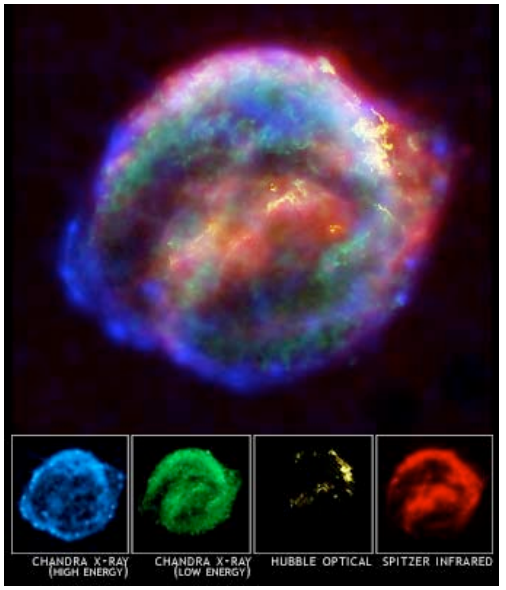
11/01/04

News? X-ray image of Kepler 1604



Eclipse?

Burt Rutan?

Sky watch: Betelgeuse coming into view, will talk about

Monocerotis, Cygnus shortly.

Pic of the day: Spitzer IR star formation region

Chapter 10 - Finding 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. How do we find them?

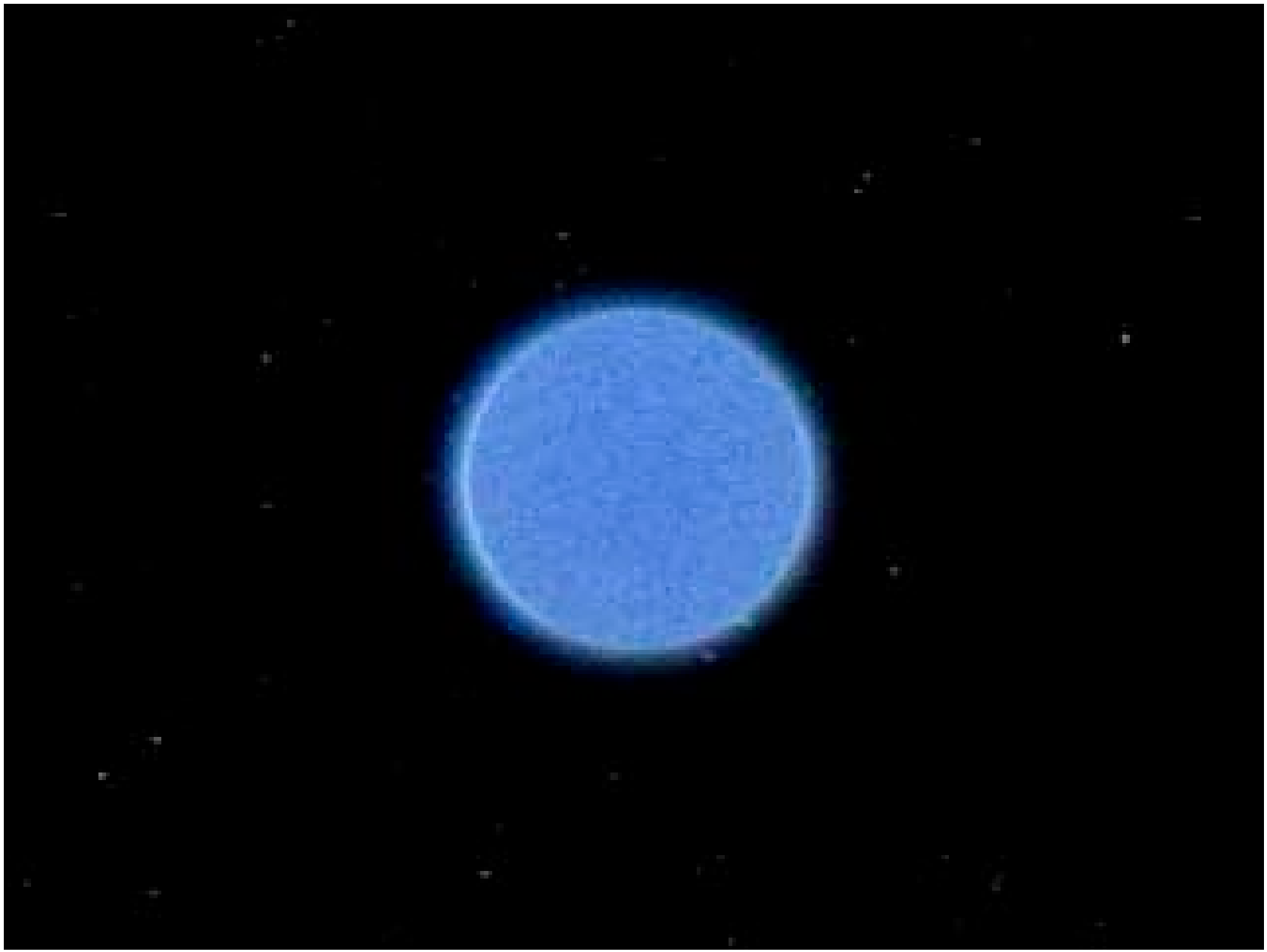
Black holes made from stars are really black! (Negligible Hawking radiation).

Those alone in space not impossible, but very tough.

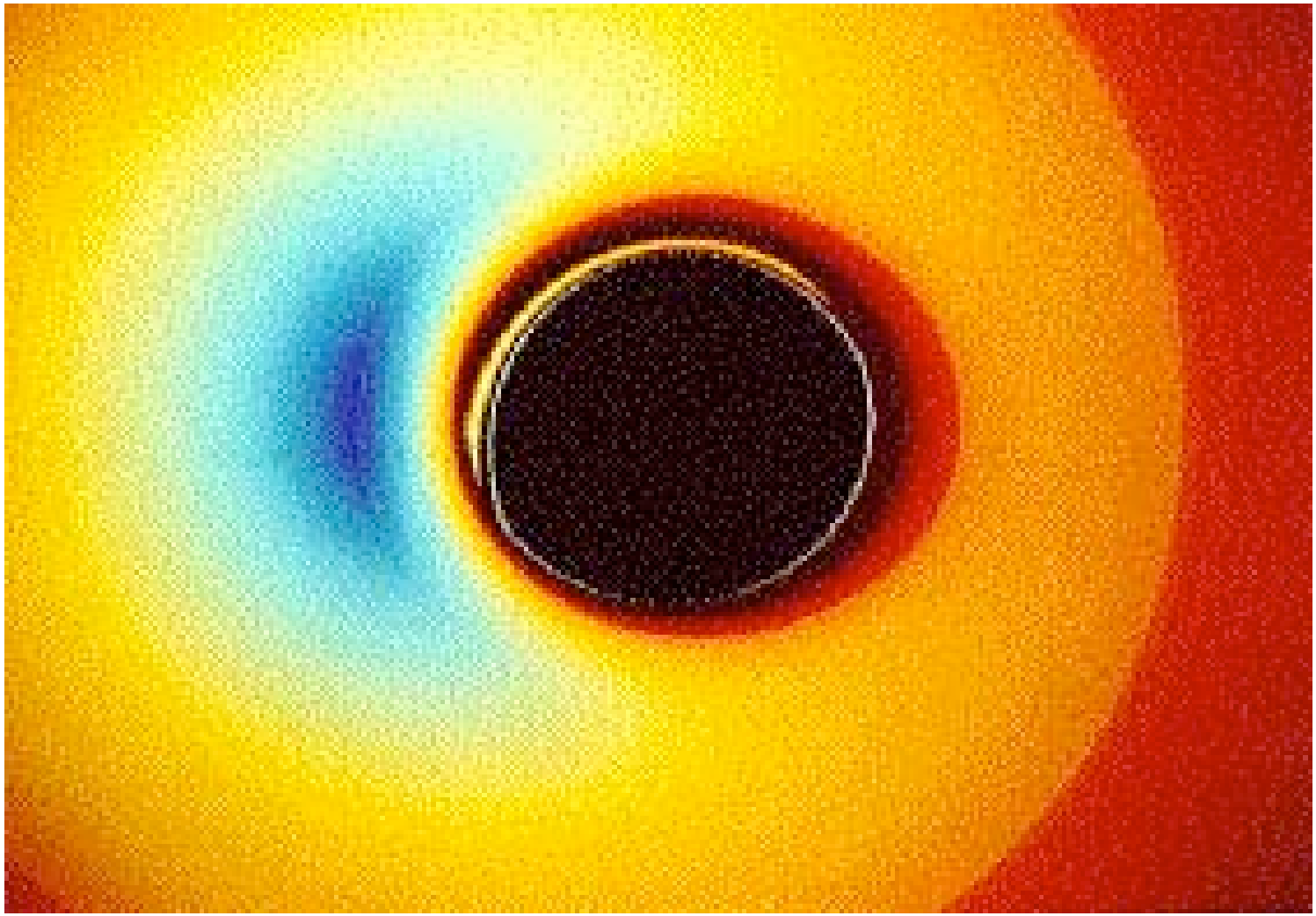
Look for binary systems, where mass accretion occurs.

Will not see the black hole, cannot yet "see" a black spot.

Can detect halo of X-rays from orbiting matter 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



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

Current evidence is still primarily circumstantial, but very strong:

Stellar mass black holes (several to ~ 10 solar masses)

Intermediate mass black holes (~ 1000 solar masses)

Supermassive black holes (million to a billion solar masses)

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 with mass exceeding 2 solar masses is, by a process of elimination, a black hole.

Cygnus X-1

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

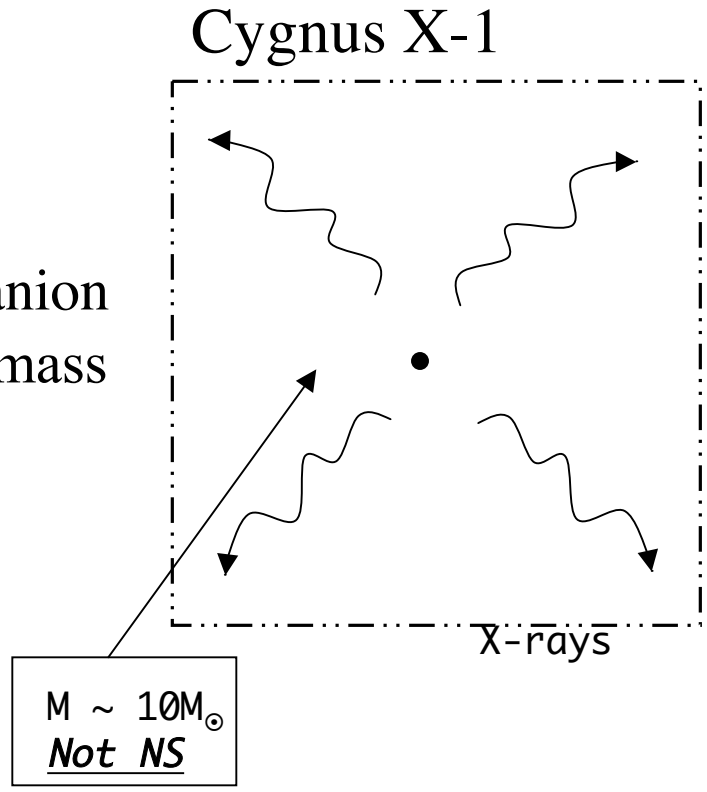
Discovered in 1970's by Uhuru Satellite (Swahili for Freedom).

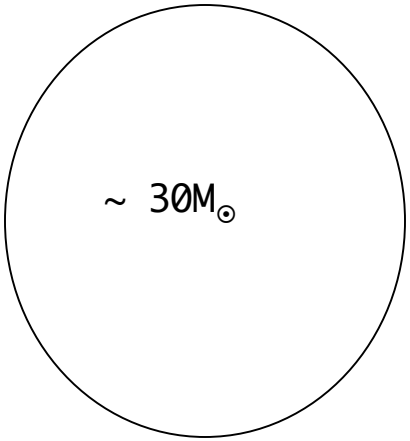
First and still most famous stellar mass binary black hole candidate.

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

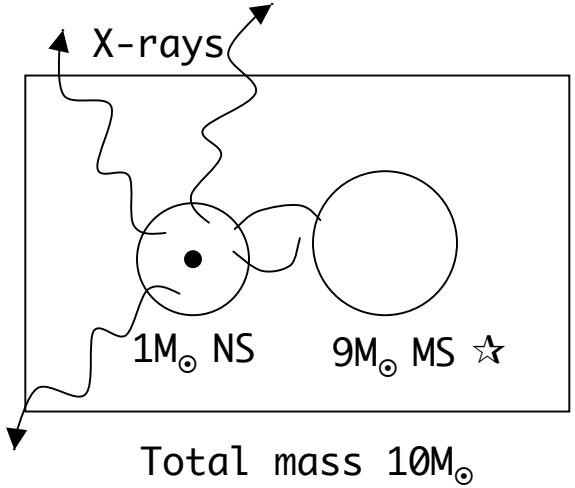
Optically dark
X-ray emitting companion
$\geq 10M_\odot$ >> NS max mass
$\Rightarrow$ BH

Could nature be tricking us? All we really know is that there is a $10M_\odot$ "thing" emitting X-rays





Blue supergiant, mass losing star



One possibility:
$9M_\odot$ normal star
"lost in glare" of $30M_\odot$
like flashlight next to searchlight. Unlikely but can't be entirely ruled out.

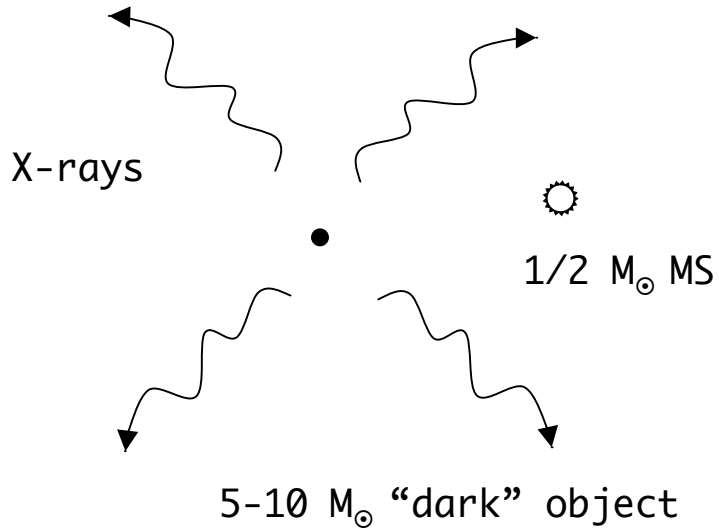
Expect only two or three systems like Cygnus X-1 in our Galaxy.

Bright, massive, short-lived companion

Maybe only one, and we found it!

Surprisingly, most binary black hole candidates have small mass main sequence companions, typically ~ 1/2 solar mass.

Observe ~20 such systems and guess there may be ~1000 in the Galaxy



For systems with small mass companions cannot hide a 3rd star in the system

$\Rightarrow$ best black hole candidates.

Evidence still circumstantial but virtual proof of black hole