

11/03/04

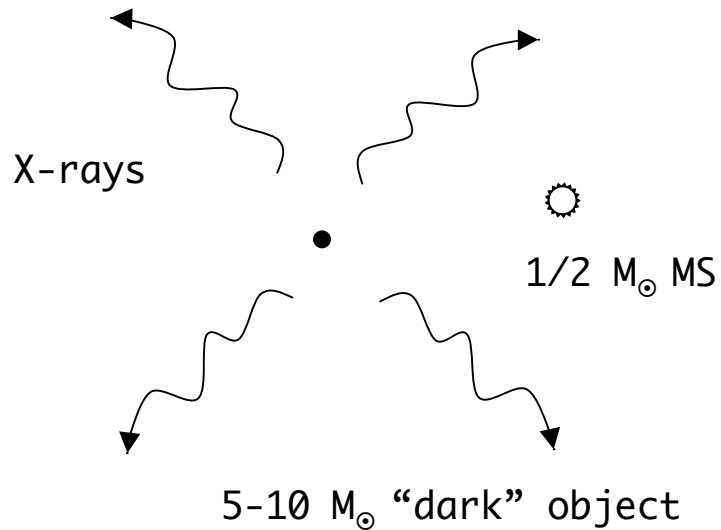
News?

Sky watch: Betelgeuse coming into view, also Monocerotis, Cygnus.

Pic of the day: Lunar Eclipse



## Binary Black Hole Candidates



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

Candidates in the directions of Sagittarius, Ursa Majoris, Perseus, Scorpius, Ophiuchus, Vulpecula, Monoceros, Lupus, Cygnus (2) (Find and observe the constellations for extra credit)

AO620-00 = Nova Mon 1975 = V616 Monocerotis - one of the first and best studied with a small mass companion, black hole about 5 solar masses.

V404 Cygni - somewhat evolved companion, but one of the best cases for a black hole with “dark” mass of about 12 solar masses.

Two candidates in the Large Magellanic Cloud:  
LMC X-1, LMC X-3

Total number of such systems known, about 20.

Not sure how these binary systems form.

Would have expected massive stars that can make black holes in core collapse to have massive companions, like Cygnus X-1.

Need to have black hole very close to small mass companion, separation smaller than size of the star that made the black hole.

Possibilities:

Common envelope swallows small mass companion?

Companion forms from left-overs of collapse?

All low companion mass systems are *X-ray Novae*

Flare every few years to decades for months, like neutron star X-ray transients

*Dwarf Nova-like accretion disk flushing instability*

No black hole analog of nova or X-ray burster. Why not?

The black hole is black and the disk does not produce X-rays in the “off” state. There are billions of small mass stars in the Galaxy.

*Do not notice these systems until they erupt!*

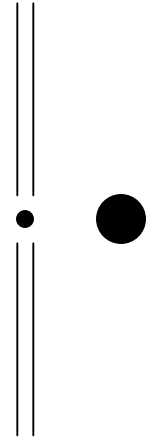
There are probably 100 “sleeping” black hole systems that we have not discovered for every one we have. Perhaps 1000 such systems in the Galaxy (but 100 million more black holes!)

Often see jets during X-ray flare

Some show “superluminal” motion

An optical illusion that occurs when the source of light moves near the speed of light, so chases its own emission.

These systems are called “microquasars” since some quasars with supermassive black holes have show the same effect.



In quiescent “off” state of X-ray novae, a hot, low-density  $\sim$  spherical region may form, heat is carried (advected) inward with the flow of gas toward the event horizon, rather than radiated away as for an accretion disk.

Very hot,  $e^\pm$  pairs may form (energy to mass  $E = mc^2$ ), gamma-rays

Low density  $\Rightarrow$  low efficiency to produce radiation  
 $\Rightarrow$  low X-ray luminosity

Only works for black hole, radiation from surface of a neutron star would spoil the hot region

Low X-ray luminosity, gamma-rays, clues that there is no surface  
 $\Rightarrow$  possible proof of black hole!

Fig. 10.1

