Introductory Astronomy

Week 8: Cosmology

Clip 1: The Cosmological Principle

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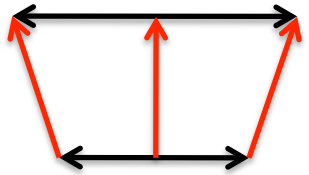
Same All Over

- The cosmological principle is the assertion that the Universe, at the largest scales, is homogeneous and isotropic
- Homogeneous: Every position is equivalent. There is no center or edge
- Isotropic: Every direction is equivalent

Evidence

- Clearly homogeneity does not hold on small scales
- Searches for large-scale structure show decaying correlations at 100Mpc
- Hubble Flow is consistent with this

$$v = H_0 D$$



$$x_i(t) = x_i(0)\,(1 + H_0 t)$$

$$v_i = H_0 x_i(0)$$

$$v_i - v_j = H_0\,(x_i(0) - x_j(0))$$

$$v_i = K x_i^2$$

$$v_i - v_j = K\left(x_i^2 - x_j^2\right) \neq K\,(x_i - x_j)^2$$

Hubble Flow

- Hubble flow determines a preferred rest frame at every position

$$v_i = H_0 x_i$$

$$v_i - v = H_0 x_i - v$$

- Peculiar velocity is motion relative to this
- In frame moving relative to Hubble flow universe is not isotropic

- Redshift is $z = (H_0/c)\, D$ for $z \ll 1 \quad D \ll c H_0^{-1}$
- Beyond small z sensitive to:
  - Relativistic correction
  - History of universe
  - Definition of distance in a changing universe
- Naively predict Big Bang at $t = -H_0^{-1}$
- Expect expansion to slow due to gravity

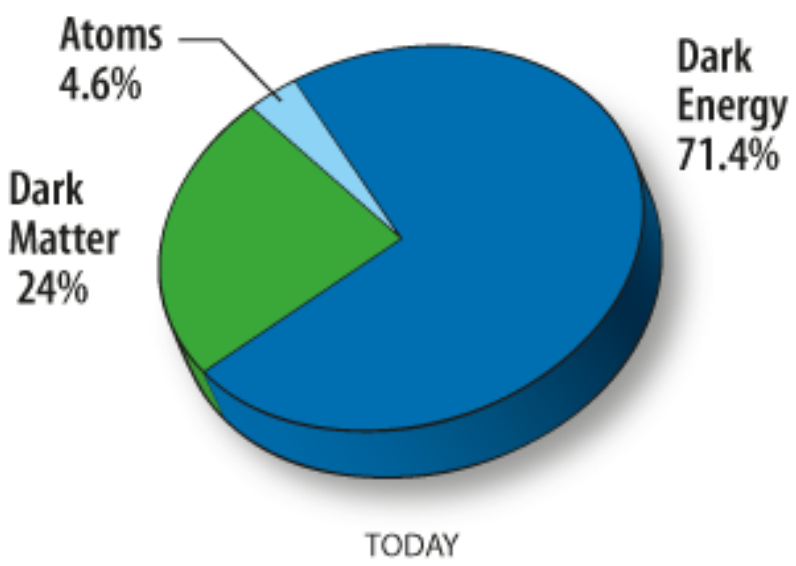
Olbers!

- In a universe of finite age sky is dark even if size is infinite
- Light from farthest visible stars is redshifted
- We have not seen everything yet
- We never will

- *"The only mode, therefore, in which…we could comprehend the* voids *which our telescopes find… would be by supposing the distance of the invisible background so immense that no ray from it has yet been able to reach us at all"* E.A. Poe 1848

This Week

- Applying General Relativity to a homogeneous isotropic universe
- Parameters of the model and how they are determined
- Open Problems and Recent Ideas



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Credits

- Pie Chart: NASA/WMAP Science Team http://map.gsfc.nasa.gov/universe/uni_matter.html