Monday, April 27, 2015

NO OFFICE HOURS TODAY

Fifth exam and sky watch, FRIDAY, May 8.

Reading for Exam 5:

Chapter 9 – Sections 9.6.1, 9.6.2, 9.7, 9.8; Chapter 10 - Sections 10.1-10.4, 10.9; Chapter 11 - all except Section 11.6 (abbreviated, focus on lectures); Chapter 12 - all; Chapter 13 (TBD); Chapter 14 - all

Astronomy in the news?

UT astronomer Judit Gyorgey-Reis reports that Asteroid 2012TCH, size of a house, will make a very close pass to Earth on October 12, 2017.

To understand how we have discovered supermassive black holes and how they affect galaxy formation and evolution. One Minute Exam

How can we discover a stellar mass black hole that has no accretion disk around it?





Look for gamma-rays

Look for jets

We can' t

One Minute Exam

What is the relation between the mass of a supermassive black hole and the galaxy in which it resides?

- There is none, the black hole can be big or small, depending on how it grew and for how long
- The larger the mass of the galactic bulge, the smaller the mass of the black hole
 - The larger the mass of the galactic bulge, the larger the mass of the black hole
 - The larger the radius of the galactic bulge, the larger the mass of the black hole

To understand the nature of cosmic gamma-ray bursts, how they may represent the birth of black holes or magnetars, and how they are connected with Type Ic supernovae.

Gamma-Ray Bursts (Chapter 11)

Cosmic explosions, flashes of gamma-rays lasting about 30 seconds, detected by satellites.





Energy is expelled in narrow jets. Energy comparable to that of supernovae, but all in gamma-rays, with later *afterglow* in X-ray, radio and optical radiation. **Birth of a black hole or magnetar?**





Swift satellite

Gamma-Ray Bursts unite stars and cosmology

Mystery since late 60's - satellites to monitor space nuclear test ban treaty, avoid confusion between astronomical effects, and bombs



Did not know the distance: guesses ranged from within the Solar system to cosmologically distant

To understand what a gamma-ray burst "afterglow" is and why it is so important.

Revolution in 1997: 1st detection of "afterglow" - optical, radio, X-ray, fading light



Position localized - could bring full armament of modern astronomy to bear on the fading radiation.

 \Rightarrow Found bursts were in distant galaxies - all at huge, cosmological distances, billions of light years away.

 \Rightarrow Very bright to shine that far

Comparable to total annihilation of entire star into pure energy!

To understand the energy in gamma-ray bursts and why it is important that the energy is "beamed." Light bulb versus laser pointer or flash light

Bursts do not radiate in all directions!

They are strongly focused into jets!

Bursts are focused into only about 1/100 of the total area of the sky

Typical gamma-ray burst energy ~ 1/3 supernova kinetic energy

But send matter at 99.997% of the speed of light

Supernova energy into a mass equivalent to Jupiter, not the mass of the Sun, as for supernovae

They explode ~100 times more often than observed (could observe about 2 per day if looked in all directions, all the time) because most have the jet aimed away from us.





Figure 11.4

Find all gamma-ray bursts in regions of massive young stars (spiral arms of spiral galaxies, irregular star-forming galaxies like the LMC) *Something to do with death of massive stars*

Explode once every 10⁴-10⁵ years in a given galaxy versus about once per 10² years for ordinary supernovae, so relatively rare.

Most popular guess is that gamma-ray bursts represent the birth of a *black hole* in the collapse of a massive star. Alternative suggestion - might be a highly magnetized neutron star or *magnetar* (Chapter 8)

Early circumstantial evidence for several bursts associated with supernovae.



Are gamma-ray bursts produced in some form of core-collapse supernova?

Circumstantial evidence was followed by proof:

GRB 030329 was nearby, only 3 BILLION light years away! Relatively bright, an ideal target.

SN2003dh was discovered a week later! Spectrum of a Type Ic supernova

By now many associated supernovae have been found: all are Type Ic supernovae

But all Type Ic supernovae are not gamma-ray bursts

The current picture: Gamma-ray bursts result from the collapse of a massive star from which the hydrogen and most of the helium have been stripped, probably to produce a black hole (but maybe a magnetar), that emits a tightly focused, highly relativistic jet.

Perhaps only in Type Ic, missing envelope, so that jet can escape from the star.

Every burst, twice a day somewhere in the Universe - the birth of a black hole aiming its jet at us?

 \sim 100 aimed elsewhere for every one aimed at us.

Have not yet proven that black holes are involved. Tough problem!

NASA Animation: Black Hole Forming in Star, producing jet and Gamma-Ray Burst



One Minute Exam

It is important to understand that gamma-ray bursts emit their energy in tightly collimated beams because otherwise

Estimates of the distance will be wrong

Estimates of the mass of the black hole formed will be wrong

Estimates of the energy emitted will be wrong

Estimates of the type of supernova in which they explode will be wrong.