

Monday, October 1

Thorne Ch. 11-14

## Agenda

- Announce:
  - Test Wednesday

## Ch. 11—BH “Paradigms”

- BH curves spacetime
- BH makes rulers/clocks rubbery
- BH is described by membrane at horizon

## Ch. 12—BH Dynamics

- Growth of BHs
  - Apparent horizon
  - Event horizon
- Area increase theorem (Hawking,others)
- Area like Entropy (Bekenstein)
- Thermodynamics
  - 2<sup>nd</sup> Law—Entropy only increases
- Laws of BH mechanics (Bardeen,Carter,Hawking)
  - Entropy  $\rightarrow$  horizon area
  - Temperature  $\rightarrow$  surface gravity
- Black Holes radiate as a black body (Hawking)
  - Massive black holes colder than small ones
  - Small ones explode w/ radiation
  - BHs very entropic

## Ch. 13—BH Innards

- Singularities—infinite curvature
- Uncertain if singularities might be avoided by non-ideal (ie realistic) conditions
- Topology and Penrose’s Singularity Theorem—All BHs have a singularity inside
- Mixmaster oscillating singularity (BKL,Misner)
- Quantum Gravity takes over
- Naked singularities? Cosmic Censorship Conjecture

## Ch. 14—Worm Holes

- Connect different parts of spacetime (through hyperspace)
- Tend to collapse (breaking the hole)
- They defocus light
- Thorne found:
  - Need negative energy density to hold open
  - There are instances of this (EM fluctuations, dark energy)
- Wormholes as time machines
- Chronology protection conjecture