Planetary Habitability in the Early Universe
The Big Bang & Expansion

- 13.8 billion yrs ago, expanding ever since
  - Distant galaxies all are receding from Earth
  - \( V = H \times d \)

- Light from distant objects is reddened by expansion of universe (redshift)
Cosmic Microwave Background

- 380,000 yrs after BB: universe becomes transparent to light for first time
- Had spectrum of object with temp = 3000 K
- Minor temp variations = density variations in early universe
Loeb’s Argument

• (1) redshifted CMB heats outer rocky planets enough for liquid water
  – 10-17 Myr after BB

• (2) variations in CMB could cause planet formation during this epoch
Reactions to Loeb

• Obstacles to life
  – Supernovae & GRBs
  – Planetesimal bombardment

• Enough heavy elements?

• < 7 Myr: too little time for life?
  – Biochemistry, formation of planetary magnetic field, etc.

• Not directly testable