

Astronomy 150: Killer Skies



This Class (Lecture 27):

Review

Compact Objects interact with
Solar System

Next Class:

Milky Way

**Exam 2 is Friday
Computer lab due on Nov 15th**

Music: Rocket Man – Elton John

Solar Observation: Extra Credit



- Chance to see sunspots using the 12 inch in the dome
- Solar Observations:
 - Monday, Nov. 1st, 10:30am-3:30pm ✗
 - Tuesday, Nov. 2nd, 10:30am-3:30pm ✓
 - Wednesday, Nov. 3rd, 10:30am-3:30pm ✗
 - Thursday, Nov. 4th, 10:30am-3:30pm
- Need to download form from class website before you go.
- Check webpage to make sure open (i.e. no clouds or rain)
- Due Nov 15th in class & worth 1% extra credit.

Exam 2



- Exam 2 in this classroom on Friday
- 40 Multiple choice questions (graded out of 105, i.e. 5% extra credit)
- Will cover material from Lecture 13 to 25
- May bring 1 sheet of paper with notes
 - Both sides
 - Printed/handwritten/whatever.. I don't really care
- Major resources are lecture notes, in-class questions, and homeworks
- Created and posted a study guide
- Short review today

Outline



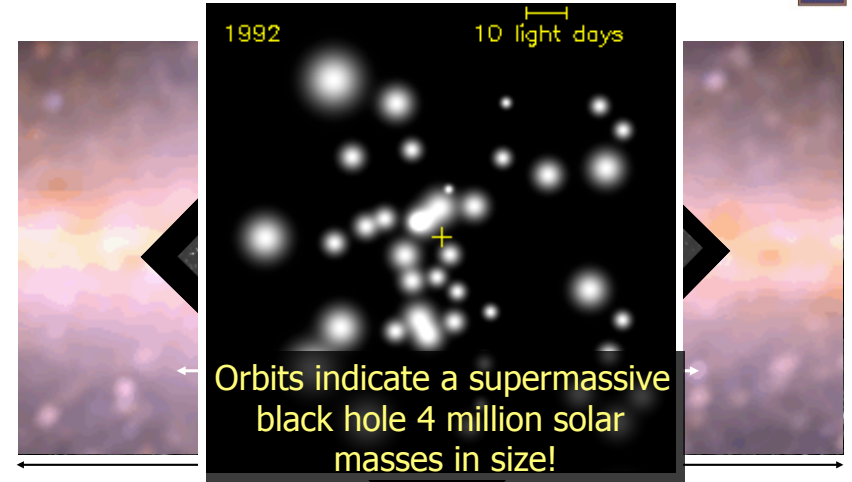
- If a compact object enters the Solar System?
 - Bad time, but very, very, very unlikely over the age of the Universe.

Massive Black Holes?

- Can we detect massive black holes?



The Monster at the Center of the Galaxy

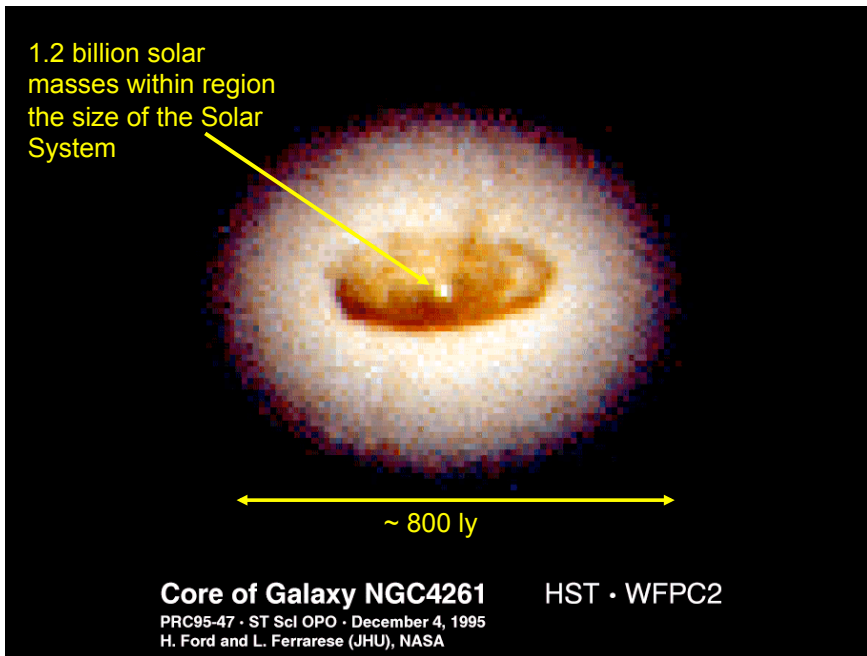
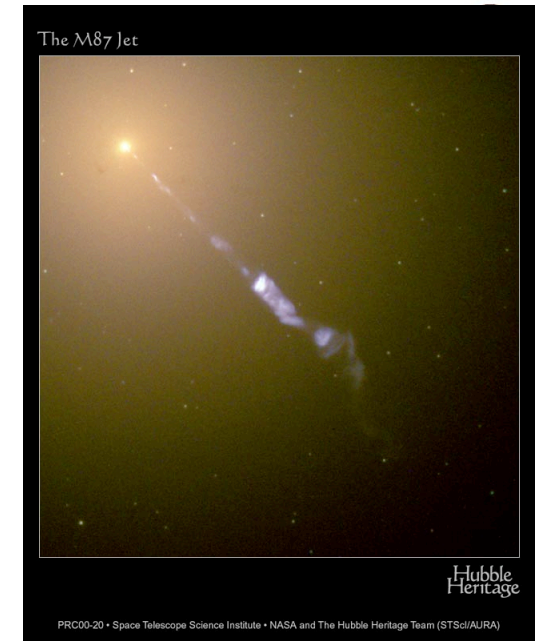


~ 100 pc (infrared)

<http://www.youtube.com/watch?v=0HmV-6qLM8Y> 3:27

The Jet of M87

- Huge jet from the center of this galaxy (50 Mlyrs away).
- 5000 light years in length!
- The jet is probably created by energetic gas swirling around a massive black hole at the galaxy's center
- We'll come back to this



Core of Galaxy NGC4261

HST · WFPC2

PRC95-47 · ST ScI OPO · December 4, 1995
H. Ford and L. Ferrarese (JHU), NASA

Question



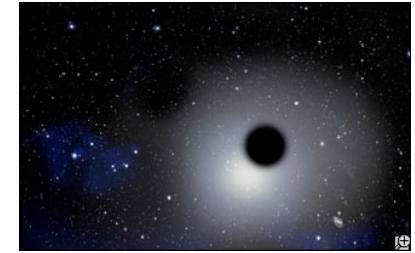
Black holes are

- a) Impossible to detect with today's technology
- b) Have hair
- c) Not seen directly, but there is strong evidence of their existence
- d) Bright emitters of Hawking radiation
- e) Going through our hands by the millions

Rogue Black Holes?



- The Galaxy has been accruing black holes for billions of years.
 - Stellar corpses
 - Primordial?
 - Globular cluster kick them out
 - Cores of consumed galaxies



Rogue Black Holes: Example

Black hole's wild ride through the Milky Way

The black hole, liberated from a globular cluster some 7 billion years ago, has been cannibalizing its companion star ever since.

Edge-on view of orbit

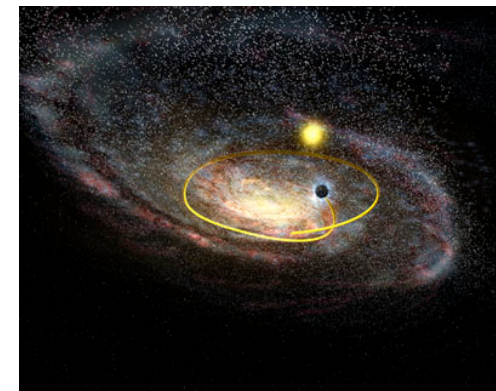
Black hole
Sun

Our Sun

Black hole's orbit

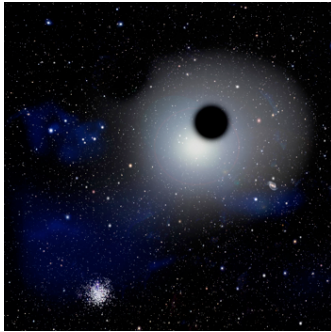
Artist's conception of the Milky Way

Rogue Black Holes: Example



GRO J1655-40, about 7 solar masses, has a stellar companion. System moving at 110 km/s! Supernova can create high speed corpses.

Rogue Black Holes: Example



The Milky Way has collided with many smaller galaxies. When this happens the smaller galaxy's massive center black hole. Hundreds of these could be rogue in the Milky Way— 1000's to 100,000's of solar masses!

Rogue Black Holes?



- Might we expect a black hole to enter our Solar System?
- If so what might happen?



Stars Collide?



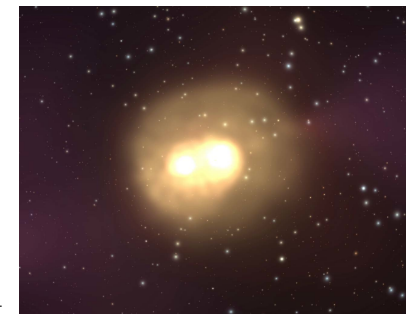
- The Galaxy may have a lot of black holes.
- But, Space is Freaky Big!
- Closest known black hole is Cygnus X-1, which is 6500 lyrs away
- Stars still are much, much, much more common than black holes.



Stars Collide?



- Chance of interacting with another star is very, very unlikely.
- Star comes within 3.26 light years every 100,000 years.
- Chances for a star to influence planets in Solar System?
- You would have to wait more than the age of the Universe!



But What If?



- Average distance to a black hole should be ~100 light years!
- That's less common than stars, but sounds close!
- Black hole colliding with the Earth would of course be a disaster.
- At the end, Earth is destroyed by tidal forces, ripped apart.
- Or even if black hole misses, it could throw Earth out of our nice orbit, which is still bad.

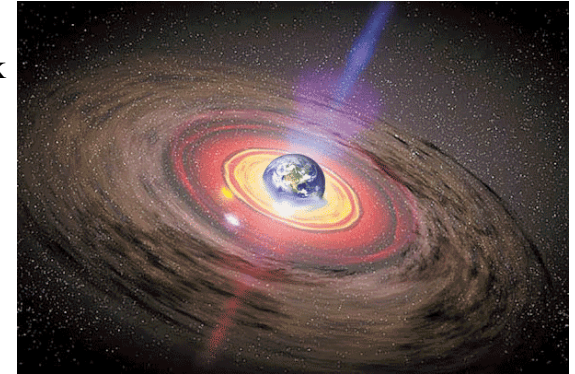


<http://www.intute.ac.uk/hottopics/spotlight/images/SPT159-smallest-black-hole-birds-eye-view.jpg>

But What If?



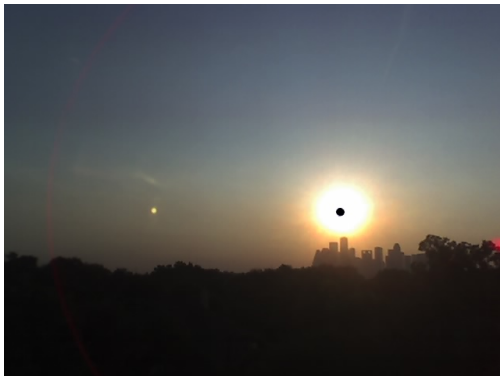
- Remember unless it is feeding, it will be hard to detect a nearby black hole.
- What if a run away stellar black hole (~10 solar mass) was heading right for the Earth?
- What would be the effects?



But What If?



- Many of the early effects of a nearby blackhole would be the same as a nearby star.
- We could go from a single star system to a binary system.
- Planets would be pulled two ways, orbits will change.
- At some point the farther out planets will be pulled harder by the new object.



But What If?



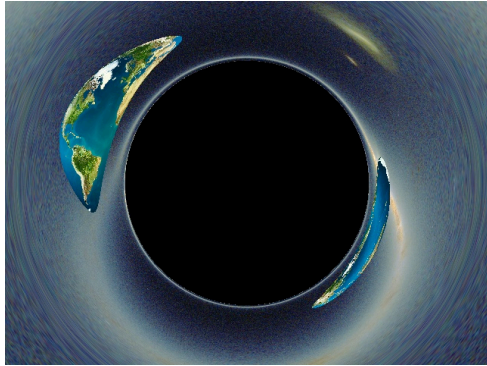
- Planets may orbit the black hole or be flung from the Solar System.
- For two massive object interaction, lower mass objects will often be ejected.
- At first, people won't notice too much, even though the orbit starts to change somewhat.



But What If?



- When a 10 solar mass black hole gets about 3 AU away, it will have more pull than the Sun.
- The Earth will then no longer be bound to the Sun.
- It will either be ejected out of the Solar System, fall into the Sun, or fall into the black hole.
- No matter which, all options are bad for us.

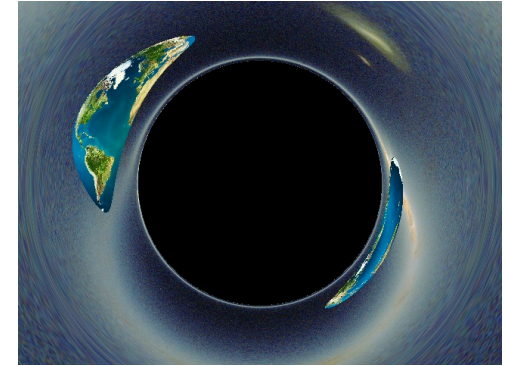


<http://www.naturalbuy.com/wp-content/uploads/2009/10/earth-orbiting-black-hole.jpg>

But What If?



- Spaghettification will take affect on the Earth as it did our helpless astronaut earlier.
- Black hole's tidal forces begin to dominate
- Tides get huge!
- Floods. Tidal waves Millions dead!



<http://www.naturalbuy.com/wp-content/uploads/2009/10/earth-orbiting-black-hole.jpg>

But What If?



- When the black hole is 7 million miles away, it's force on you is greater than the Earth's.
- Moon already ejected from system.
- Tides are 20,000 times worse.
- You are weightless.
- With a small kick you can fly upward.
- Earthquakes, continents torn apart.

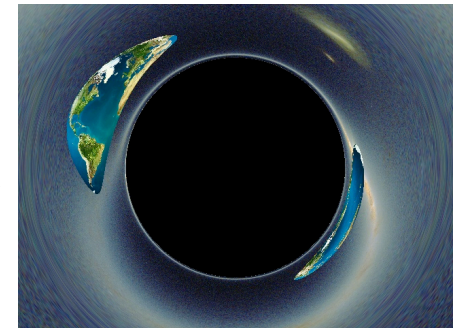


<http://home.vicnet.net.au/~hmkhelp/images/tidal.wave1.jpg>

But What If?



- Final tides are too much for Earth to handle.
- Earth is torn apart like astronaut from before.
- You are killed from either suffocating or if you grabbed a spacesuit spaghettification or from the accretion disk radiation.
- Adding the Earth doesn't really make it any bigger, still about 40 miles across.



http://lh3.ggpht.com/_4ruQ74zrFA/SdG3vE19631/AAAAAAAAAB70Yb5XCaaVITQ/earth-orbiting-black-hole.jpg

But What If?



- For the rest of the Solar System, it will depend on the orbits.
- If the black hole doesn't get close to the Sun, it will be fine, otherwise, it may get torn apart too.
- Then, the black hole likely moves on.



<http://www.intute.ac.uk/hottopics/spotlight/images/SPT159-smallest-black-hole-birds-eye-view.jpg>

Question



If a black hole collides with the Earth, which of the following is not a consequence?

- a) Spaghettification of the Earth.
- b) Earthquakes.
- c) Earth is either ejected out of the Solar System, falls into the Sun, or falls into the black hole.
- d) Destroys all life on the side of the Earth facing the black hole only.
- e) Tidal waves.