

**The Accuracy of AGN Black Hole
Masses Estimated from Single-Epoch
Spectra: Comparison of Masses
Estimated by E. A. Dibai (1980, 1984)
with Recent Reverberation Mapping
Results**

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Abstract

- The first set of black hole mass estimates published in 1980 and 1984 by E. A. Dibai prove to be in excellent agreement with recent reverberation-mapping estimates.
- Comparison the masses of 17 AGN covering mass interval $\sim 10^6 - 10^9$ solar masses shows that the masses values obtained by Dibai agree with reverberation-mapping masses to significantly better than ± 0.3 dex and are, on average, only 0.14 dex ($\sim 40\%$) lower than masses obtained from reverberation mapping.
- We show a data comparison and briefly discuss possible causes of the remarkable accuracy of Dibai's estimates of a quarter of a century ago.

Dibai's AGN mass estimates

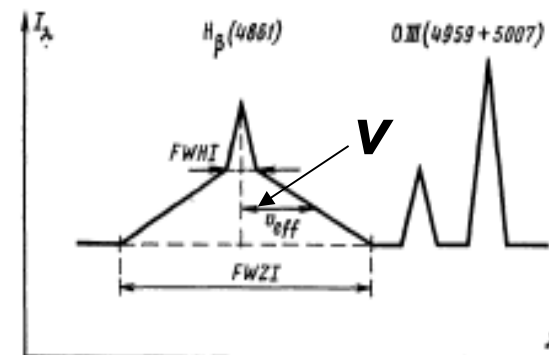
- E.Dibai (1980) "The mass-luminosity relation for active galaxy nuclei."-- *Astron. Zh.*, **57**, 677.
- E.Dibai (1984) "An empirical model for active galactic nuclei. I. The catalog" – *Astron. Zh.*, **61**, 417.
- "The central structure mass estimation ... regarding the gas clouds responsible for the broad emission lines are moving at approximately parabolic velocity in the force field of some massive object":

$$M_{\text{BH}} = 1.5Rv^2/G; \quad \varepsilon \cdot (4\pi R^3/3) = L(\text{H}\beta)/E(n, T).$$

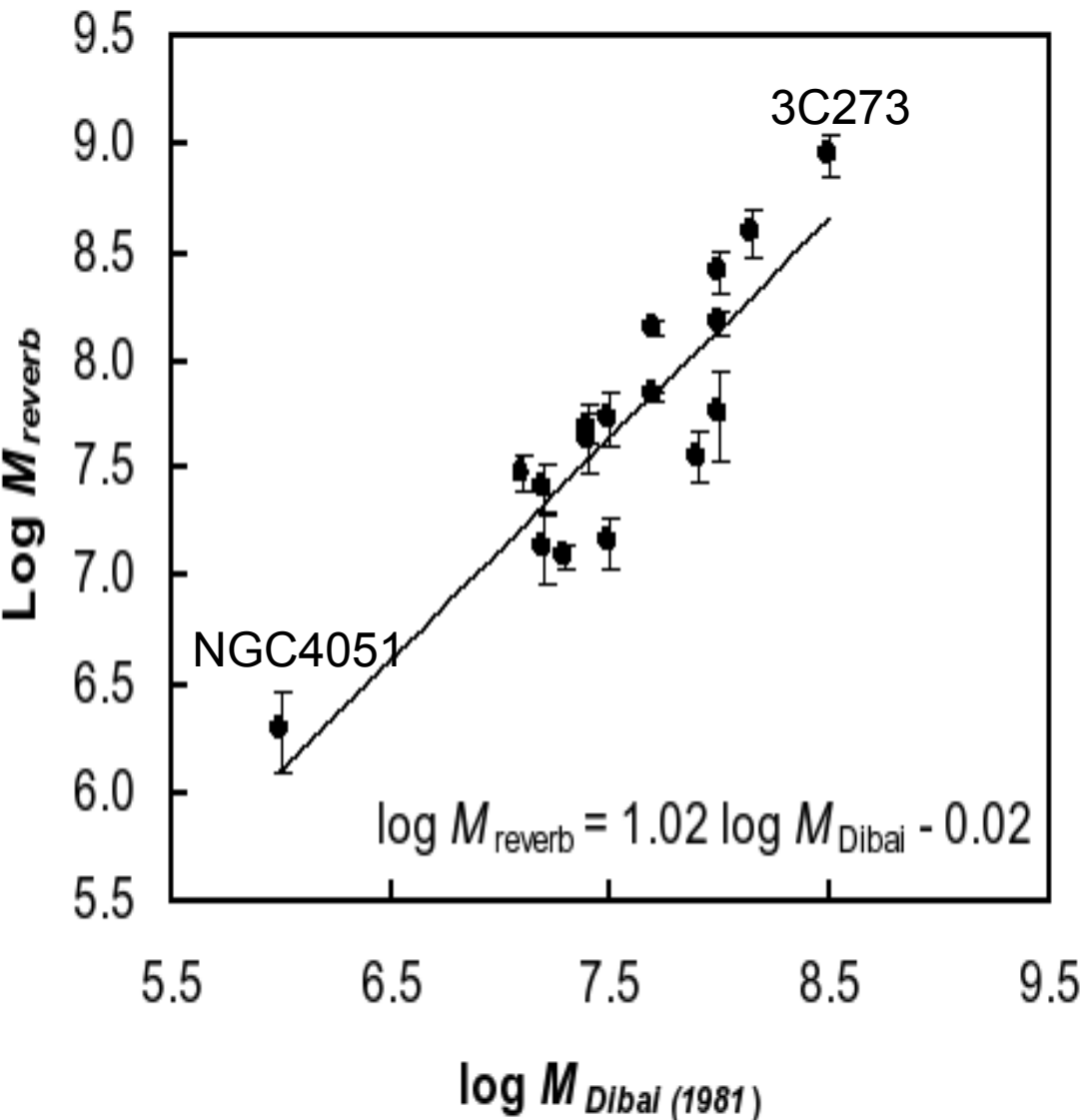
- For all Sy1 and quasars:
- emissivity $E(\text{H}\beta) = 1.21 \cdot 10^{-7} \text{ erg}/(\text{cm}^3 \cdot \text{s})$
as for HII regions with $n = 10^9 \text{ cm}^{-3}$, $T = 10^4 \text{ K}$;
- filling factor $\varepsilon = 10^{-3}$ (similar to Crab nebula).
- We use M_{BH} according Dibai (1984).



**Ernst A.
Dibai**
(1931-1983)



BH masses in AGN: Dibai (1984) vs. reverberation mapping



M_{reverb} according to:
Vestergaard & Peterson (2006)
and Peterson *et al.* (2004)
→ statistical error ± 0.105 dex.

$\langle \log(M_{Dibai}/M_{reverb}) \rangle = -0.14$
→ $\langle \text{mass differences} \rangle \sim 40\%$.

Scatter: ± 0.28 dex (± 0.26 dex
with V&P observational errors).

Dibai mass scatter 0.20 dex, if
errors are equally distributed
between 2 methods.

What does the agreement tell us?

- All “classical” type-1 AGNs (where BLR are seen) are *very similar* in their properties. *Viz.:*
 - $R_{\text{BLR}} \sim L^{1/2}$
 - Spectral Energy Distributions (SEDs) similar
 - Kinematics similar (BLR gravitationally dominated)
 - Filling factor similar ($\epsilon \approx 0.001$)
 - $L/L_{\text{Edd}} = 1\text{-}10\%$ for most AGNs selected
- Single-epoch spectra (i.e., Method pioneered by Dibai) give reliable central BH mass estimates (Very important for studying cosmic evolution of black hole and host galaxies)
- [Exceptions – very high- and very low-accretion-rate AGNs, Blazars, LINERS *etc.*]