Review

Review sessions:
  • Sunday, G125, 3-5pm (Bryan)
    - come with questions!

Final

Monday 1:30pm
Bring calculators
Cumulative
Black hole concepts

• Newtonian vs GR ideas
• event horizon
• Schwarzschild radius
• No hair / singularity theorems
• Different types of black holes
• What happens if you fall inside
Special relativity concepts

• constancy of the speed of light (experiments)
• relativity of simultaneity
• thought experiments for time dilation (SR)
• $E = mc^2$ and why that matters for fusion in stars and accretion on to black holes
General relativity concepts

• foundations: the equivalence principle
• consequences: gravitational red shift / time dilation, curved space time
• gravitational lensing
• gravitational waves
• black holes
Stars and their fates

• how stars of different masses evolve
• what happens at end of main sequence
• different remnants
  - white dwarfs (e degeneracy pressure)
  - neutron stars (n degeneracy pressure)
  - black holes
• supernovae of the 2 different types
• importance of binaries – give us a way to detect otherwise invisible NS and BH
Stellar mass black holes

- what is the evidence (NS maximum mass, mass measurement in binaries)
- observable signature – due to accretion
  - concept of an accretion disk
  - flow of energy as mass falls in
  - X-ray binary
- Gamma-Ray Bursts as signals of black hole formation (observations, different types)
Supermassive black holes

• what is the evidence
  - Galactic center (stars)
  - other galaxies: stars, gas or maser disks
• different modes of accretion
  - Galactic center and most nearby galaxies, “quiescent” (why?)
  - accreting through a thin disk like an X-ray binary, Active Galactic Nuclei
• black hole properties linked to galaxy properties
New physics

- Hawking radiation
- idea of the Planck mass
- entropy and its connection to horizon area
- dark matter