Astronomy 330

What do you do with it ?
I think you're supposed to get in the back
of it and make moaning noises !

<u>This class (Lecture 22):</u>
Communication
Nicholas Leners
Karna Gowda

<u>Next Class:</u>
Future of Civilization
Sean White
Lindsay Ellch

Rough Drafts due on the 15th!!

Music: *What's the Frequency Kenneth* – R.E.M.

HW 3

- **Jonah Wolff:**
  http://aliens.monstrous.com/majestic_12.htm

- **Jenny Christie:** http://ufoalert.com

Presentations

- **Nicholas Leners**: Roswell

- **Karna Gowda**: Extraterrestrial Civilizations

Outline

- What does our number of civilizations mean?
- How can we communicate with ET?

Drake Equation

That's 333 advanced civlizations in our Galaxy!!!!!!!!!!!

Frank Drake

$$N =$$

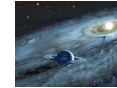# of advanced civilizations we can contact in our Galaxy today

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Drake Equation

That's 333 advanced civlizations in our Galaxy!!!!!!!!!!!

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
	15 stars/ yr	0.5 systems/ star	2.7 x 0.134 = 0.36 planets/ system	0.95 life/ planet	0.1 intel./ life	0.40 comm./ intel.	3250 yrs/ comm.

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= 2.5 x 10¹¹

Communicating Civilizations

Drake Equation For Optimist

62.5% of all stars in our Galaxy.

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

# of advanced civilizations we can contact	Rate of formation of Sun-like stars	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
	50	1	1	1	1	1	5 x 10⁹

Birthrate of 50/year!

Nov 1, 2007

= 7.5 x 10⁻⁶

Communicating Civilizations

Drake Equation For Pessimist

Must wait 10⁷ years for one!

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

# of advanced civilizations we can contact	Rate of formation of Sun-like stars	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
	5	0.1	0.15	0.01	0.01	0.01	100

Birthrate of 7.5 x 10⁻⁸ /year!

Nov 1, 2007

Slide 1

$$= 9.3 \times 10^5$$

Communicating Civilizations

Drake Equation For Average

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

# of advanced civilizations we can contact	Rate of formation of Sun-like stars	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
	10	0.5	0.89	0.5	0.7	0.6	1×10^6

Birthrate of 0.93 /year!

Slide 2

Hmm..

- None of these results are wrong.
- The average results of around 1/year would suggest that any life that is contacted is presumable older and therefore more advanced.
- It is interesting to note that for our values lifetimes greater than around 90 years, gives more than 10 civilizations with which to talk.
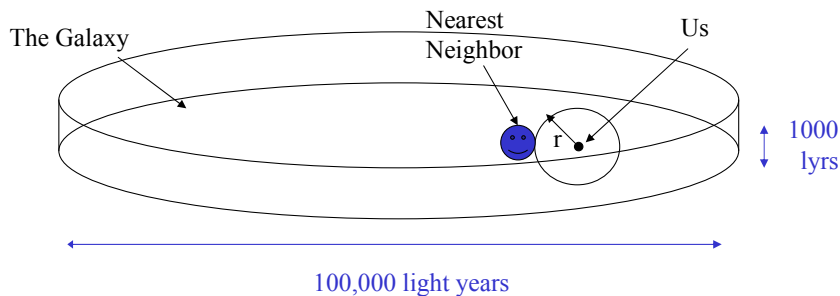- Our number was **3250** years.

Slide 3

Distance to Nearest Neighbor

- Assume that the alien civilizations are uniformly scattered in our galaxy and N > 8000.
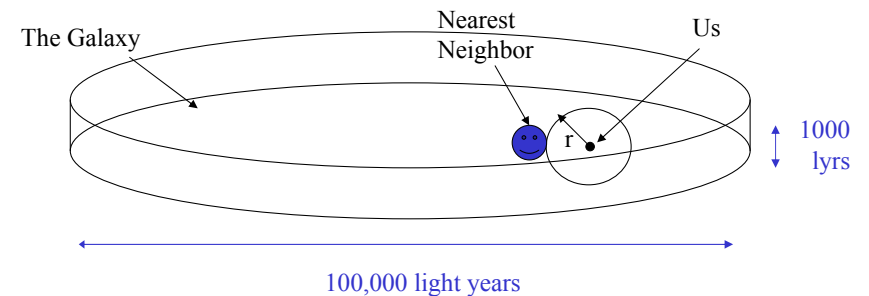- We can then assume spherical volume to find ET, i.e. flatness of Galaxy not an issue.

The Galaxy — Nearest Neighbor — Us — r — 1000 lyrs

100,000 light years

Slide 4

Distance to Nearest Neighbor

- Assume N > 8000

$$\frac{Average\ Galactic\ Volume}{Number\ of\ Civilizations} = \frac{\pi\ r_{galaxy}^2 h_{galaxy}}{N} = \text{alien density}$$
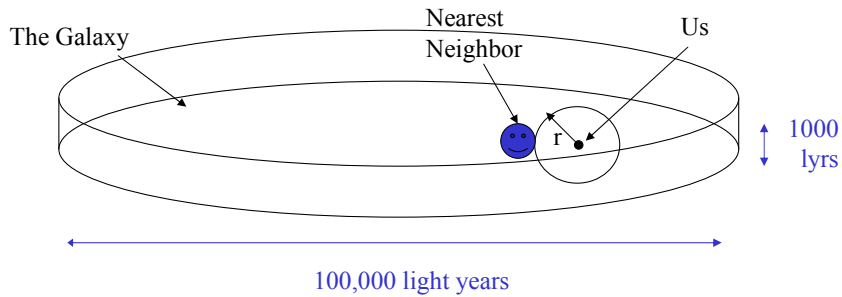
The Galaxy — Nearest Neighbor — Us — r — 1000 lyrs

100,000 light years

Distance to Nearest Neighbor

- Assume N > 8000

$$alien\ density = \frac{\pi\ r^2_{galaxy} h_{galaxy}}{N} = \frac{7.85 \times 10^{12}\ \text{lyrs}^3}{N}$$

The Galaxy • Nearest Neighbor • Us • r • 1000 lyrs • 100,000 light years

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Distance to Nearest Neighbor

- Assume N > 8000

$$alien\ density = \frac{\pi\ r^2_{galaxy} h_{galaxy}}{N} = \frac{7.85 \times 10^{12}\ \text{lyrs}^3}{N}$$

The Galaxy • Nearest Neighbor • Us • r • 1000 lyrs • 100,000 light years
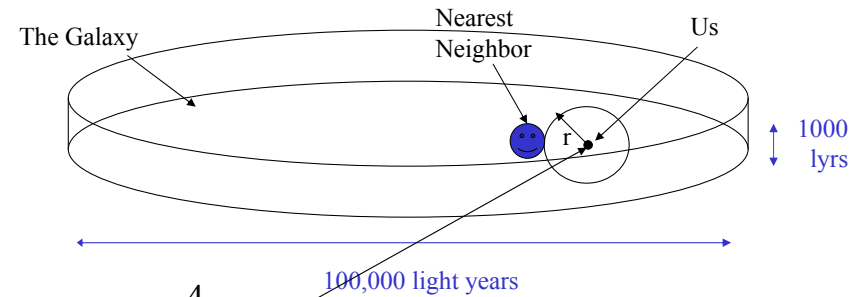
$$search\ volume = \frac{4}{3}\pi\ r^3$$

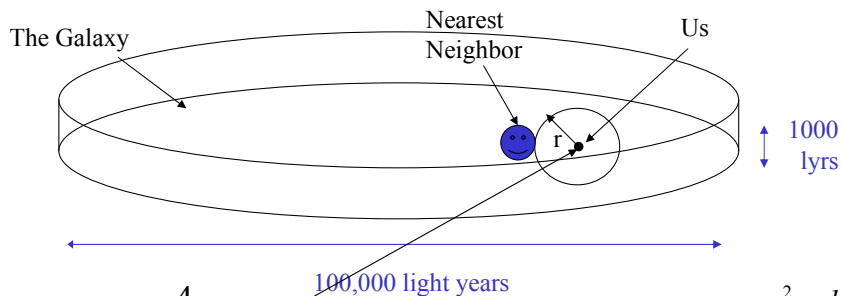
Distance to Nearest Neighbor

- Assume N > 8000

$$\frac{4}{3}\pi r^3 = \frac{7.85 \times 10^{12}\ \text{lyrs}^3}{N}$$

The Galaxy • Nearest Neighbor • Us • r • 1000 lyrs • 100,000 light years

$$search\ volume = \frac{4}{3}\pi\ r^3 \qquad alien\ density = \frac{\pi\ r^2_{galaxy} h_{galaxy}}{N}$$

Distance to Nearest Neighbor

- Assume N > 8000

$$\text{Then} \qquad r \approx \frac{12000\ ly}{N^{\frac{1}{3}}}$$
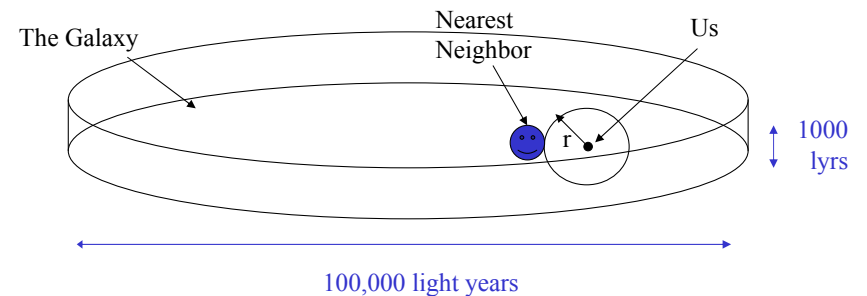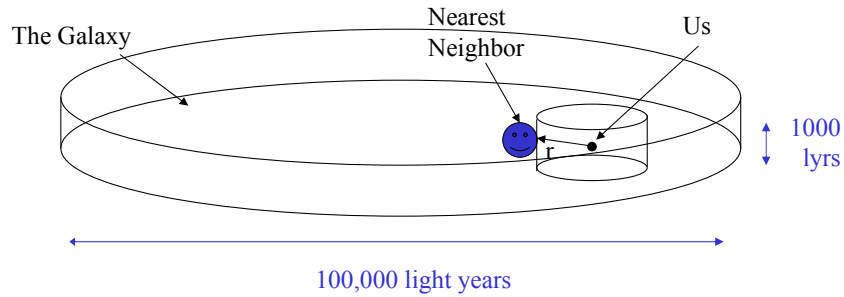
The Galaxy • Nearest Neighbor • Us • r • 1000 lyrs • 100,000 light years

Distance to Nearest Neighbor

- Assume that the alien civilizations are uniformly scattered in our galaxy and N < 8000.
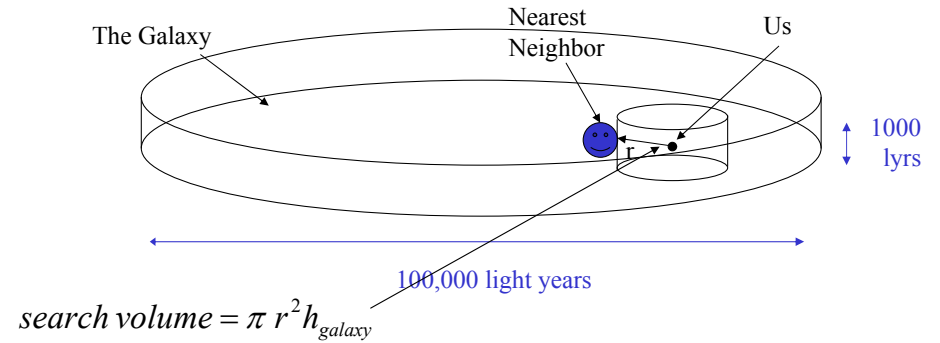- Then, the flatness of Galaxy is an issue.

The Galaxy
Nearest Neighbor
Us
1000 lyrs
100,000 light years

Distance to Nearest Neighbor

- Assume N < 8000

$$\frac{Average\ \ Galactic\ Volume}{Number\ of\ Civilizations} = \frac{\pi\, r^2_{galaxy} h_{galaxy}}{N} = \text{alien density}$$

The Galaxy
Nearest Neighbor
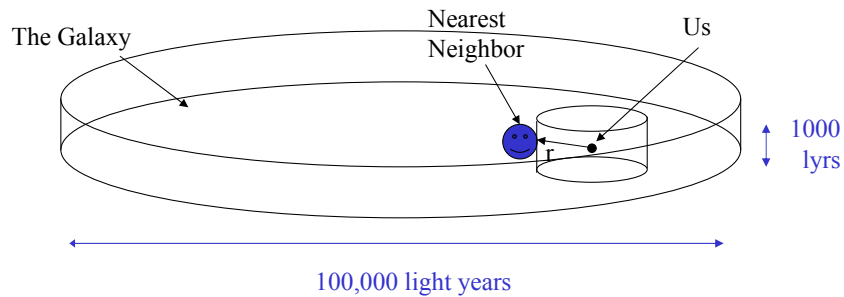Us
1000 lyrs
100,000 light years

$$search\ volume = \pi\, r^2 h_{galaxy}$$

Distance to Nearest Neighbor

- Assume N < 8000

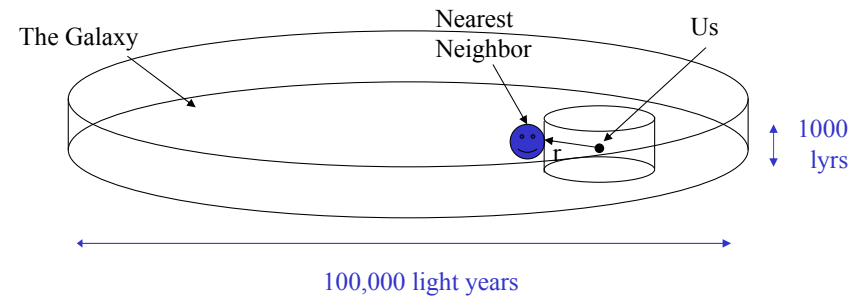$$\pi r^2 h_{galaxy} = \frac{7.85 \times 10^{12}\ \text{lyrs}^3}{N}$$

The Galaxy
Nearest Neighbor
Us
1000 lyrs
100,000 light years

Distance to Nearest Neighbor

- Assume N < 8000

$$\text{Then} \quad r \approx \frac{50000\, ly}{N^{\frac{1}{2}}}$$

The Galaxy
Nearest Neighbor
Us
1000 lyrs
100,000 light years

The Neighbors
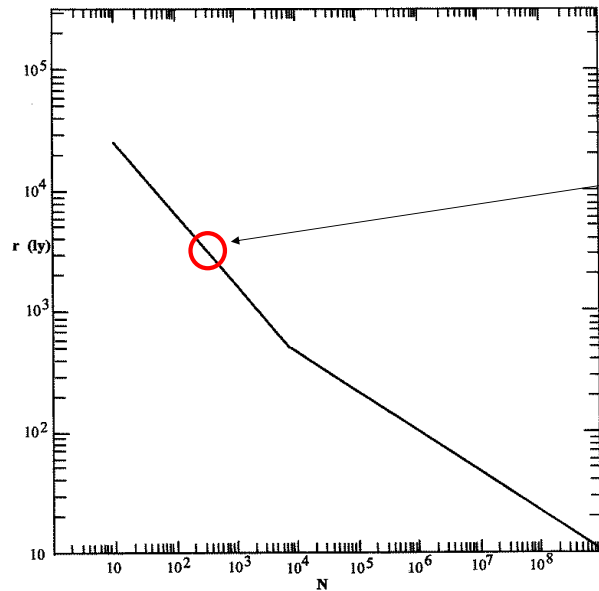
We need to look at every star within ~3000 lyrs for one detection!

Using N=333

Interesting Points

1. We assumed uniform density of civilizations.
   - Underweights the galactic center, but maybe that's okay– supernovae.
2. Distance away is the <u>average</u>.
   - Could be closer, but unlikely to be much closer.
3. Note that r is better defined than N.
   - R depends on $N^{1/2}$ or $N^{1/3}$.
   - If we are wrong in N by a factor of 100, then only off in r by factors of 10 or 4, respectively.
4. For communication, it may be that the distance there and back is longer than L.

How to Communicate?

- Okay, our estimate is optimistic.
- So, how do we go about detecting our neighbors?
- Are we seriously sending out messages now?
- No.

How to Communicate?

- We are relatively a young civilization, with radio technology for only a hundred years.
- Right now, we are mostly a passive "lurker" civilization.
- Okay, so what will an advanced civilization use?
- Hard to figure out.. They are aliens!

Light me up

- Visible light is only a tiny portion of the full electromagnetic spectrum
- Red light has longer wavelength and lower frequency than blue light.
- Divisions between regions are from biology or technologies.