

Friday, April 22, 2016

Fifth exam and sky watch, FRIDAY, May 6.

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 - all; Chapter 14 - all

Astronomy in the news?

Earth day!

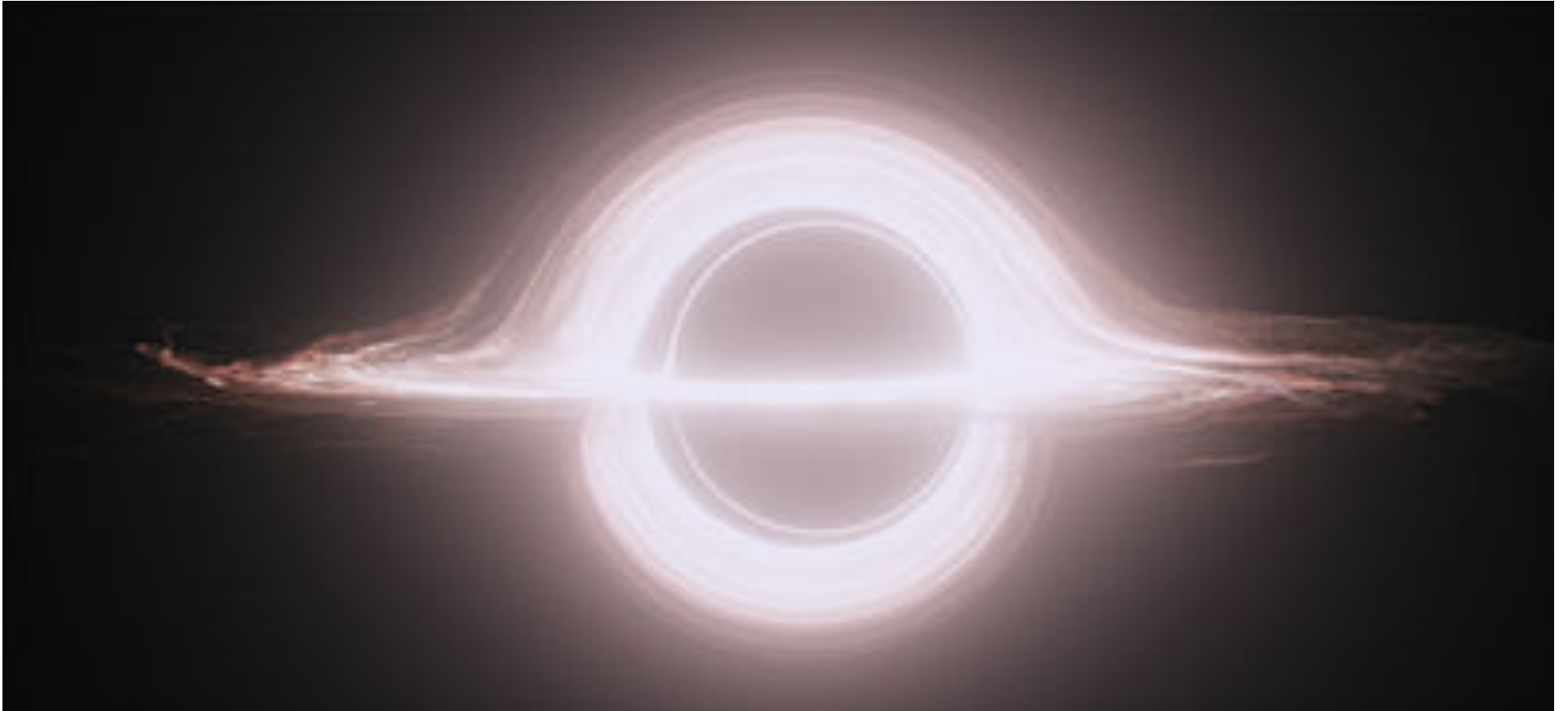
Hug a tree!



Goal:

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

Gargantua: the giant black hole from the movie *Interstellar*




Gravitational lensing of accretion disk in the equatorial plane.

Supermassive Black Holes

Long suspected in quasars, active galactic nuclei: huge power from small volume, billion solar mass black hole could do it.

More recently, proof that many ordinary galaxies also have a supermassive black hole in their centers (dead quasar).

Again, do not yet see a “dark spot,” but use Kepler’s Laws, motion of many stars, gas  orbital period, separation

3.7 million M_{\odot} black hole in our Galaxy [UCLA link - movie]

Center of Milky Way Galaxy in direction of constellation Sagittarius – (find Sagittarius for sky watch)

Supermassive Black Holes

Up to 10 billion M_{\odot} black holes in quasars (maybe 17 billion).

Jet from billion M_{\odot} black hole in center of M87, large elliptical galaxy in the Virgo cluster (find Virgo!)



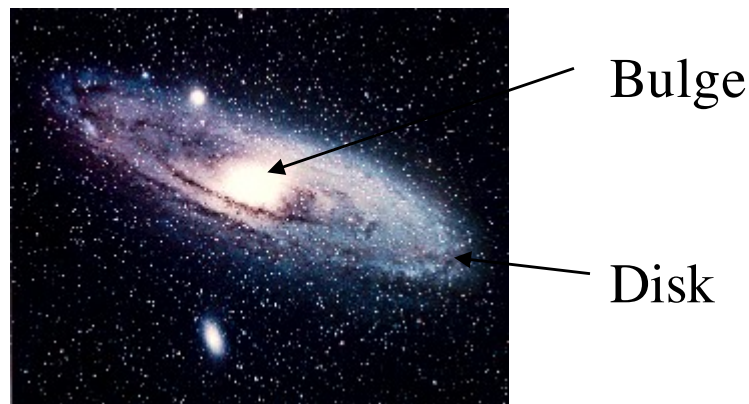
Surprising discovery:

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

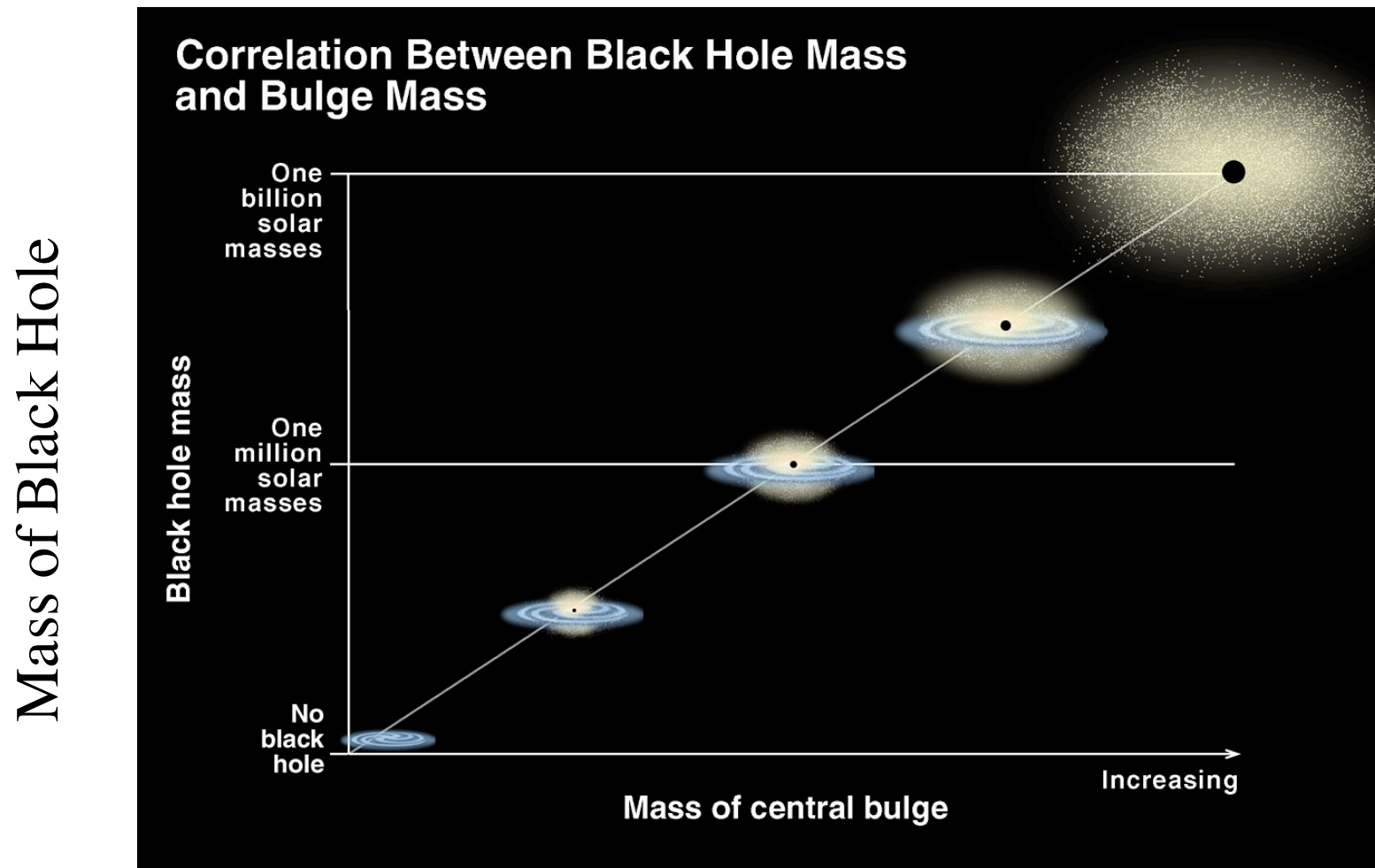
Formed of matter that somehow drained into the center of the galaxy, so galaxy could have large mass or small mass black hole depending on circumstances.

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 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.

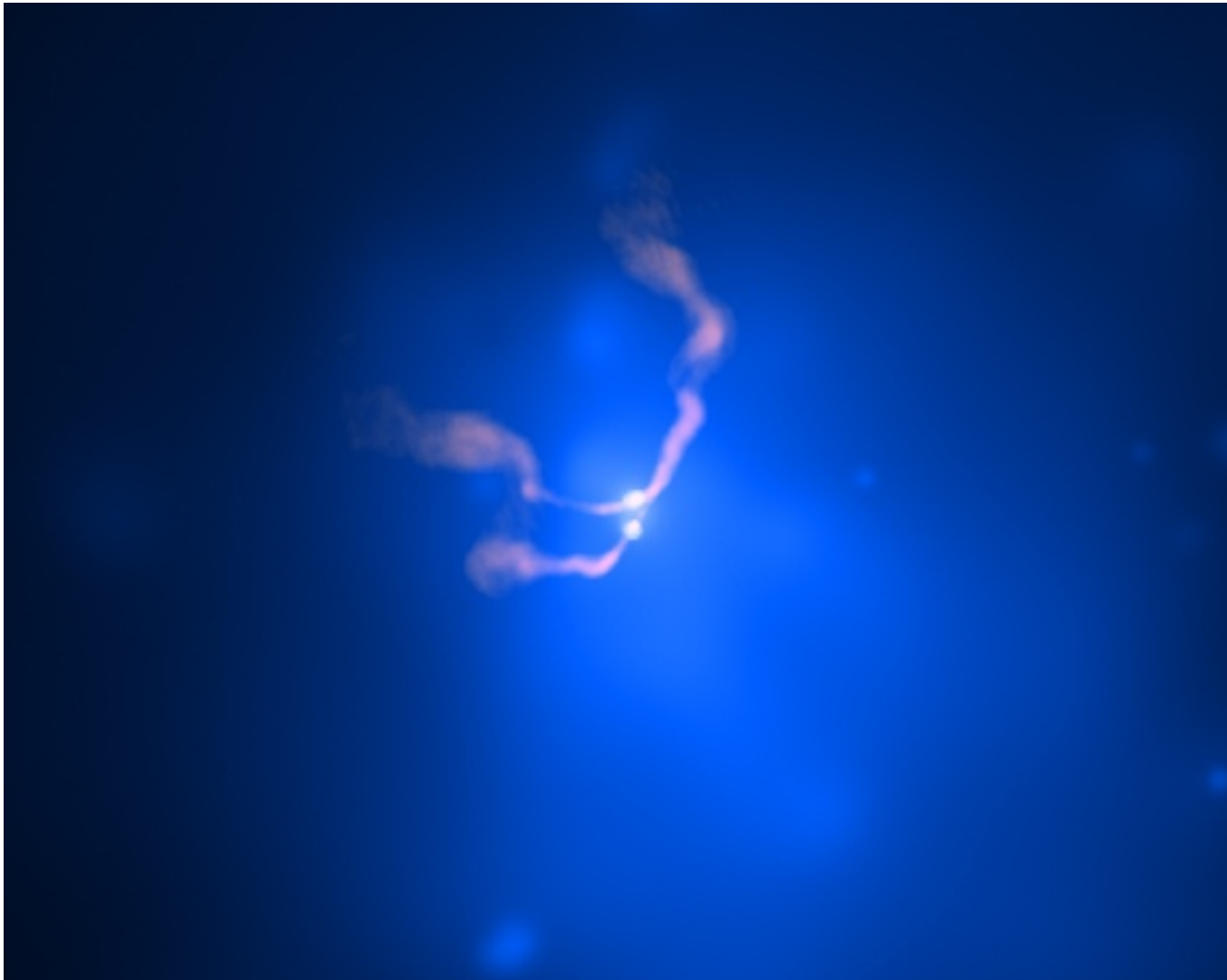
This means that *the formation of the black hole is somehow intimately connected with the formation and structure of the whole galaxy.*

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.

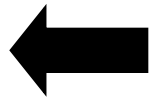


One Minute Exam

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



Look for gravitational lensing

One Minute Exam

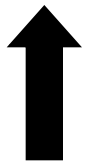
What is the relation between the mass of a supermassive black hole and the galaxy in which it resides?



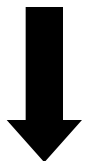
There is none, the black hole can be big or small, depending on how it grew and for how long



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