November 5, 2010

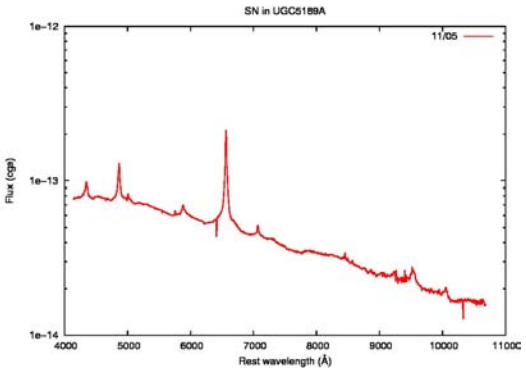
Reading: Chapter 10, Sections 10.1-10.4, 10.9, Chapter 11.

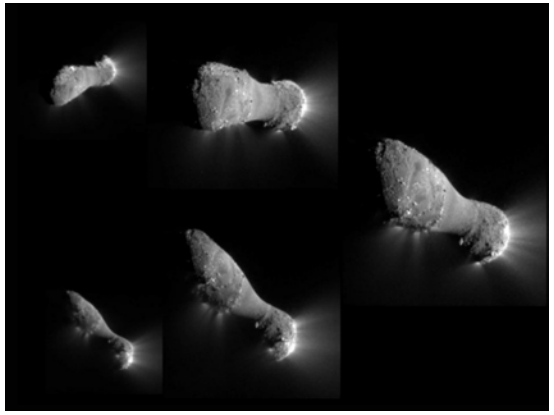
Astronomy in the News? Final launch of Space Shuttle Discovery delayed again.

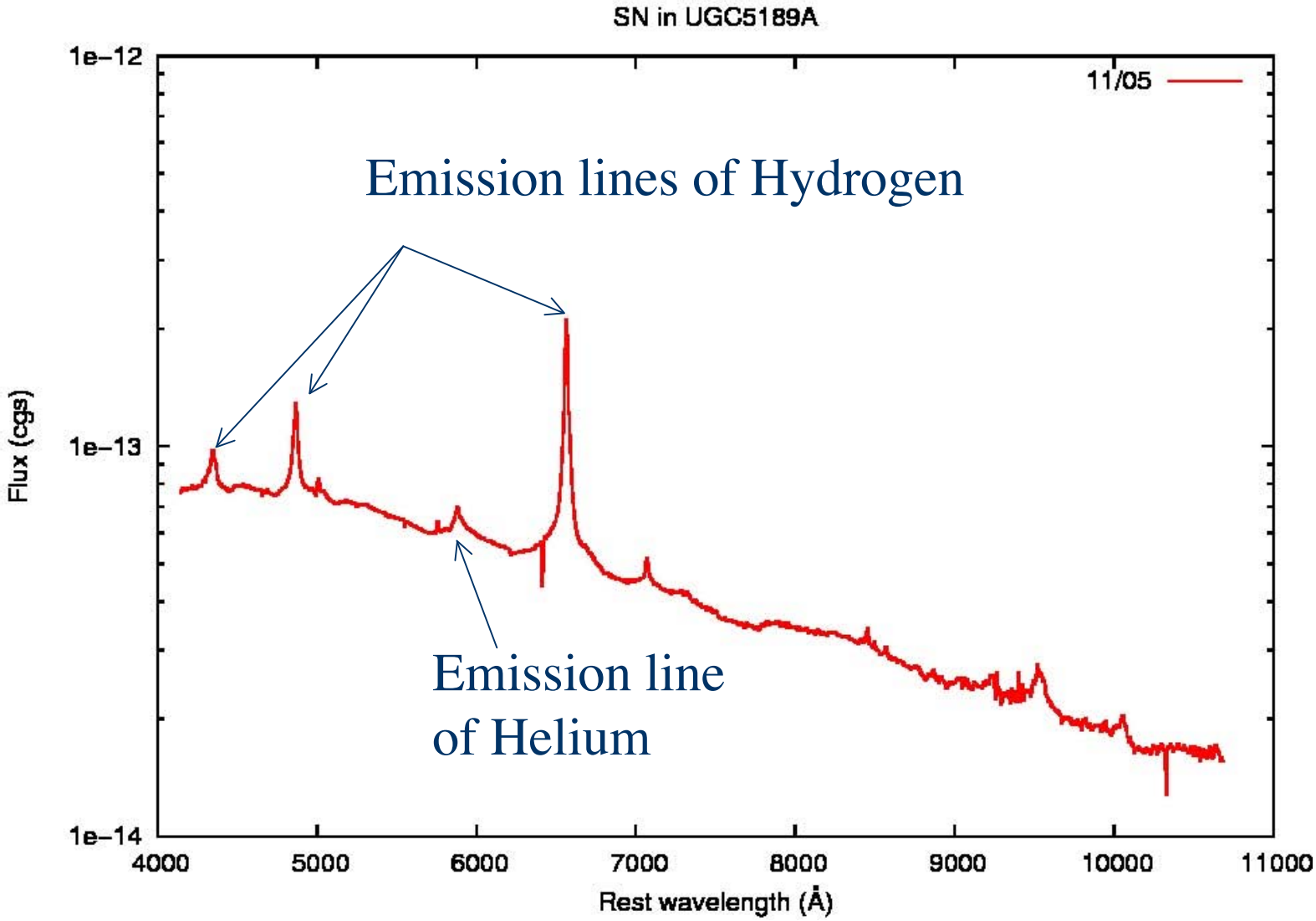
Deep Impact space mission flies within 435 miles of 1.2 mile long nucleus of Comet Hartley 2.

New very bright supernova in Leo, Type IIn, n for narrow lines. Not yet given a number, observations fresh from Hobby-Eberly Telescope (about 1 per day have been discovered all term, all fainter).

Pic of the Day – new supernova, nucleus of Comet






SN in UGC5189A
11/05
Emission lines of Hydrogen
Emission line
of Helium
Flux (cgs)
1e−12
1e−13
1e−14
4000
5000
6000
7000
8000
9000
10000
11000
Rest wavelength (Å)

Goal:

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

Surprising discovery:

It was long thought that supermassive black holes were somewhat incidental to galaxies,

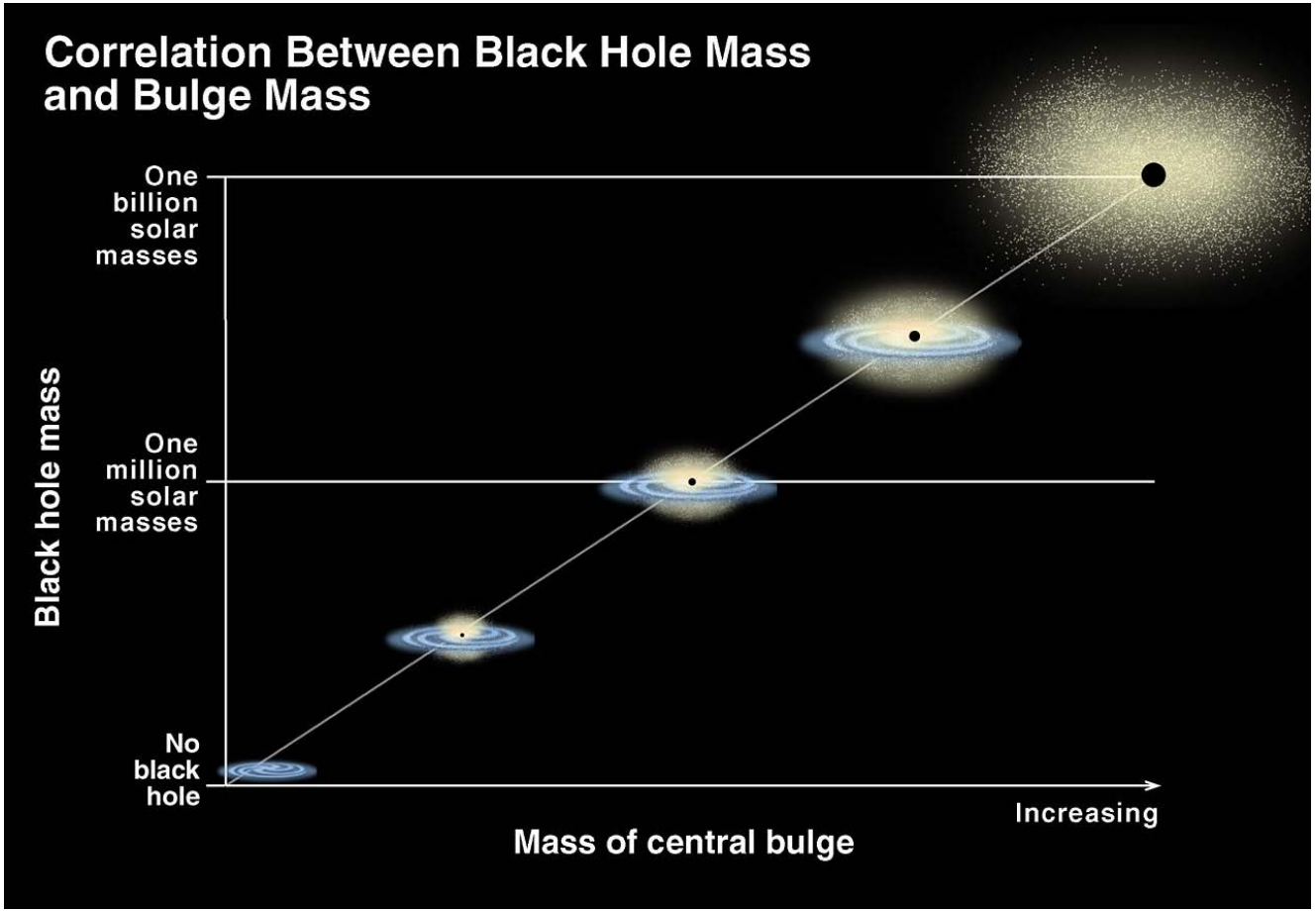
Formed of matter that somehow drained into the center of the galaxy, so galaxy could have large mass or small mass black hole depending on circumstances.

Recent work by Karl Gebhardt (UT) and others has shown that even stars so far from the center that they cannot possibly feel the gravity of the black hole *now* are moving in such a way that ***the larger the mass black hole, the higher the speed of the stars!***

Andromeda
M31

Correlation Between Black Hole Mass and Galaxy Bulge Mass

Mass of Black Hole



Mass of Central Bulge of Galaxy

The implication is that the mass of the galaxy (at least the inner portions, the Bulge) is always close to 800 times the mass of the black hole.

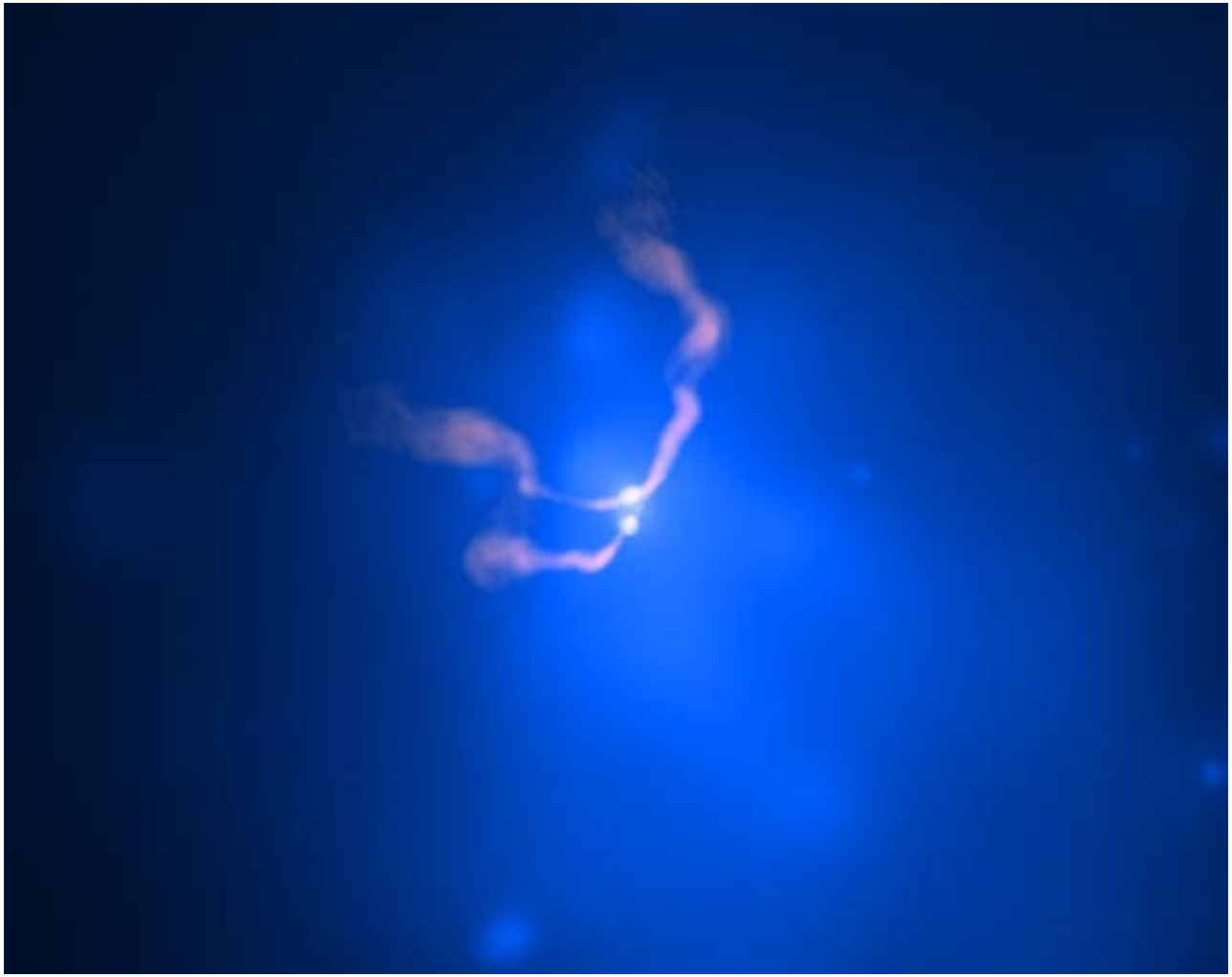
This means that ***the formation of the black hole is somehow intimately connected with the formation and structure of the whole galaxy.***

Galaxies “know” how big a black hole to make.

Mechanism uncertain: Does the galaxy control the black hole or the black hole somehow control the galaxy?

Most popular current idea: energy from accretion of matter into disk around black hole feeds back to the surrounding galaxy, blowing excess galaxy gas away when galaxies are young and growing.

Colliding black holes in 3C75, feed energy back into the stars and gas of the colliding galaxies.



One Minute Exam

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

 Look for X-rays

 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 galaxy, the smaller the mass of the black hole


The larger the mass of the galaxy, the larger the mass of the black hole


The larger the radius of the galaxy, the larger the mass of the black hole

Goal:

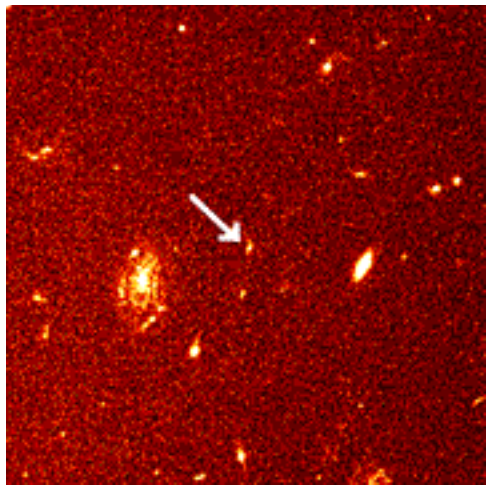
To understand the nature of cosmic gamma-ray bursts, how they may represent the birth of black holes or magnetars, and how they are connected with Type Ic supernovae.

Gamma-Ray Bursts (Chapter 11)

Swift satellite

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

Seen across the Universe.



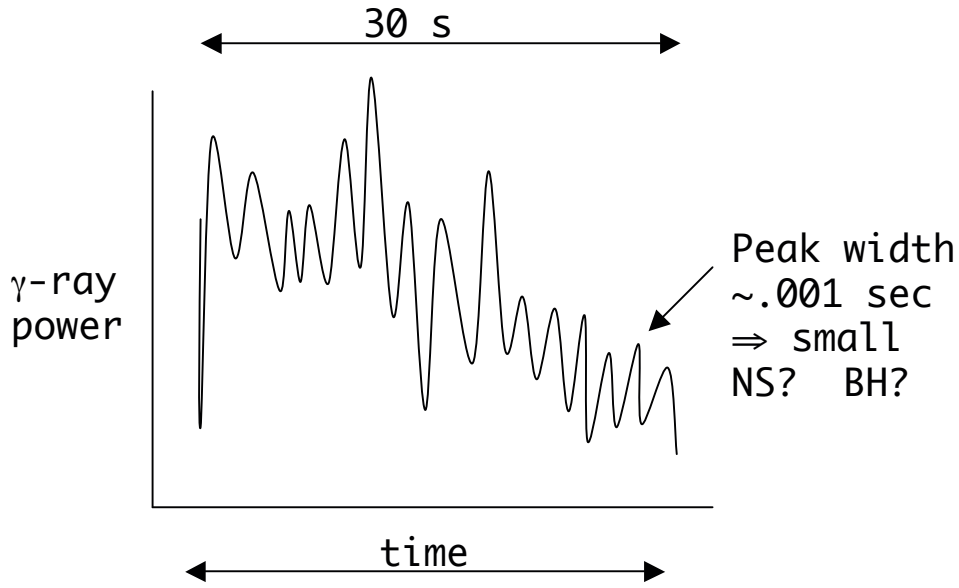
Energy is expelled in narrow jets.
Energy comparable to that of supernovae, but all in gamma-rays, with later ***afterglow*** in X-ray, radio and optical radiation.
Birth of a black hole?

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

Flare of γ -rays lasts ~ 30 sec

Never Repeat - for 30 years, no optical counterpart,
C*an't focus gamma-rays*.
Did not know which of millions of stars to look at.



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

Goal:

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

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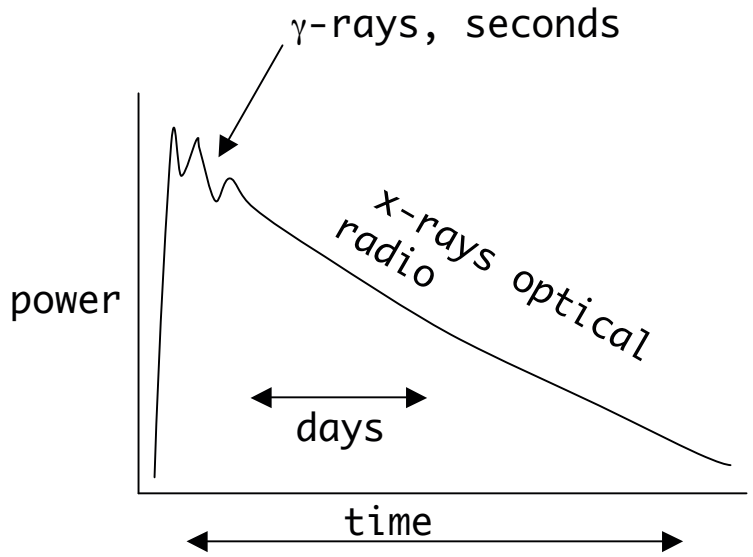
Revolution in 1997: 1st detection of "afterglow" - optical, radio, X-ray, fading light



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

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

⇒ Very bright to shine that far

January 23, 1999 optical flash associated with the gamma-ray burst itself (need to discover, swivel telescope, look in 30 seconds!)

9th magnitude - human limit 6th magnitude, could almost see with naked eye, could have seen with good binoculars, but half way across the Universe!

March 19, 2008, “naked-eye” GRB 080319B discovered by Swift satellite had a peak apparent magnitude of 5.8 and remained theoretically visible to human eyes for approximately 30 seconds.

September 16, 2008, GRB 080916C discovered by new Fermi Satellite, 12.2 billion light years way, was the intrinsically brightest optical event ever recorded, equivalent to brightness of 9000 supernovae.

April 23, 2009, GRB 090423 discovered by the Swift satellite, one of the most distant objects ever observed in the Universe, about 13.1 billion years ago, when the Universe was only 630 million years old.

If gamma-ray bursts shine equally in all directions, the energy released in gamma rays would be 1000-10,000 × SN or 10-100 × core collapse neutrinos.

Comparable to total annihilation of entire star into pure energy!