Astronomy 330

HW2 due on Wednesday

Music: *Moonlight Sonata* – Beethoven

Questions?

- The End of the Universe depends on Dark Energy.
- Any questions?
- Discussions?

Grouped

- We spent last week discussing the End of the Universe.
- In groups of 3-4, try to write a 4-5 sentence explanation of the End of the Universe for a non-science major friend.

Presentations

- The presentation schedule has been decided by random selection.
- It is posted in the schedule section of the webpage.
- Make sure to check those dates ASAP.

Presentations

- Will be treated like a real talk.
- I will keep you to 12 minutes with 5 minutes of questions. (Peers should deduct points if too short, or I will.)
- Any speculative claims *MUST* have a scientific reference source.
  - Can't just claim that monkeys live on the Moon.

Presentations

- Can give presentation in any format you want.
- Over last few semesters:
  - 99% powerpoint
  - 0.5% talking with pics from webpages
  - 0.4% dedicated webpage
  - 0.1% overhead slides

Presentation

- You must email me lwl @ illinois by 1700 on the night before your presentation (or CD, DVD, memory stick the week before!), or your grade will suffer.
- This is necessary to:
  - 1. Make transitions smoother
  - 2. Make class go faster
  - 3. Make sure your files work on my laptop
  - 4. Make sure you don't do anything wrong

Oral Presentation

1. How relevant is the general topic to this class (e.g. search for extraterrestrial life)?
2. How interesting is the topic for the general class audience?
3. Rate the extent of the speakers knowledge on the topic?
4. Rate the quality of the overall presentation?
5. Does the research have a solid scientific basis?

These questions are rated 1-10 out of 10 scale by your peers!

Common Mistakes

- Too much text on a slide.
- Too long (only 2% are too short).
- Background graphics or color makes text hard to read.
- Reading the slides is boring, use as points but not the whole message.
- 12 minutes is not as long as it sounds.

Presentation Example:
Last Semesters Best One (99.8%)

Extremophiles

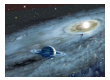
Highest grade: 99 %

Lowest grade: 91%

Drake Equation

Frank Drake







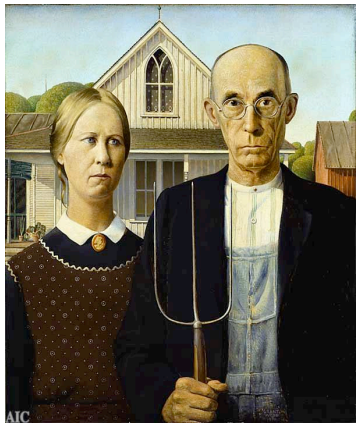

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# 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
	? stars/ yr	systems/ star	planets/ system	life/ planet	intel./ life	comm./ intel.	yrs/ comm.

Lifecycle of a Star

- Star formation
  - Take a giant molecular cloud core with its associated gravity and wait for 10^4 to 10^7 years.
- Death
  - Exhaust hydrogen
  - Red giant / supergiant or supernova
  - White dwarfs, neutron stars, black holes

Stellar Lifestyles



Low-mass stars

Massive stars

Lifecycle of a Star

- Star formation
  - Take a giant molecular cloud core with its associated gravity and wait for 10^4 to 10^7 years.

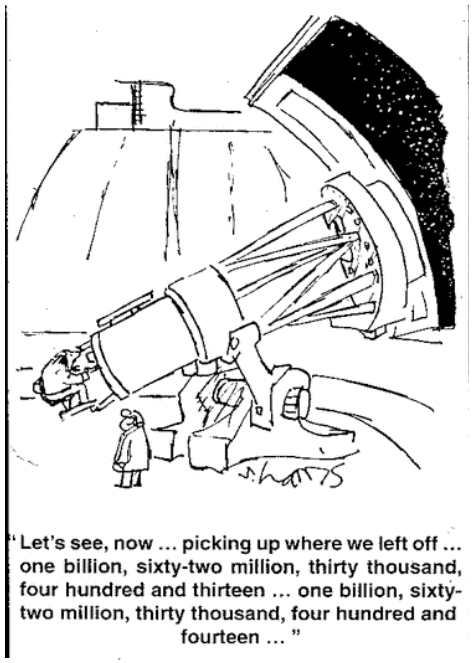
- Death
  - Exhaust hydrogen
  - Red giant / supergiant or supernova
  - White dwarfs, neutron stars, black holes
- Main sequence life (depends on mass!)
  - Few x 10^6 years to more than age of Universe
  - Thermonuclear burning of H to He

Stars

- The fundamental building blocks of the Universe.
- High mass stars are 8 to 100 solar masses
  - Short lived: 10^6 to 10^7 years
  - Luminous: 10^3 to 10^6 L_{sun}
  - Power the interstellar medium– input of energy
- Intermediate mass stars are 2 to 8 solar masses
- Low mass stars are 0.4 to 2 solar masses
  - Long Lived: $>10^9$ years
  - Good for planets, good for life.
  - Not so luminous: 0.001 to 10 L_{sun}

Estimate of R_*: The Star Formation Rate

- We are about to start the topic of star formation and planet formation, but really the field is not well enough developed to estimate R_*.
- It is more accurate to just take the total number of stars in the Galaxy and divide by the age of the Galaxy.
- Later we will correct for the stars that are too big, too small, or too variable.



"Let's see, now ... picking up where we left off ... one billion, sixty-two million, thirty thousand, four hundred and thirteen ... one billion, sixty-two million, thirty thousand, four hundred and fourteen ... "

Counting Stars

Estimate of R_*: The Rate of star formation

Take the total number of stars in the galaxy and divide by how long it took those stars to form.

Sounds easy, but it isn't. We can't see all of the stars, interstellar dust blocks our view of most of them.

We can estimate the number of stars based on the total mass of the Galaxy and some corrections.

$$N_* = 5\times10^{10} \text{ to } 5\times10^{11} \text{ stars}$$

Estimate of R_*: The Rate of star formation

Age of our galaxy is around 10^{10} years (if you want to be more precise, use 13.7 billion years minus ~200 million).

$$R_* = \frac{5\times10^{10} \text{ to } 5\times10^{11} \text{ stars}}{10^{10} \text{ years}} = 5 \text{ to } 50 \frac{\text{stars}}{\text{year}}$$

Probably the best estimate for the entire Drake Equation, meaning it can only be off by a factor of 10 or so.

Estimate of R_*: Discuss

$$R_* = \frac{5\times10^{10} \text{ to } 5\times10^{11} \text{ stars}}{10^{10} \text{ years}} \approx 5 \text{ to } 50 \frac{\text{stars}}{\text{year}}$$

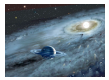
1. Discuss the calculation of this value.
2. Choose a lower/higher number if you think that the star formation rate was biased by non-uniform star formation.
   - Did the early galaxy produce more stars in the past than it does now? Was there a starburst long ago?
   - But remember that we are constantly obtaining new gas from our satellite galaxies (around 1 solar mass per year). It might average out.

Drake Equation

The class's first estimate is

Frank Drake





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