AST 205. Lecture 21. December 1, 2003 Cosmic, Geological, Biological and Human Timescales!

- Context
- The statistics of time
- Cosmic, geological, biological & human time
- Plate tectonics, a *slow* dynamical process
- Periodization as a conceptual timescale tool
- Galactic time units as a conceptual timescale tool
- An origins chronology in Galactic time units
- Implications for extrasolar planets and extraterrestrial life & civilizations



$N = f(p)n(e)f(1)f(i)f(c)R_*L$

- Radial velocity techniques have provided first direct clues about f(p), ≥ 5 -10%
- No direct information on n(e) yet
- R_{*} measured by astronomical observations
- f(l) depends on biochemistry & cell biology
- Depends on evolution towards complexity
- One & only one case + no general theory
- Zero cases + no theory -> speculation
- Some lower & upper bounds/constraints



Examples of time statistics

- If you pick a Princeton undergraduate at random and determine his/her age, you are twice as likely to have chosen someone 19 or 20 years old (between 19th and 21st birthdays) as someone who is 19 years old (between 19th and 20th birthdays).
- Roll a pair of dice until you get a 7, then until you get a 2, then until you get a 12, then start over and go back to trying to roll a 7 and repeat the sequence many times. On average you will have to make 6 times more rolls to get each 2 or 12 as each 7 because 7's are 6x more probable than 2's or 12's.



Geological TimeImage: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2"Image: Colspan="2"Image:











































Implications for extrasolar planets and extraterrestrial life & civilizations

- We are minute and isolated in the time dimension as well as the spatial ones, lost in time as well as space.
- Extrasolar terrestrial planets are much more likely to resemble the Earth's far past or future than its present.
- Despite "appearances" it may be easy/probable to form simple (prokaryotic) unicellular life but difficult or improbable to form complex multicellular life and/or advanced intelligence and technological civilizations.
- Extraterrestrial civilizations will be either *extremely* rare or *much* older than our own.

