4/15/05

Star Party Wednesday- write enough of a description that I know **YOU** saw the star or constellation, not that someone else did and told you about it. For full 5 points of extra credit, need to do something beyond the mass viewing.

News: Michael Griffen confirmed as new NASA Administrator, plans to revisit Hubble after safe shuttle lunch, May/June (refueling test yesterday)

Pic of the day:

Wind-blown bubble



### Rotating Kerr Black Hole

Mass and spin, but no electrical charge

Assume all mass in singularity, no mass anywhere else (assumption necessary to solve equations)

Find *singularity is a ring* (not a point)



0 thickness,  $\infty$  density, still uncertainty problem

Infinite Universes!

#### Cross-sectional view of rotating Kerr black hole



## In future



Are Different Universes Real?

In Real Universe:

Light falls in

Accelerated to higher energy: Bluesheet warp space change mathematical, hence physical solution

So, probably not in this case, but stay tuned...

# 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 to fine, 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), binary systems in our Galaxy or nearby galaxies

*Intermediate mass black holes* (~ 1000 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  $\sim 2$  solar masses

Intense X-ray source with mass exceeding 2 solar masses is, by a process of elimination, a candidate 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!