Monday, April 18, 2016

Fourth exam and sky watch back Wednesday.

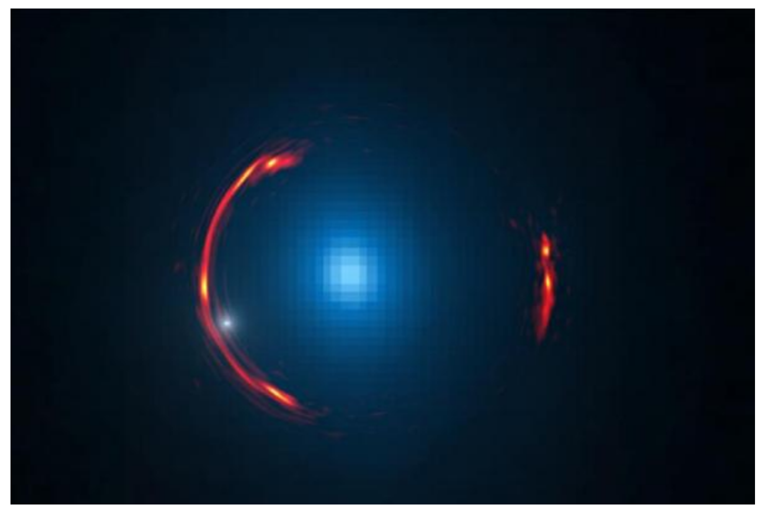
Fifth exam and sky watch, FRIDAY, May 6.

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 (TBD); Chapter 14 - all

Astronomy in the news?

Astronomers detect tiny dark, dwarf galaxy 4 billion light years away by its distortion of the gravitational lensing of a larger, brighter galaxy.



Goal:

To understand the conflict between Einstein's theory of gravity and the Quantum theory.

Information Loss??

Black holes have only three fundamental properties: mass, spin, and electrical charge (= 0 in practice)

Deep issue.

What happens to the ***information*** about all the stuff that fell into the black hole?

Quantum theory insists there must be no loss of information.

Maybe the information is in the Hawking radiation or maybe it is still somehow in the singularity, or stored at the event horizon.

Can a singularity evaporate and disappear? Don’t know in absence of a theory of ***Quantum Gravity.***

The problems get ever deeper.

With *quantum entanglement*, you can't cleanly differentiate the observer who watches the volunteer turn black at the event horizon and the volunteer who rapidly plunges in and dies. With Hawking radiation, the volunteer may hit a blazing "firewall" and die that way.

Hawking recently suggested that maybe event horizons are not permanent.

Total confusion in physics as to the correct way to think about all this.

Thinking about black holes remains on the intellectual frontiers.

A proper theory of quantum gravity may reconcile these issues.

Book by Leonard Susskind - Black Hole Wars: My Battle with Stephen Hawking to Make the World Safe for Quantum Mechanics, will discuss later. You may be a hologram…

Goal:

To understand how we search for real black holes and why binary systems with mass transfer and accretion disks are so important.

Chapter 10 - Finding Black Holes for Real

Reading: Chapter 10, Sections 10.1-10.4, 10.9

We know that massive stars evolve to form iron cores that absorb energy and collapse. A compact object must be left behind.

Some explode and leave rotating, magnetic pulsars

Some explode and leave highly magnetic magnetars

Some explode but leave black holes or completely collapse to leave black holes

We don't know which massive stars do which! Tendency to think that more massive stars are more prone to making black holes, but the rotation of the star, the presence of a binary companion, and other factors may influence the outcome.

We do know that black holes exist, so some stars make them.

Black Holes for Real

There may be 1 - 100 million black holes in the Galaxy made by collapsing stars over the history of the Galaxy.

That means that the nearest black hole may be only a few tens of light years away. How do we find them?

Black holes made from stars are really black! (Negligible Hawking radiation).

Those alone in space are not impossible to find, but very tough. They will gravitationally lens stars behind them.

Event horizon of 10 solar mass black hole has a radius of 30 km ~ 20 miles, somewhat bigger than size of Austin, easily fit between Georgetown and San Marcos

Very black

None yet identified.

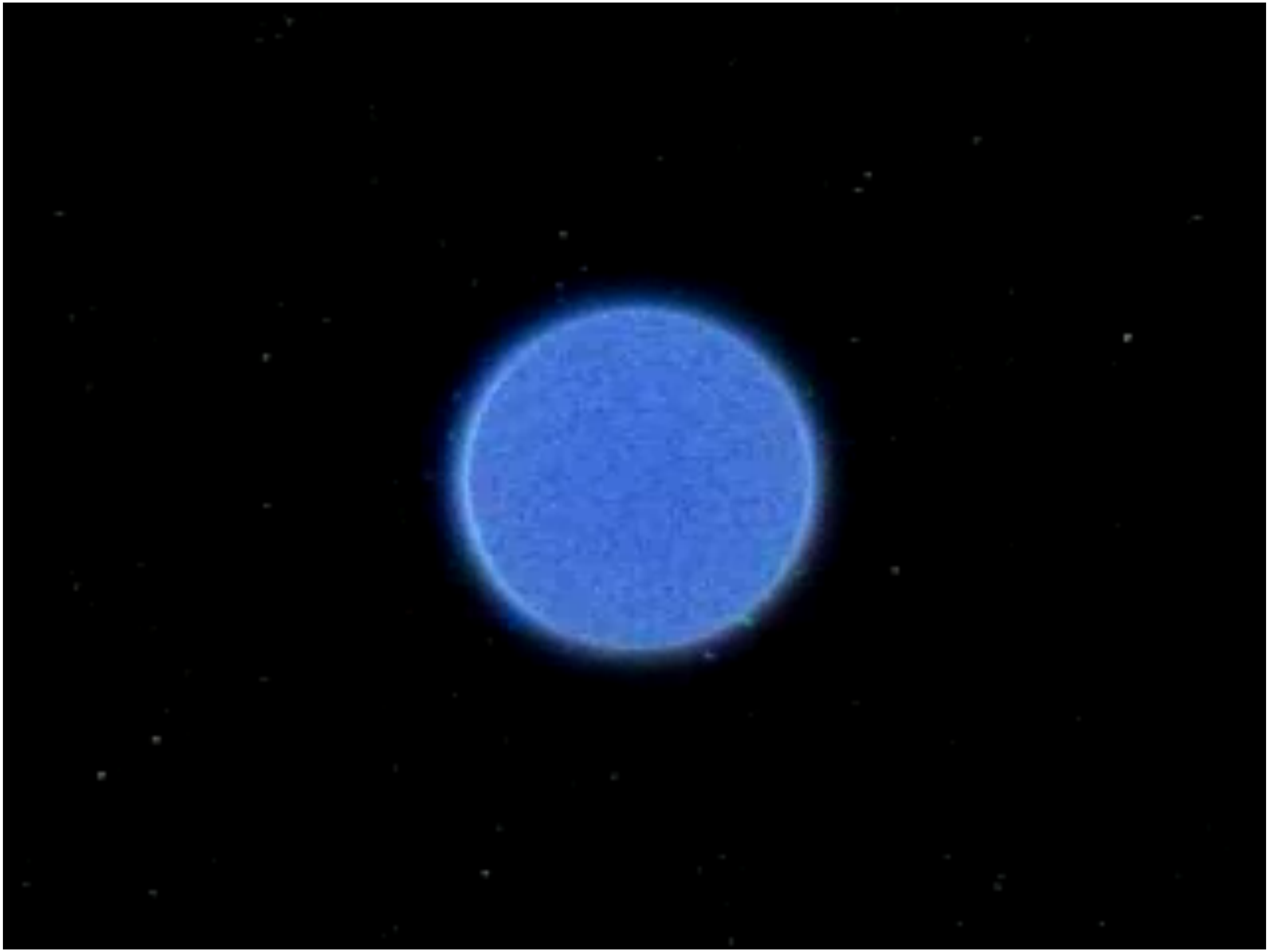
Black Holes for Real

Look for binary systems, where mass accretion occurs.

Will not see the black hole, do not yet have the technology to "see" a black spot, but that is getting closer with the Event Horizon array of radio telescopes.

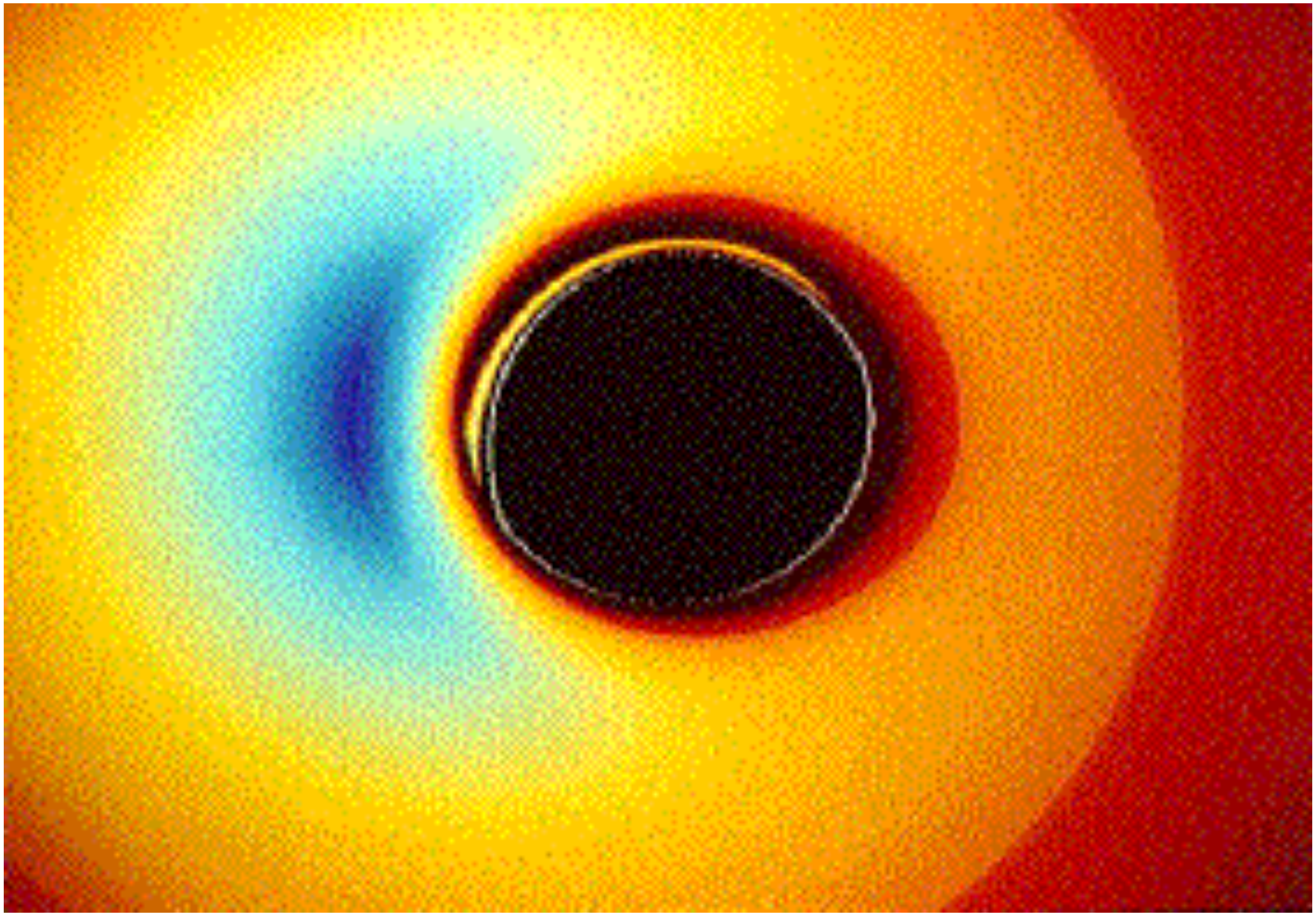
Can detect the ***halo of X-rays*** from orbiting matter, the accretion disk, near the event horizon that will reveal the presence and nature of the black hole.

Look in accreting binary systems!



Goal is to get close-up study of strongly warped space:

Event Horizon Telescope, array of radio telescopes plans to examine the massive black hole in the center of the Milky Way



Perez and Wagoner, Stanford: computer simulation of radiation from inner black hole accretion disk

Black holes are so weird and so important that the standards of evidence have to be high!

Current evidence is still primarily circumstantial, but very strong:

Stellar mass black holes (several to ~ 10 solar masses), in binary systems in our Galaxy or nearby galaxies

Intermediate mass black holes (~ 1000 - 10,000 solar masses)??, in binary systems or stellar clusters in our Galaxy or nearby galaxies

Supermassive black holes (million to a billion solar masses) in the middle of our Galaxy and in the middle of many, many others.

Circumstantial arguments for presence of black hole in a binary system:

Only neutron stars and black holes have the high gravity necessary for intense X-rays.

Use Kepler's laws to measure the total mass of the system, astronomy to determine the mass of the mass-losing star, subtract to get mass of "unseen" companion emitting X-rays.

Maximum mass of neutron star is ~ 2 solar masses

Intense X-ray source in binary star system with mass exceeding 2 solar masses is, by a process of elimination, a candidate black hole.

There are about 20 binary star black hole candidates in our Galaxy and in the Large Magellanic Cloud (near enough to detect the X-rays) that have masses measured to be greater than 3 solar masses, and hence too massive to be a neutron star.

There are another 25 binary star black hole candidates with simlar X-ray properties, but no measured mass.

Cygnus X-1

First X-ray source discovered in the direction of the constellation Cygnus.

Discovered in 1970's by Uhuru Satellite (Swahili for Freedom).

First and still most famous stellar-mass binary black hole candidate.

Can't see this system with the naked eye, but can find constellation Cygnus - look for it for sky watch!