

Wednesday, September 27

Thorne pgs.: Ch. 8-10

Agenda

- Announce:
 - Read up to Chs. 11-14 (and Epilogue)
 - Test one week
- Second Part of Movie
- Story so far
- Ch. 8
- Ch. 9
- Ch. 10

Movie Part II

- Energy increases w/ square of velocity
- 1905—miraculous year for physics Einstein published papers:
 - Establishing existence of atoms
 - Establishing existence of light quanta (photons)
 - Laying out special theory of relativity
 - $E=mc^2$
- Far reaching consequences
 - Meitner & Hahn bombard big elements with neutrons to make bigger ones...end up with smaller ones
 - Sum of two smaller masses less than that of big mass atom
 - First to convert mass to energy

Story So Far

- 1915—General Theory of Relativity to handle acceleration ends up a new theory of gravity
- 1916—Schwarzschild solution
- 1930s—Not clear if star would stop collapsing before BH formation
- 1940s—Becoming clear that white dwarfs and neutron stars couldn't stop massive stars
- WWII
- 1950s—Properties of BHs start being found
- 1965-1975—Golden Age of Relativity/BHs
- Modern day—searching for direct evidence of BHs

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 - Idea: A BH passing through hot gas will produce shock fronts in its wake

X-Ray Binaries

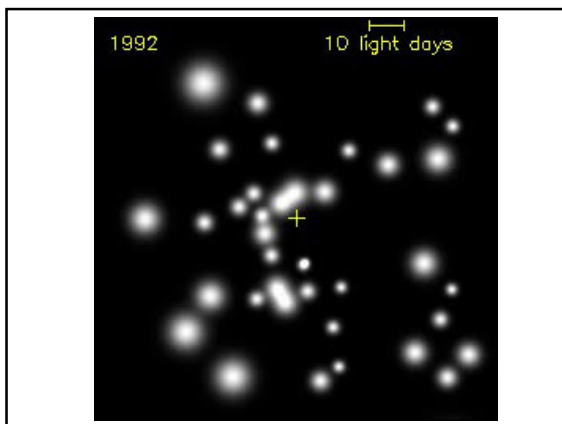
- X-Rays:
 - Extremely energetic electromagnetic radiation..generally associated w/ very energetic events
 - Tends to go through things...hence hard to focus
 - Blocked by atmosphere
- X-Ray detectors associated with arms race:
 - Launched on rockets
 - Used to study nuclear testing (both ours and theirs)
- Look for BHs in accreting binary systems
- Best candidate: Cygnus X-1

Ch 9.—Supermassive BHs

- 1930s—Bell engineer finds radio noise from center of galaxy
- 1940s—Amateur builds first radio antenna and finds “radio loud” spots including center of galaxy
- Postwar: radar engineers help with radio astronomy (more interplay war/science)
- 1949—built radio interferometers...to get resolution
- 1950s—Discovery of radio galaxies
- 1960s—Discovery of quasars
 - Moving at incredible speeds (e.g. 37% of c)
 - Billions of light years away
 - Meant hugely bright
 - Not bigger than a light-month

What powers quasars?

- Chemical? Nuclear? Antimatter?
- Gravity? First case where one really needs GR?
- Gigantic, spinning black hole:
 - Fit the light-month size
 - Can power a jet stably for millions of years..hole’s rotation acts as gyroscope despite accretion
 - Can produce magnetic fields which can get electrons to radiate synchrotron radiation



Ch. 10—Gravitational Radiation

- History shows opening of new spectra brings new physics:
 - Radio astronomy
 - X-Ray astronomy
 - Gamma-ray astronomy
- These are all electromagnetic!

GR Waves

- What’s waving?
- What info do they carry?
- Why so weak?

GR Detection

- Weber
- Thorne
- LIGO
- Need to know roughly what to look for:
 - Amplitude
 - Frequency
 - Event rate
 - Matched filtering