The mass function of local active black holes

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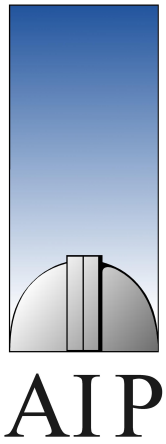

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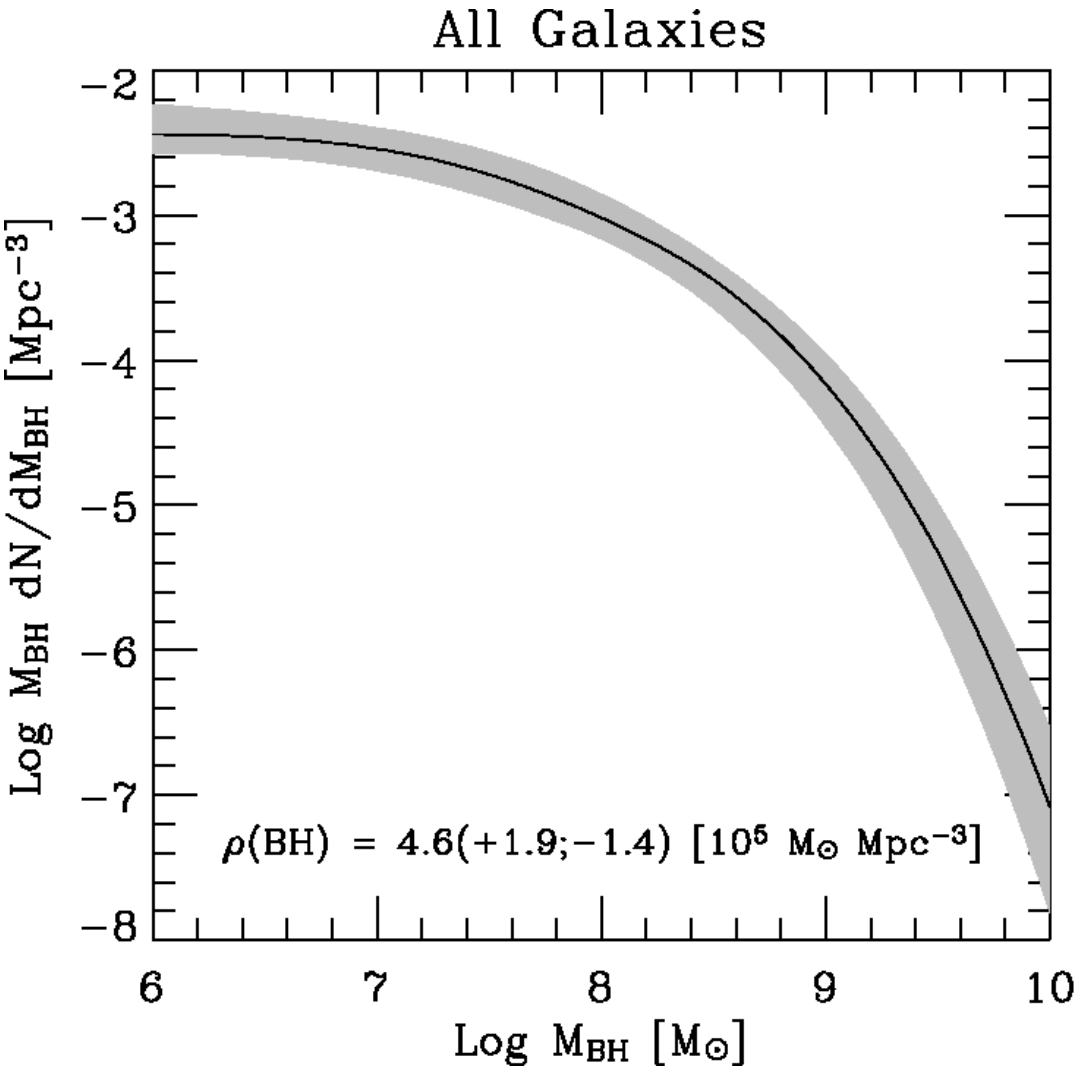
Ierapetra, 06.06.2008

Introduction

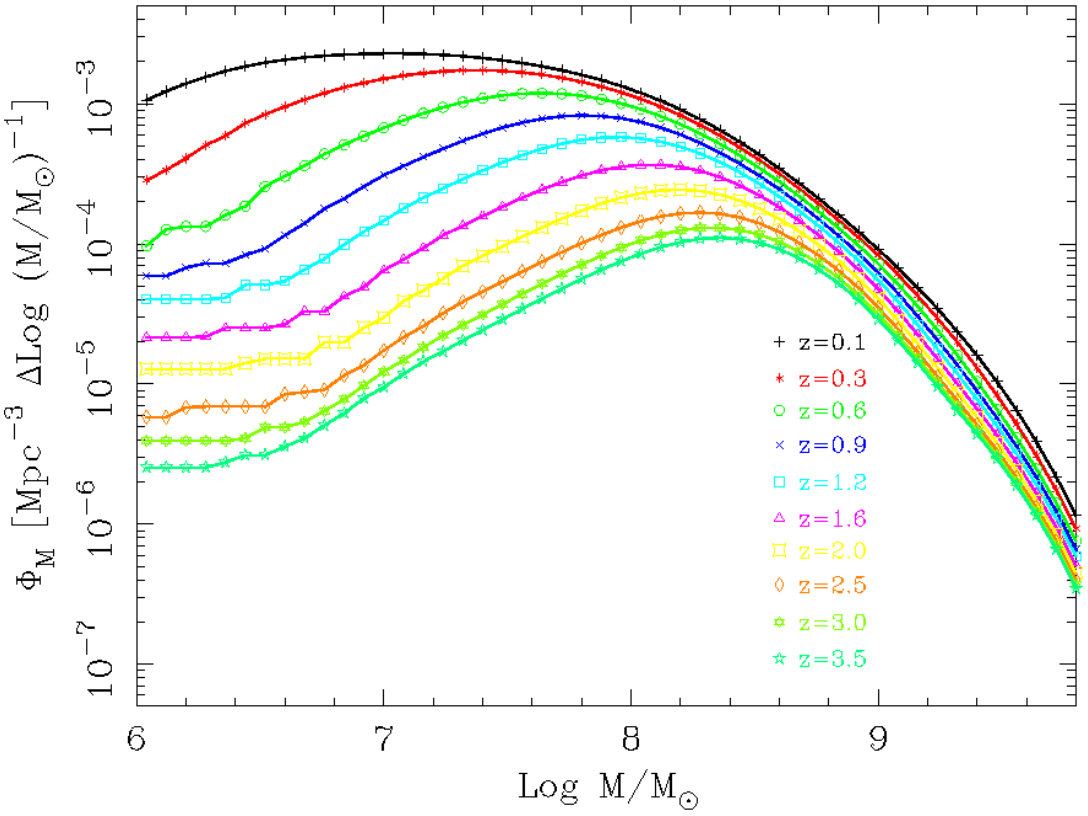
local quiescent BHMF from observed relations between M_{BH} and galaxy spheroidal properties

close connection between growth of black holes and galaxy evolution



Marconi et al. 2004

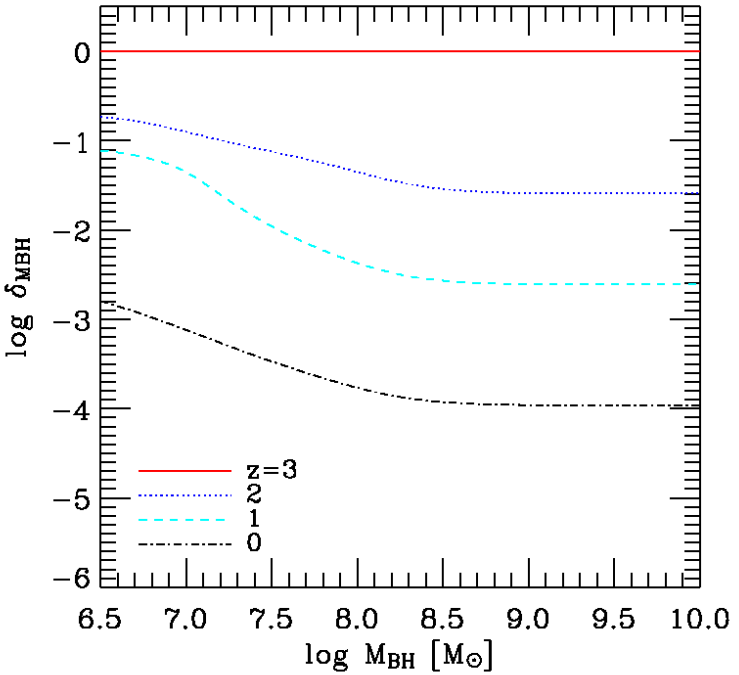
Black hole growth from QSO luminosity function



Merloni 2004

possible to construct BHMFs, Duty Cycles, ...

but needs further assumptions



Marconi et al. 2004

Direct determination of active black hole mass function

Additional contraints on black hole growth from active black hole mass function

Necessary :

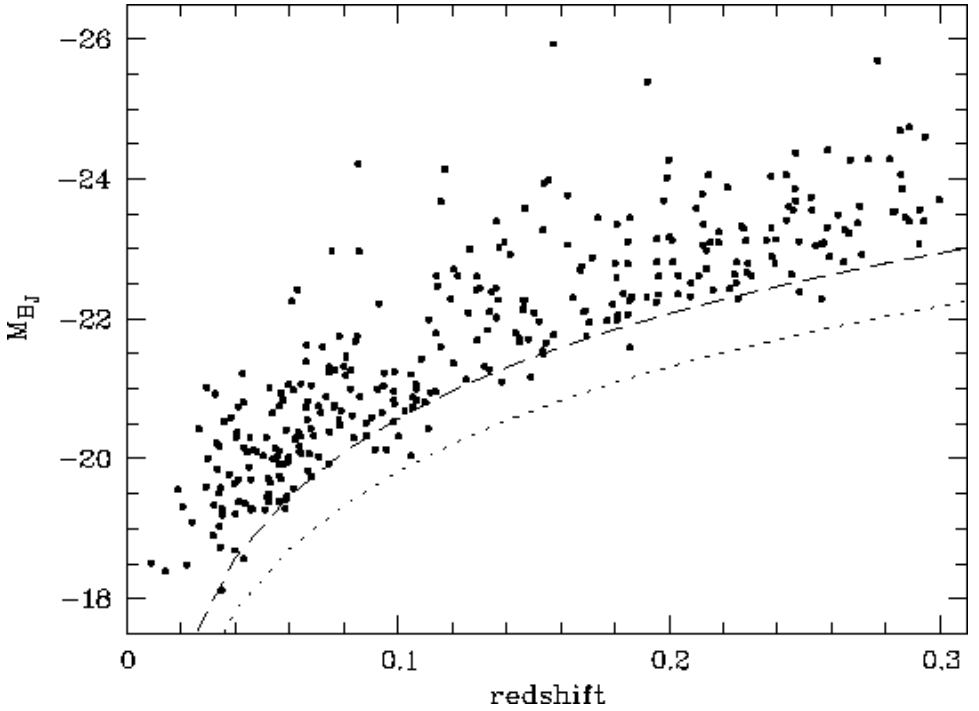
- method to estimate black hole masses for large samples (only possible for type-1 AGN)
- sample with well defined selection criteria

Hamburg/ESO Survey

- wide-angle, slitless spectroscopy survey for bright QSOs
- area covered $\sim 9500\,\mathrm{deg}^2$
- $13 \leq B_J \leq 17.5$
- well-defined, flux limited sample (high degree of completeness)
- final HES QSO catalog contains 877 type-1 AGN
- z < 3.2
- spectra from follow-up observations

Our Sample:
all HES AGN with z<0.3

329 objects



Local (z<0.3) Hα AGN luminosity function

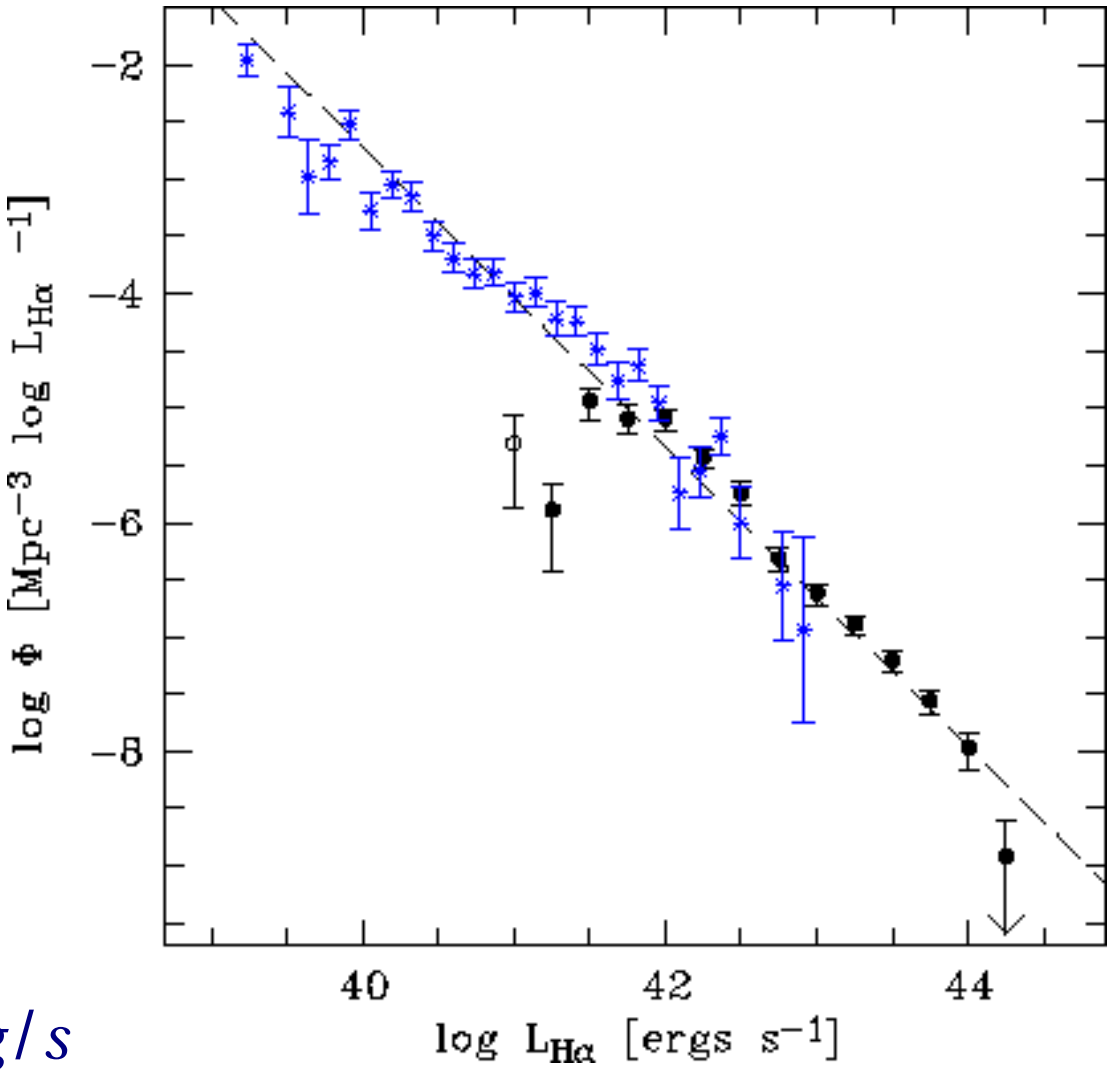
measure Hα and Hβ luminosity from line fit

$$\Phi(L) = \frac{1}{\Delta \log L} \sum_k \frac{1}{V_{max}^k}$$

LF well described by power law

+ Hao et al. (2005)

consistent with power law over $10^{39} < L(H\alpha) < 10^{44}\, erg/s$



Estimating black hole masses

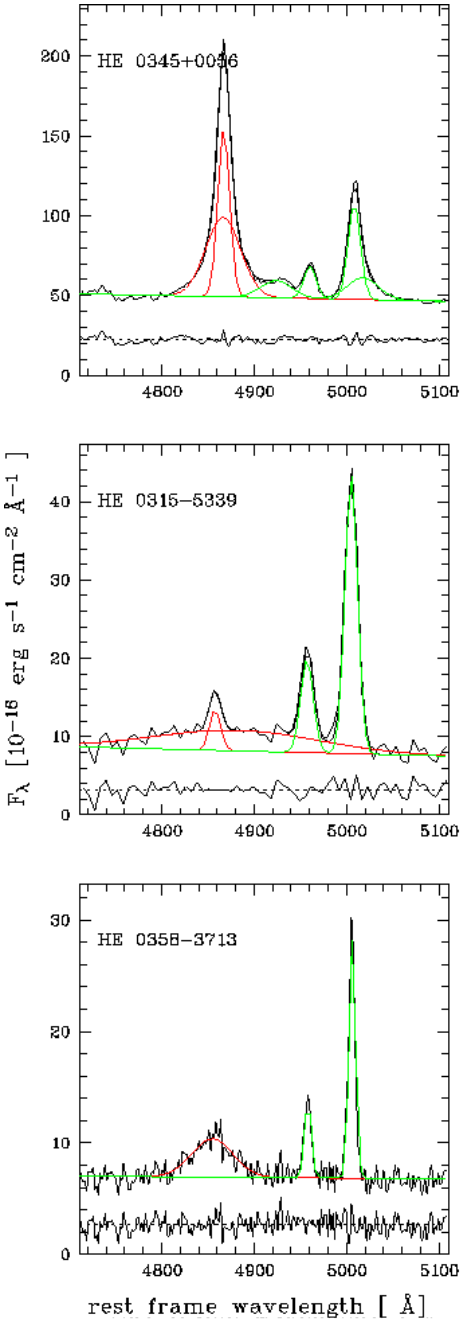
assuming virial equilibrium black hole mass is given by:

$$M_{BH} = f \frac{R_{BLR} \Delta V^2}{G}$$

R_{BLR} by scaling relation (e.g. Kaspi et al. 2005, Bentz et al. 2006;2007)

$$M_{BH} = 24.6 \left(\frac{L_{5100}}{10^{44} erg/s} \right)^{0.54} \left(\frac{\sigma_l}{km/s} \right)^2 M_\odot$$

- use Hβ line dispersion
- scaling relation of Bentz et al. 2007
- $f = 3.85$ from Collin et al. 2006

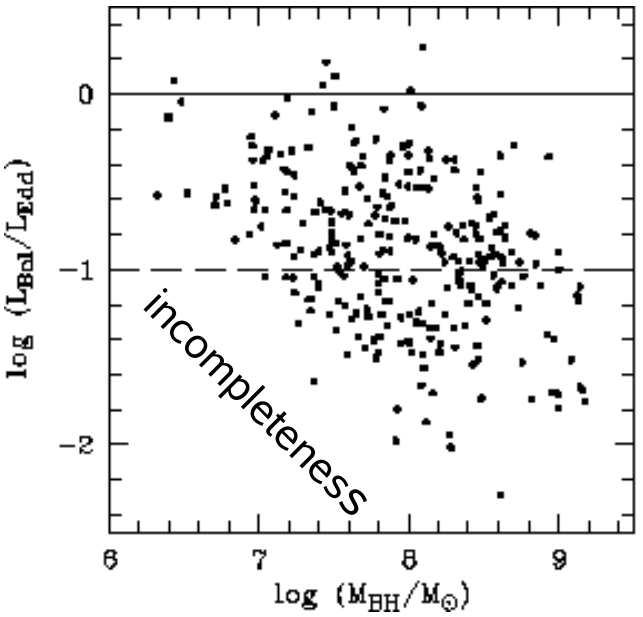


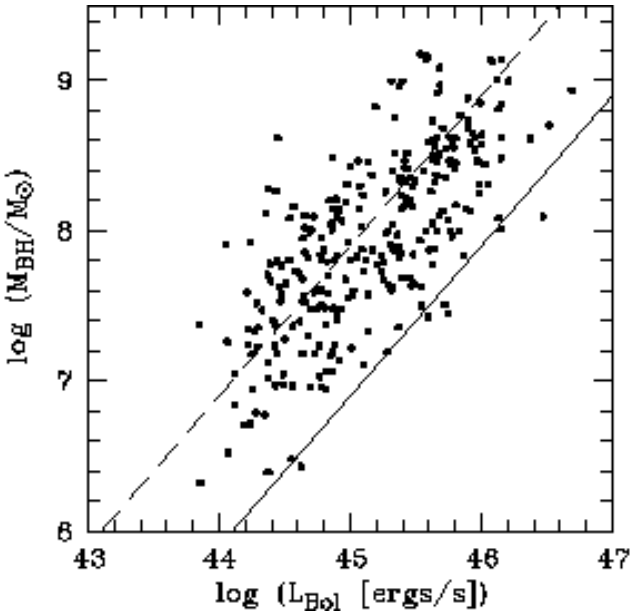
Black hole masses

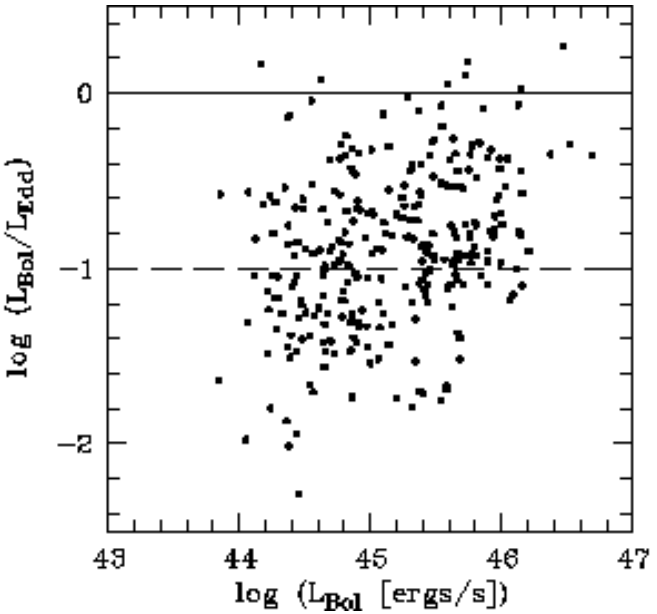
bolometric Luminosity : $L_{bol} = 9\, L_{5100}$

Eddington ratio : $\epsilon = \dfrac{L_{bol}}{L_{Edd}}$

correlation between M_{BH} and L_{bol}







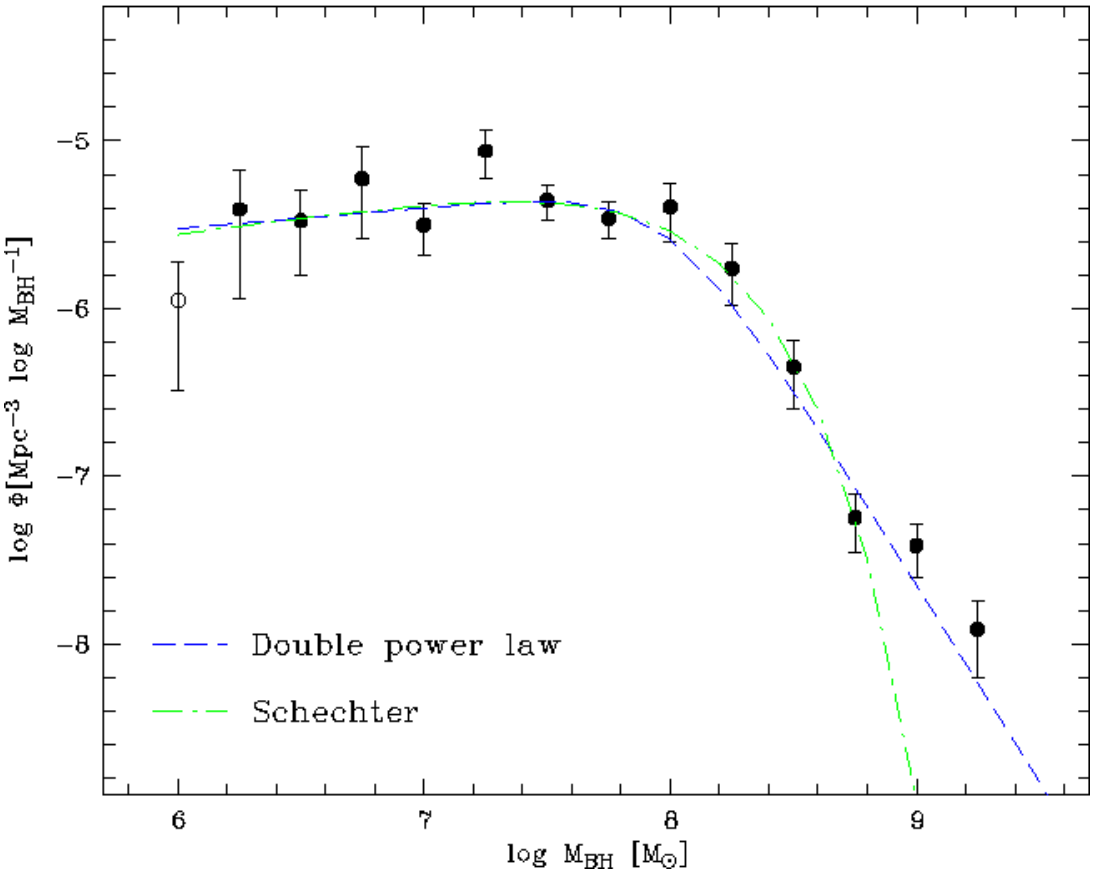
lack of high mass objects with high accretion rate

Active black hole mass function (BHMF)

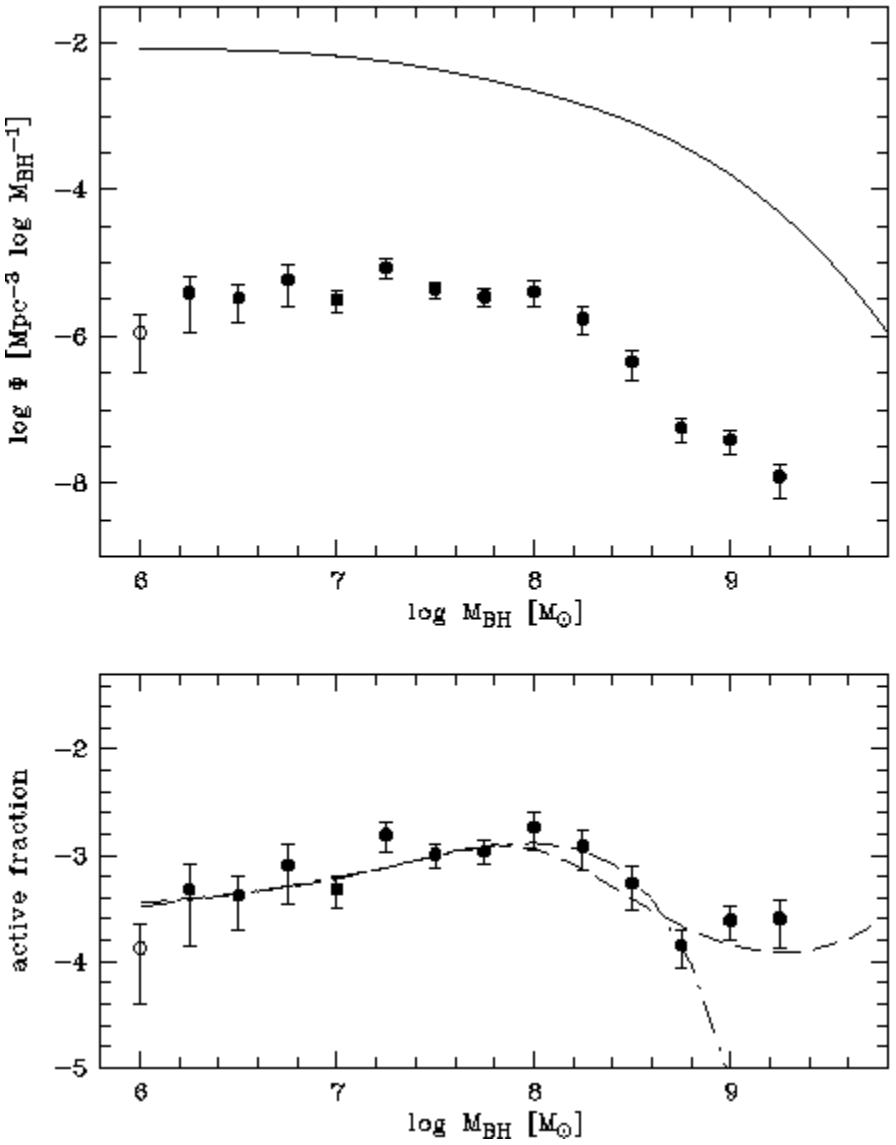
$$\Phi(M_{BH}) = \frac{1}{\Delta \log M_{BH}} \sum_k \frac{1}{V_{max}^k}$$

- corrected for evolution

  shifted to z=0
- Best fit double power law:
- low mass slope: $\alpha \approx -0.8$
- high mass slope: $\beta \approx -3.1$
- break at $\log M_* \approx 8.0$



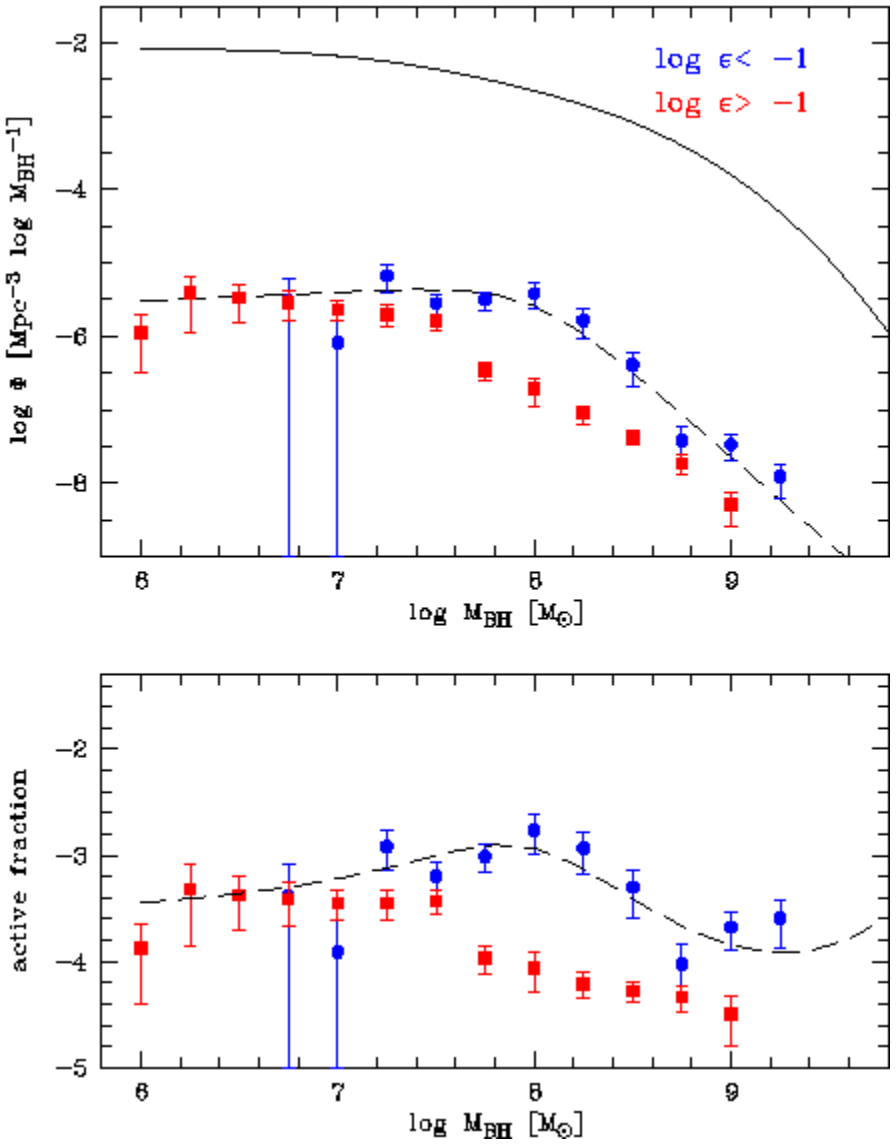
Active fraction of black holes



compare to quiescent BHMF of Marconi et al. 2004

- ~0.1% of all BHs are in an active stage
- slight decrease of active fraction toward higher BH mass

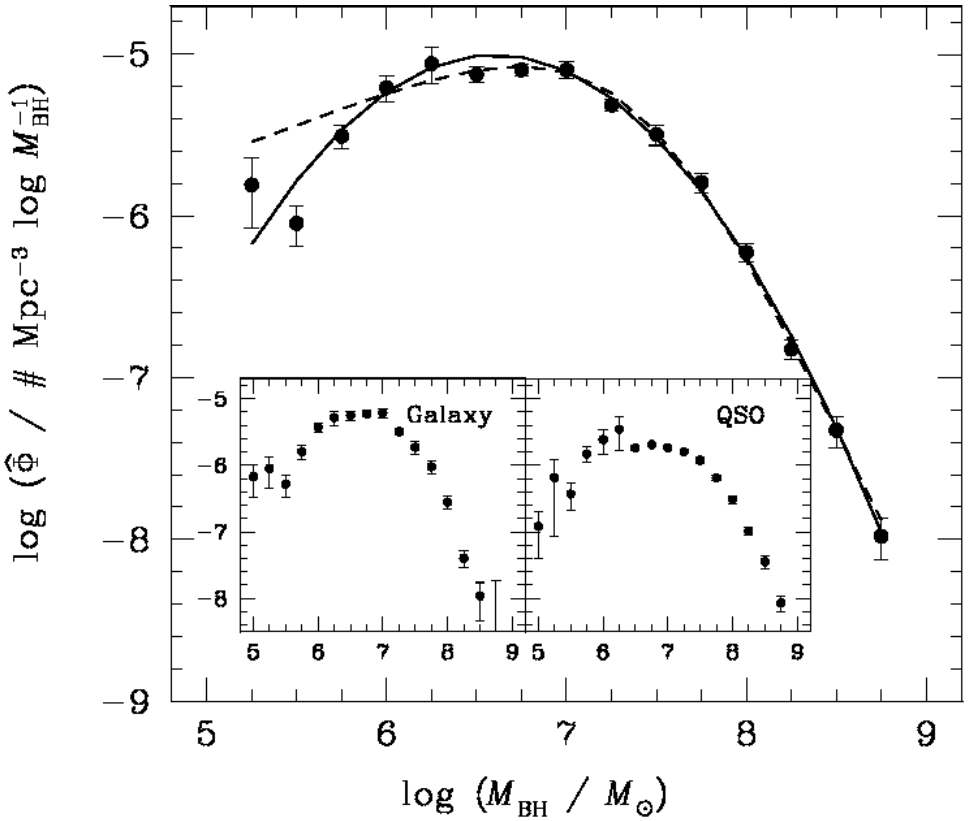
Active fraction of black holes



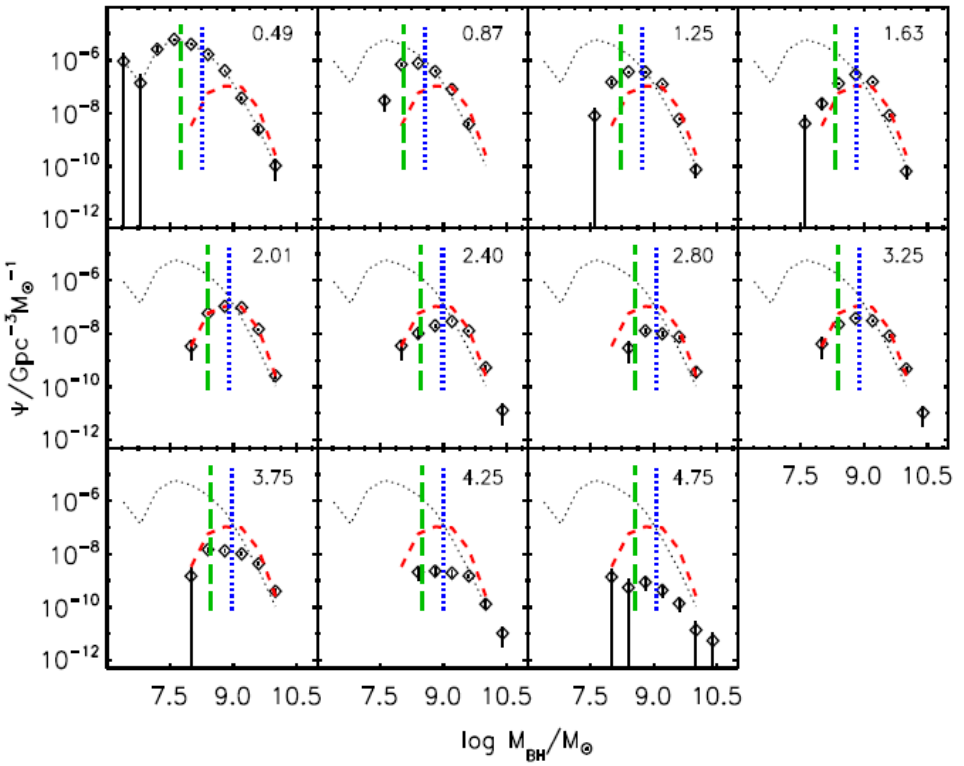
compare to quiescent BHMF of Marconi et al. 2004

- ~0.1% of all BHs are in an active stage
- significant decrease of active fraction toward higher BH mass for high Eddington ratio subsample
- indication for anti-hierachical black hole growth

Other recent results on active BHMF



Greene & Ho 2007
0<z<0.35

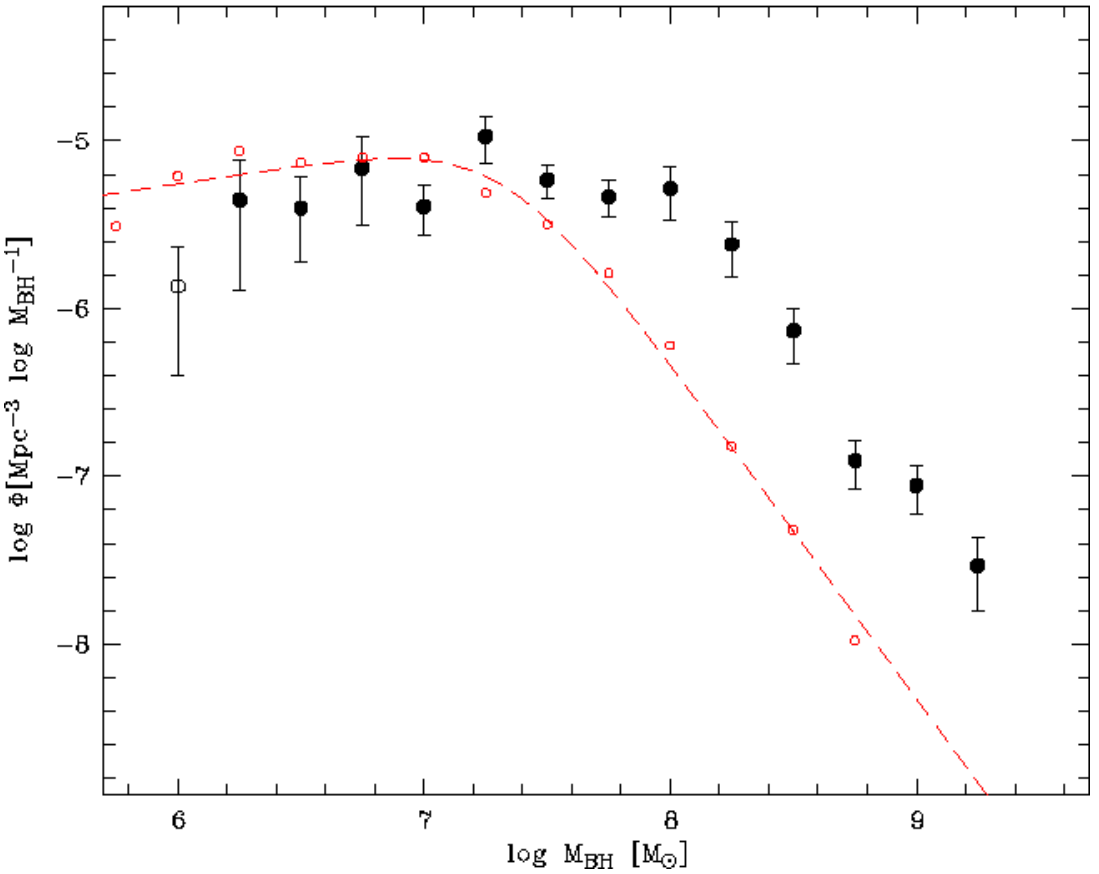


Vestergaard et al. 2008
0.3<z<5

Comparison with Greene & Ho 2007

+ Greene & Ho 2007

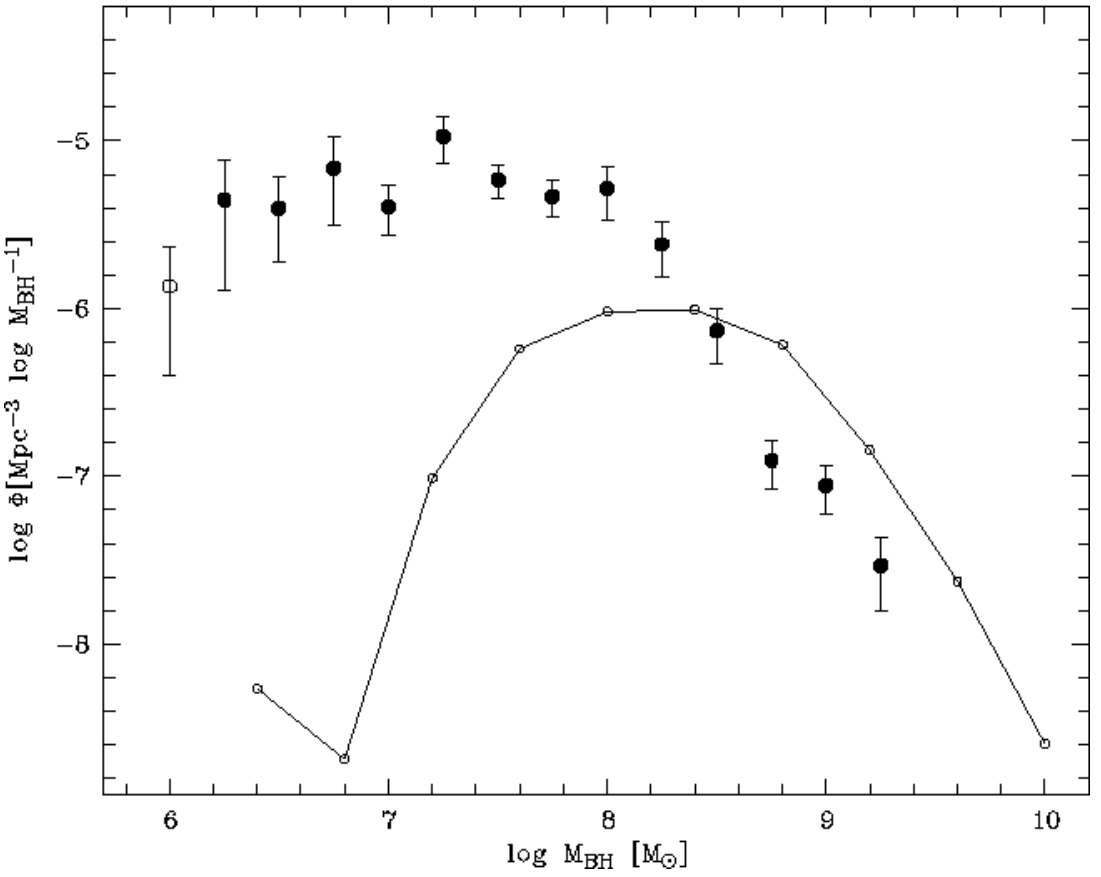
- BHMFs inconsistent at high black hole mass
- discrepancy already present in AGN LF
- maybe related to their sample selection



Comparison with higher redshift

+ Vestergaard et al. 2008 BHMF for $0.3 < z < 0.7$

- similar high mass slope
- higher space density for higher z BHMF
- seems to imply increase of active fraction toward higher redshift at high mass end



Conclusions

- fraction of active black holes decreases with mass
- most massive black holes are in a less active stage in present universe
- strengthens picture of anti-hierarchical growth of black holes