Astronomy 102 — Recitation #11

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Review of lectures 21–22 and Ch. 14.

Wormholes

- Valid solution to the Einstein field equation, constructed with two "expanding" singularities connected in hyperspace.
- While the wormhole is open, there is no horizon or singularity present.
- Wormholes require exotic matter to remain open while real matter passes through.
- If the distance between the two mouths of the wormhole is changed in real space (expanded at relativistic speeds), but the distance between them remains constant in hyperspace, then the wormhole can be used to travel forwards or backwards in time.

The Universe

- The Universe is isotropic and homogeneous.

  Isotropic Looks the same in any direction from a given viewpoint.

  Homogeneous Looks the same from any viewpoint.

- Solutions of the Einstein field equation for an isotropic and homogeneous universe either collapse into a mass-density singularity or expand from a mass-density singularity.

  Closed universe ends in a collapse to a mass-density singularity.

  Flat universe expands from a mass-density singularity; said expansion slows and eventually stops.

  Open universe expands from a mass-density singularity forever.

- The expanding mass-density singularity incorporated in all types of universes is called the Big Bang.
- Einstein introduced a "cosmological constant" into his field equation to try and eliminate these mass-density singularities.

In-class problems

1. For each of the following distributions, determine if it is homogeneous and/or isotropic.
   (a) The distribution of stars in a globular cluster
   (b) The distribution of stars in our galaxy
   (c) The distribution of galaxy clusters in the universe averaged over large scales
2. Which prospect do you find more depressing: eternal expansion or the fiery "big crunch"? Or perhaps you find neither one depressing — all things must die, and the universe is no exception.