Super-critical accretion of supermassive black holes

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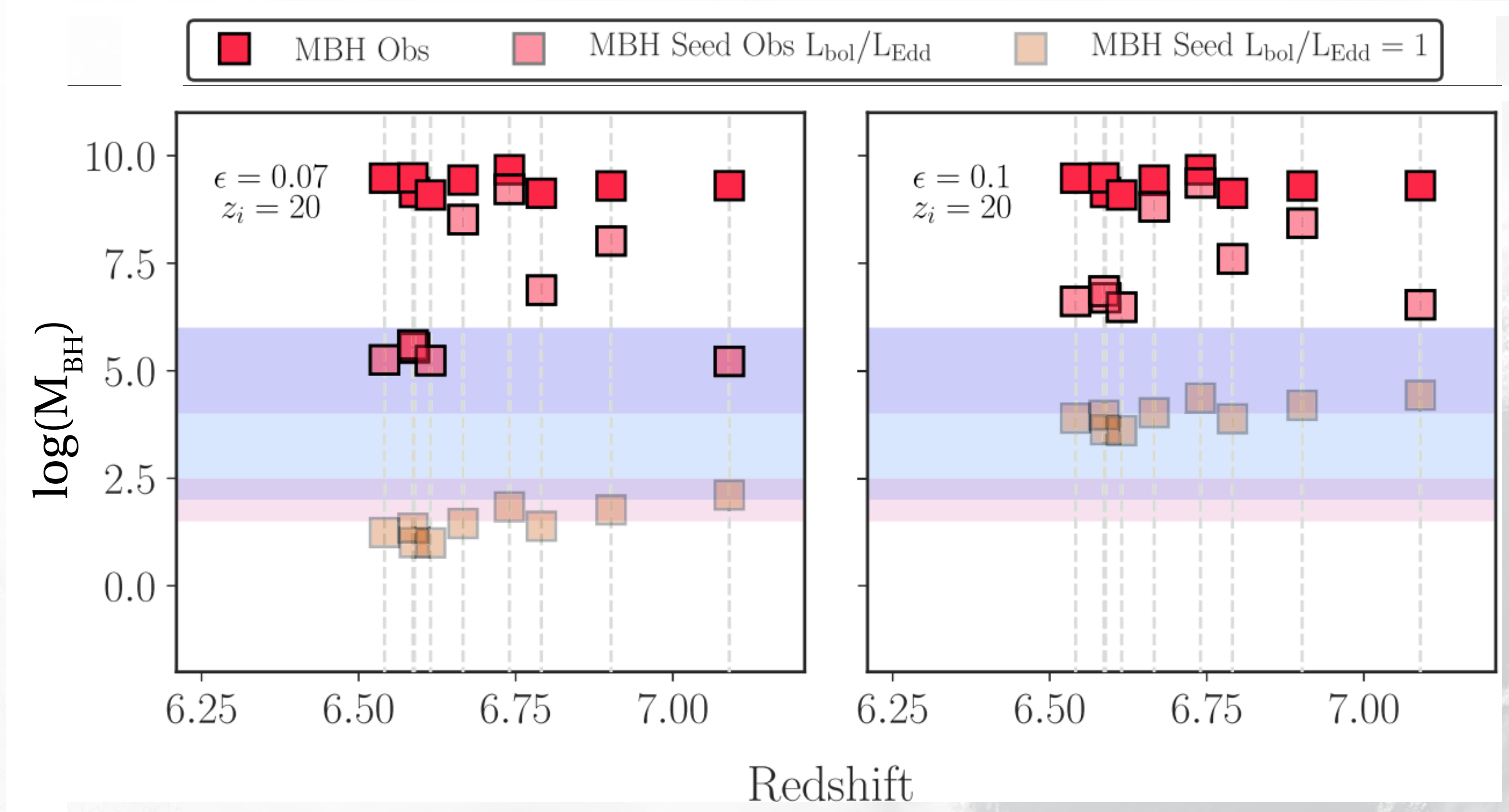
Motivation:



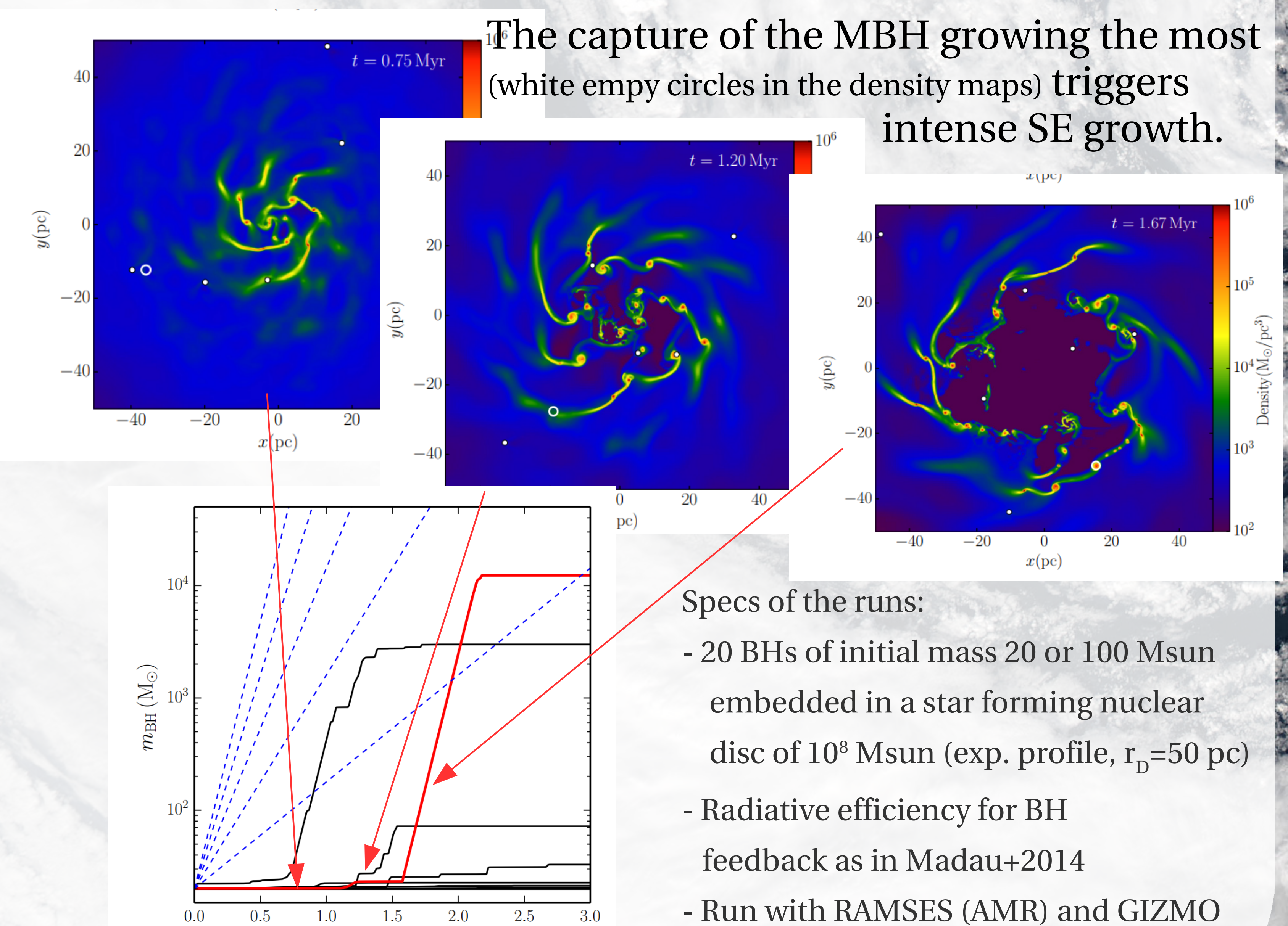
High-z observations of active MBHs requires <u>high seed masses</u> and a <u>full-time Eddington</u> radiative efficient accretion *(fine tuning required)*, unless all the observed MBHs have <u>dimensionless spin parameter a<0.3</u> (e.g. Mazzucchelli+ 2017)

Unless accretion proceeds as a collection of small patches of mass raining isotropically onto the MBHs *(fine tuning required)*, keeping such a small spin is terribly hard (Dotti+ 2010, 2013, Maio+ 2012, Sesana+ 2013, Dubois+ 2014)

How to fuel SE accretion?

(An example from Lupi+ 2016)

In gas rich high-z galaxies small seeds can get stocastically captured by large gas clumps, undergoing episodic events of SE accretion (possible only if the BH feedback is limited as in radiative inefficient scenario).



The capture of the MBH growing the most (white empy circles in the density maps) triggers intense SE growth.

Specs of the runs:

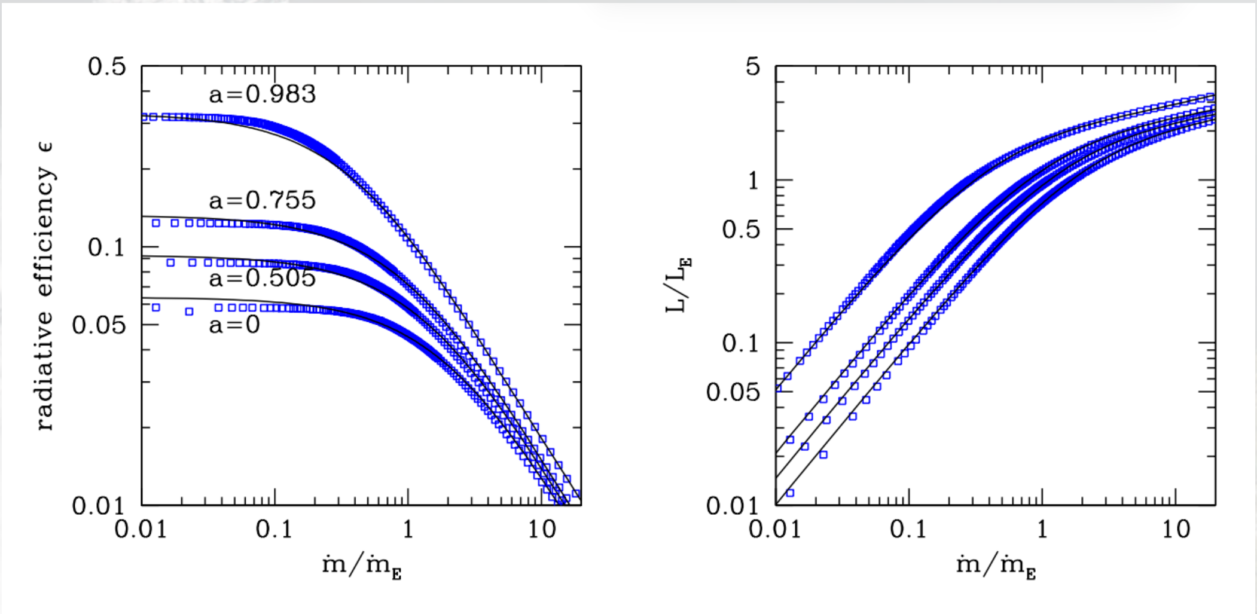
- 20 BHs of initial mass 20 or 100 Msun embedded in a star forming nuclear disc of 10^8 Msun (exp. profile, r_D=50 pc)
- Radiative efficiency for BH feedback as in Madau+2014
- Run with RAMSES (AMR) and GIZMO (mesh-free, FM), down to 0.02 pc resolution (still way too large to resolve the accretion disc)

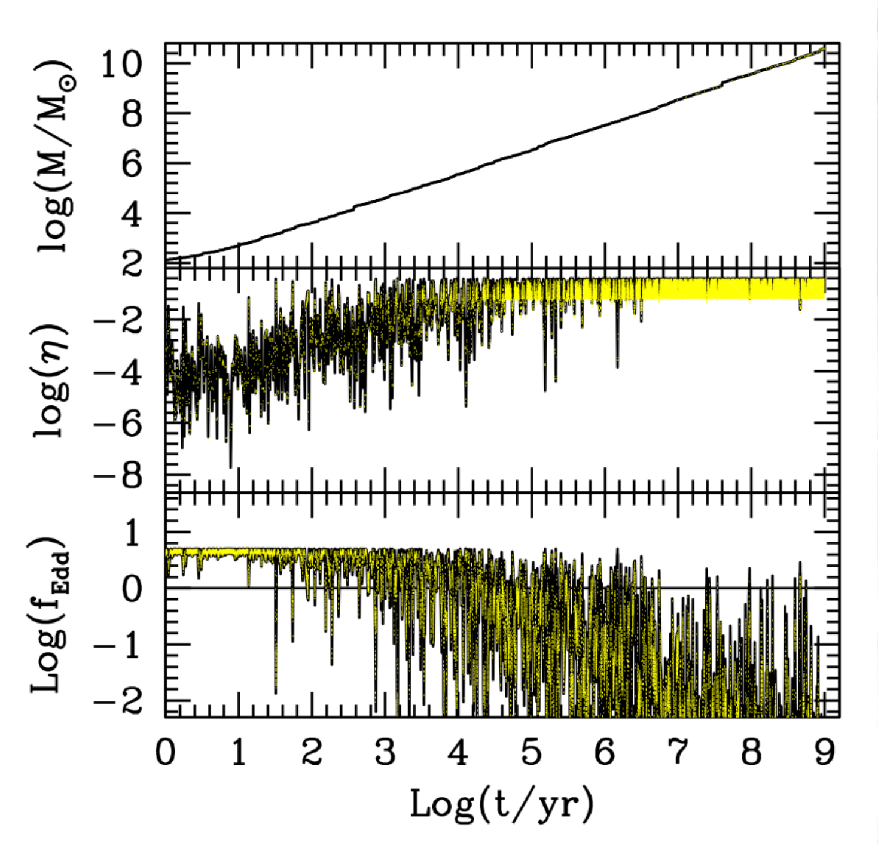
A way out: inefficient accretion

At sufficiently high feeding rates, radiation from the central regions of accretion disc gets trapped and advected into the MBH

↓

radiative inefficient slim disc solutions:
(Data: Sadowski 2009)
(Fit: Madau+ 2014)





The figure on the left shows the growth history of a MBH if the gas feeding rate is dictated by the host galaxy properties.

A log-normal distribution of accretion rates peaked at 0.1 Msun/yr with a width σ=0.1 dec is assumed.

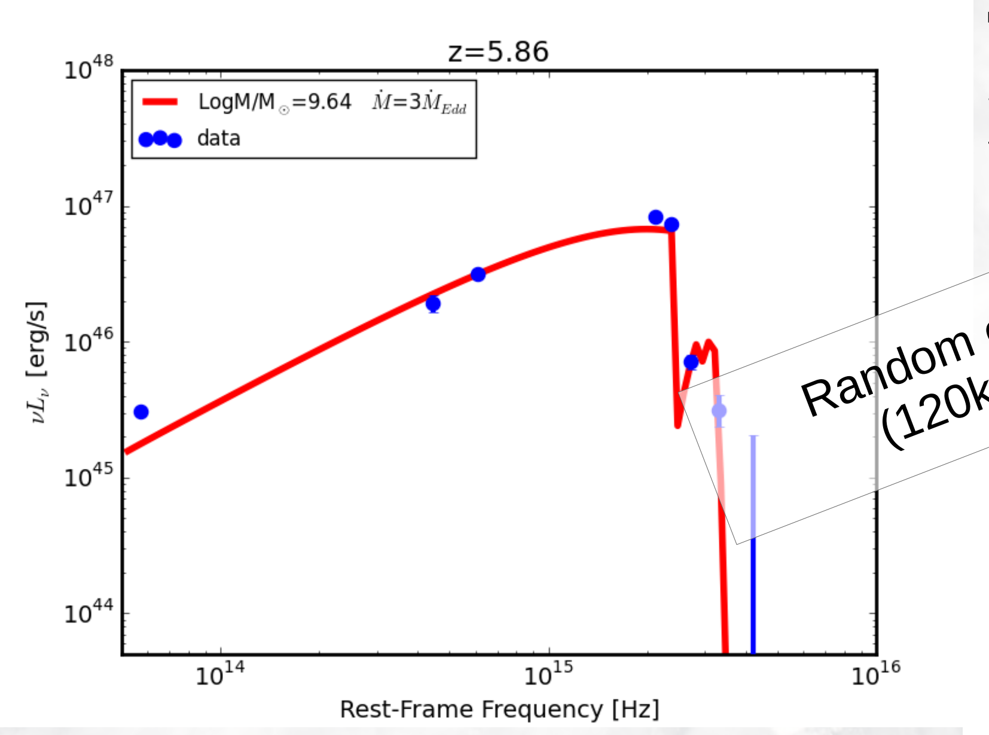
<u>SE duty cycle=0.044</u>, mostly at <u>low masses</u>… **hard to detect**!

Seeking SE accretors at high-z

(…in progress…)

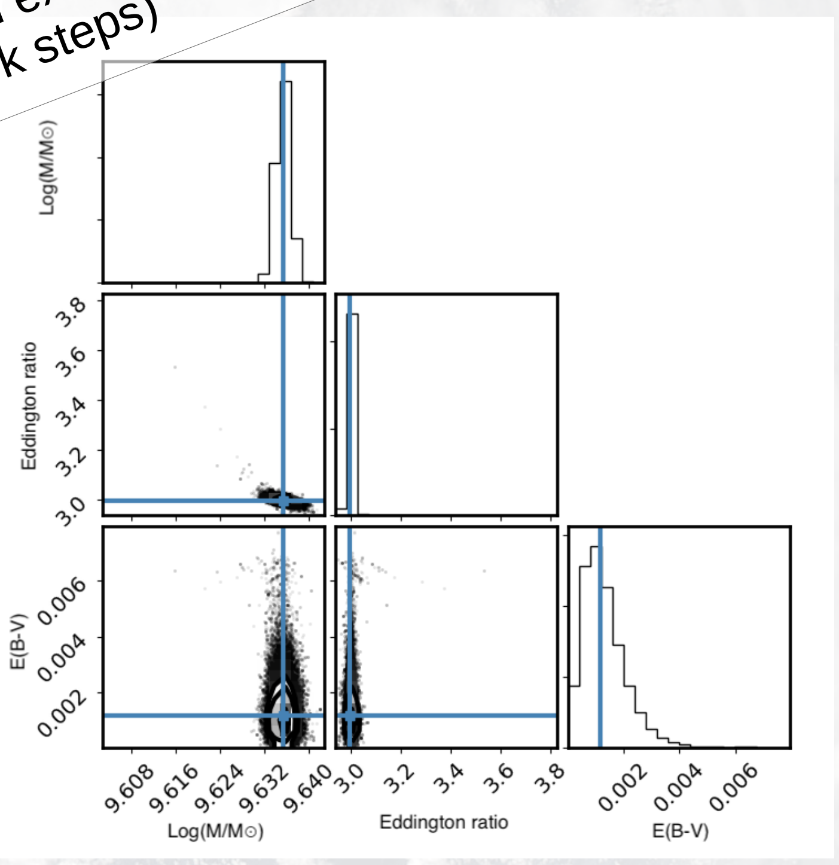
SED modelling of disc accretion inclusive of SE regime, i.e. no emission assumed within the photon trapping radius (as in Pezzulli +2017)

Intrinsic SED corrected for reddening, Gunn-Peterson, and convolved with IR-to-UV filters



To date, MCMC search over 3 parameters (M_{BH}, $\dot{M}$, E(B-V))

Random example!
(120k steps)



The analysis covers ~150 quasars at z>5.7 (various ground-based facilities + HST + Spitzer)

To be tested against M_{BH} from MgII spectroscopy (for ~30 QSO)

To be merged with QSFIT (Calderone et al. 2017), to include constraints from the available spectra

References:

Calderone G., Nicastro L., Ghisellini G., Dotti M., Sbarrato T., Shankar F., Colpi M., 2017, MNRAS, 472, 4051 • Dotti M., Volonteri M., Perego A., Colpi M., Ruskowsky M., Haardt F., 2010, MNRAS, 402, 682 • Dotti M., Colpi M., Pallini S., Perego A., Volonteri M., 2013, ApJ, 762, 68 • Lupi A., Haardt F., Dotti M., Fiacconi D., Mayer L., Madau P., 2016, MNRAS, 456, 2993 • Madau P., Haardt F., Dotti M., 2014, ApJ Letters, 784, 38 • Maio U., Dotti M., Petkova M., Perego A., Volonteri M., 2013, ApJ, 767, 37 • Mazzucchelli C. et al., 2017, ApJ, 849, 91 • Pezzulli E., Valiante R., Orofino M., Schneider R., Gallerani S., Sbarrato T., 2017, MNRAS, 466, 2121 • Sadowski A., 2009, ApJS, 183, 171 • Sesana A., Barausse E., Dotti M., Rossi E., 2014, ApJ, 794,104