    - Energy generation and element production in self-gravitating mass of gas
  - Planets
    - Ice, rock, gas surrounding stars form planetesimals, then planets

Life on Earth

- Time to examine terrestrial evolution.
- Need to understand what is needed for life to arise.
- Again, some Earth chauvinism.
- Relies on chemical evolution
- Eventually life began?

http://www.accessexcellence.org/bioforum/bf02/awramik/bf02a1.html

Life on Earth

- In our scientific approach, we look at life as a result of chemical evolution of complexity.
- We will view the formation of "life" on planets as we did star formation
  - A natural consequence of natural laws
  - More specifically, as a consequence of the complex chemistry that is sometimes achieved.

http://www.toothpastefordinner.com/052802/science-only-happens.gif

Cosmic Imperative?

- But is life a cosmic imperative?
- Just like gas forms galaxies, and in galaxies stars and planets form, do chemicals on some planets form molecules that lead to life?