THE ASTROPHYSICAL BLACK HOLES

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NO-HAIR THEOREM

- Mass Multipole Moments: $M_n = M a^n$, $a := J/Mc$
- Charge Multipole Momts.: $Q_n = Q a^n$
- Schwarzschild Radius: $R_S = 2GM/c^2 = 3\text{km}\ M/M_|$
- Critical Mass density: $o_{crit} = o_N (7\ M_|/M)^2$
- Centrifugal Constraint: $c^2J^2/GM^2 + Q^2 < Mc^2$
- Irreducible Mass: $M_{irr} = M [1 - (cJ/GM^2)^2 - Q^2/GM^2]^{1/2}$
- Temperature: $T = h\ c^3/16\pi^2\ G\ M\ k = 10^{-7.1}K\ (M_|/M)$
- Evaporation Time: $t_{evap} = 10^{10}\ \text{yr}\ M_{14}{}^3$

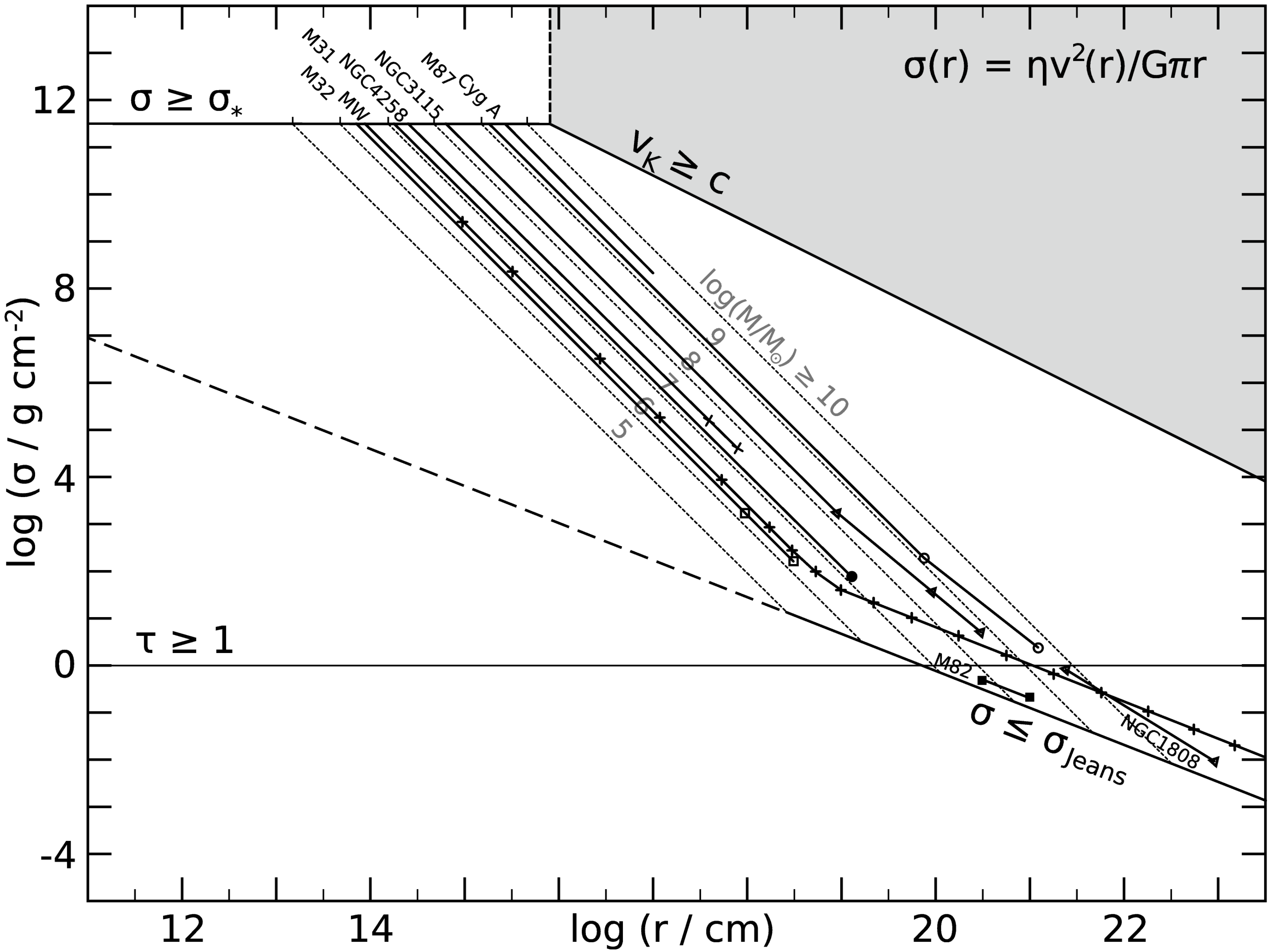
BLACK-HOLE CATEGORIES

$\mu := (hc/2\pi G)^{1/2}$, $m :\upsilon m(\pi)$

NAME	MASS	SIZE	TEMP.	AGE
Observable Univ.	$\mu^4 m^{-3} = 10^{55}$g	10^9 lyr	10^{-28} K	10^{120} aeon
MAXI				
Chandrasekhar M.	$\mu^3 m^{-2} = 10^{34}$g	10 km	10^{-7} K	10^{56} aeon
MIDI	1	1	1	1
Hawking Mass	$\mu^2 m^{-1} = 10^{15}$g	1 fm	10^{12} K	1 aeon
MINI	Ø	Ø	Ø	Ø
Planck Mass	$\mu = 10^{-5}$ g	10^{-33} cm	?	10^{-60} aeon

Why the CEs of QSOs cannot be BHs

- Their CEs are thought to be burning disks (BDs), i.e. fast-spinning disklike stars.
- The QSO phenomenon asks for larger (average) masses of the CEs, by $\Im$ 10^3.
- The mass outflow rates (through the BLR) equal the infall rates (inferred from L).
- The high γ-ray compactness of BH engines would destroy the jet plasma in situ.
- Their ejecta look like the ashes of nuclear burning, $\Im$ 10^2 times solar.
- Their hard spectra, often peaking at $\Im$ TeV, clash with BH Ts of keV$(M_{|}/M)^{1/4}$.
- Their best birth sites, the galactic centers, are underdense for BH formation.
- The inverted evolution of the QSO phenomenon: CEs lose mass with age.
- The CE masses scale like the masses of the bulges of their hosts.
- The universality of the jet phenomenon asks for non-BH engines.
- A number of high-mass CEs in gas-rich environs are seen not to be active.



σ(r) = ηv²(r)/Gπr
σ ≥ σ*
τ ≥ 1
v_K ≥ c
σ ≤ σ_Jeans
M31 NGC4258
M32 MW
NGC3115
M87 Cyg A
log(M/M⊙) ≥ 10
9
8
7
6
5
M82
NGC1808
log (σ / g cm⁻²)
log (r / cm)
12
8
4
0
-4
12
14
20
22

Why the stellar-mass BHCs cannot be BHs

- The BHCs are thought to be n*s inside mssive disks: M(D) ≈ 5 $M_{|}$.
- Compared with n**, BHs lack a solid surface, an oblique magnetic moment, and a (strong) wind. They are thus unable to radiate at Ts above soft X-rays, generate jets, emit strong ELs, have aperiodic light-curves, radio outbursts, quiescent & super-Eddington epochs, periods and quasi periods, state transitions, superhumps, polarized emission.
- Instead, the BHCs are indistiguishable from n*-binaries, as a class, in most properties other than their (higher) mass and their `supersoft´ epoch (when the massive disk is filled up).
- Massive disks around binary n*s are expected to form frequently in the intermediate mass interval between low- and high-mass systems.

Signatures of massive Accretion Disks

- Massive Disks, with $M \Im M_{|}$, differ from low-mass disks by having much higher (degenerate) mass densities; hardly in their geometry.
- During its formation, a massive disk is a supersoft X-ray source.
- The outer parts of massive disks tend to rotate rigidly, hence not to discharge. The BHCs can therefore have long quiescent epochs.
- The inner parts of massive disks behave like low-mass disks, giving rise to familiar epochs with outbursts, flickering, jet formation, ...
- Massive disks are long-lived, hence give rise to long-lived sources.
- Even the inner parts of a massive disk will tend to have higher press-ures (than ordinary), and thus cut more deeply into a magnetosphere.