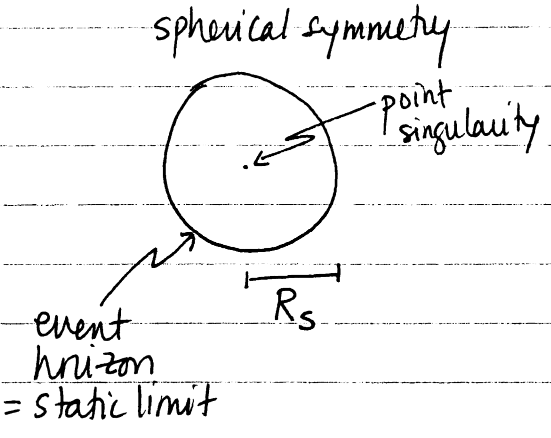
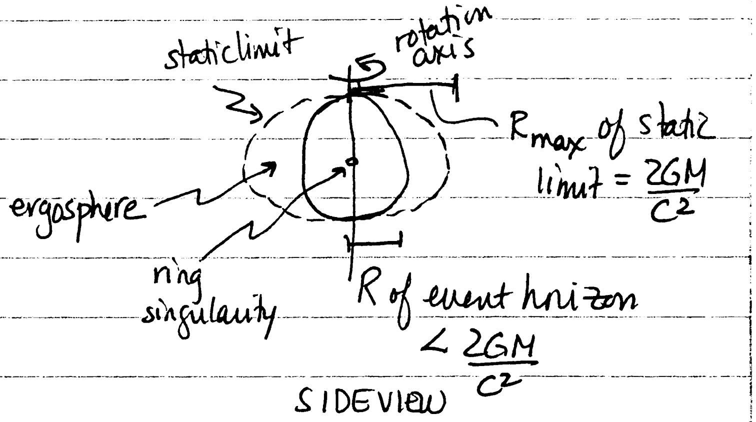
Astronomy 111
Prof. Kwitter

More Black Holes

If a BH is rotating, it's a "Kerr BH." There are interesting differences in the anatomy compared with a Schwarzschild BH.





1. no spherical symmetry
2. event horizon < R_S (there are 2 EH's, actually, but the inner one doesn't concern us here)
3. static limit now a separate surface – outside EH ~ oblate spheroid
4. volume between static limit + event horizon "ergosphere" – E can be extracted from the BH!
5. inside ergosphere – you can't stand still – you must move around the singularity – but you can still escape ($V_{esc} < c$)
6. singularity not a point, but a ring (theoretically, you can avoid hitting it, and go through the middle, to ...?

Hawking Radiation - virtual particles come + go out of the vacuum, obeying HUP: $\Delta E \Delta t \sim \hbar$
so that you can "borrow" ΔE for a time $\Delta t \sim \frac{\hbar}{\Delta E}$,
to make particle-anti-particle pairs,
and then "give it back." But if one of the pair falls below the event horizon + the other doesn't, the latter must be made real, by taking mass +/or rotational E from the BH.

$\Longrightarrow$ BH's radiate (+ evaporate!)

T_{bb} of a BH w/ mass $M = \frac{5\times10^{-8}K}{M/M_\odot}$

evaporation accelerates as M ↓, giving

lifetime = 2×10^{67} yrs $\times \left(\frac{M}{M_\odot}\right)^3$

We have never observed Hawking radiation or BH evaporation.

BH seem to come in 3 varieties:

stellar ($\sim 10 M_\odot$)

$10^{2-3} M_\odot$ found in globular clusters

$10^{6-9} M_\odot$ found in nuclei of galaxies

There seems to be a relation between the mass of a BH and the mass of its environment.