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HIDDEN PARENTS OF HIGH-Z BLAZARS: QUENCHING AND DARK BUBBLES

these new results can be found in Ghisellini & Sbarrato 2016, in press on MNRAS

Malaga, 3 June 2016

LOOKING FOR BLAZARS AT HIGH Z

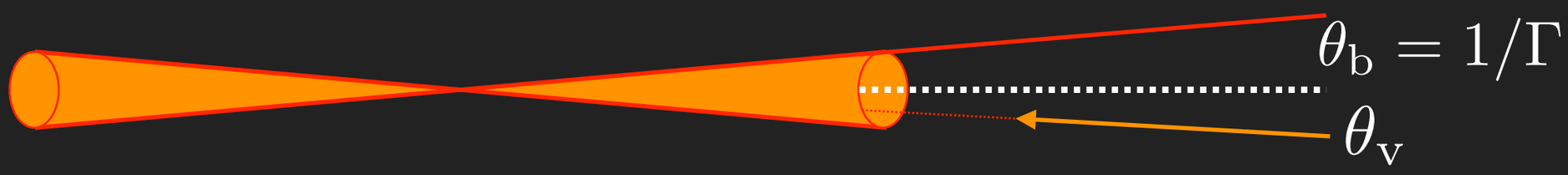
WHY BLAZARS?

finding extremely massive SMBHs
hosted in jetted AGN

$M > 10^9 M_\odot \qquad z > 4$

constraints on SMBH formation models

clues on jets role in SMBH formation



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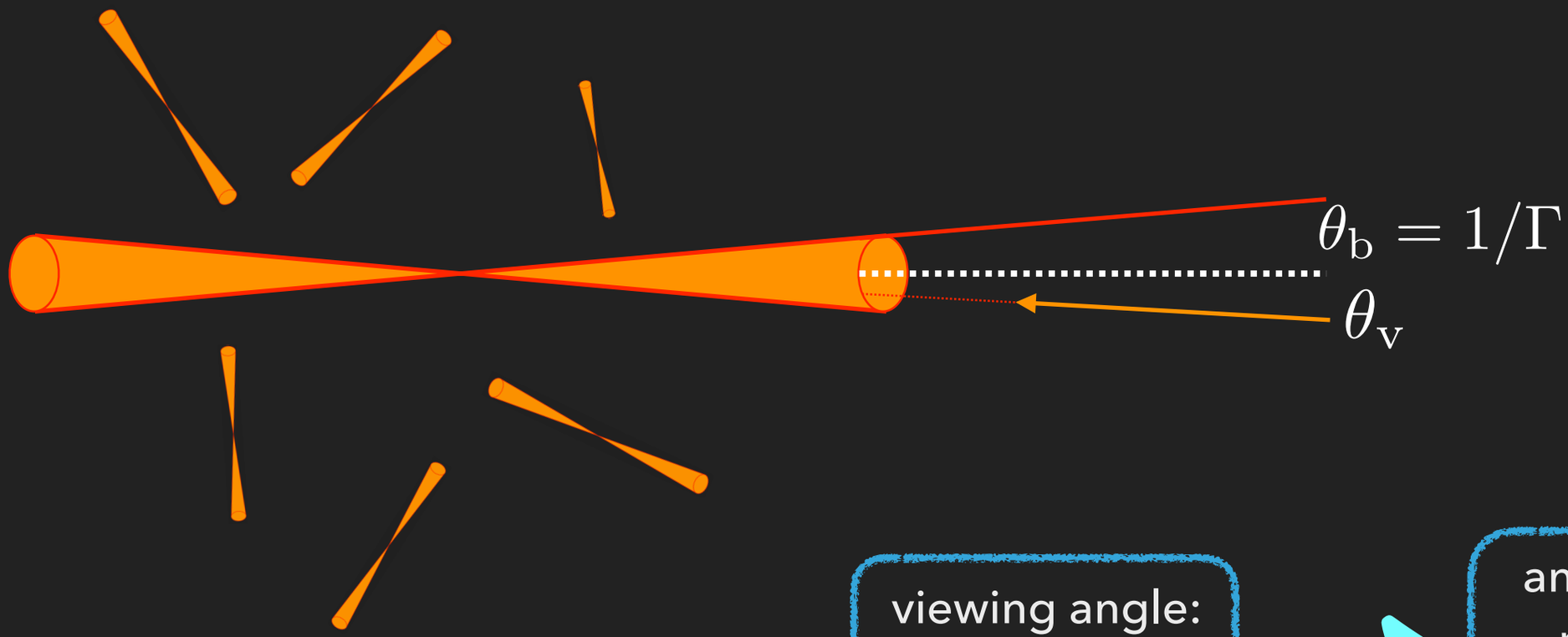


viewing angle:
$\theta_\mathrm{v} < 1/\Gamma$

→ analogous jetted AGN, randomly oriented:
$2\Gamma^2 \sim 340 - 450$

LOOKING FOR BLAZARS AT HIGH Z

SYSTEMATIC SEARCH

naked disc → blazars found in optical quasar catalogs

SDSS + FIRST quasar catalog 105783

- ☐ z > 4 1248
- ☐ radio–detected >1mJy 53
- ☐ R > 100 31

$R = F_{5\mathrm{GHz}} / F_B$

LOOKING FOR BLAZARS AT HIGH Z

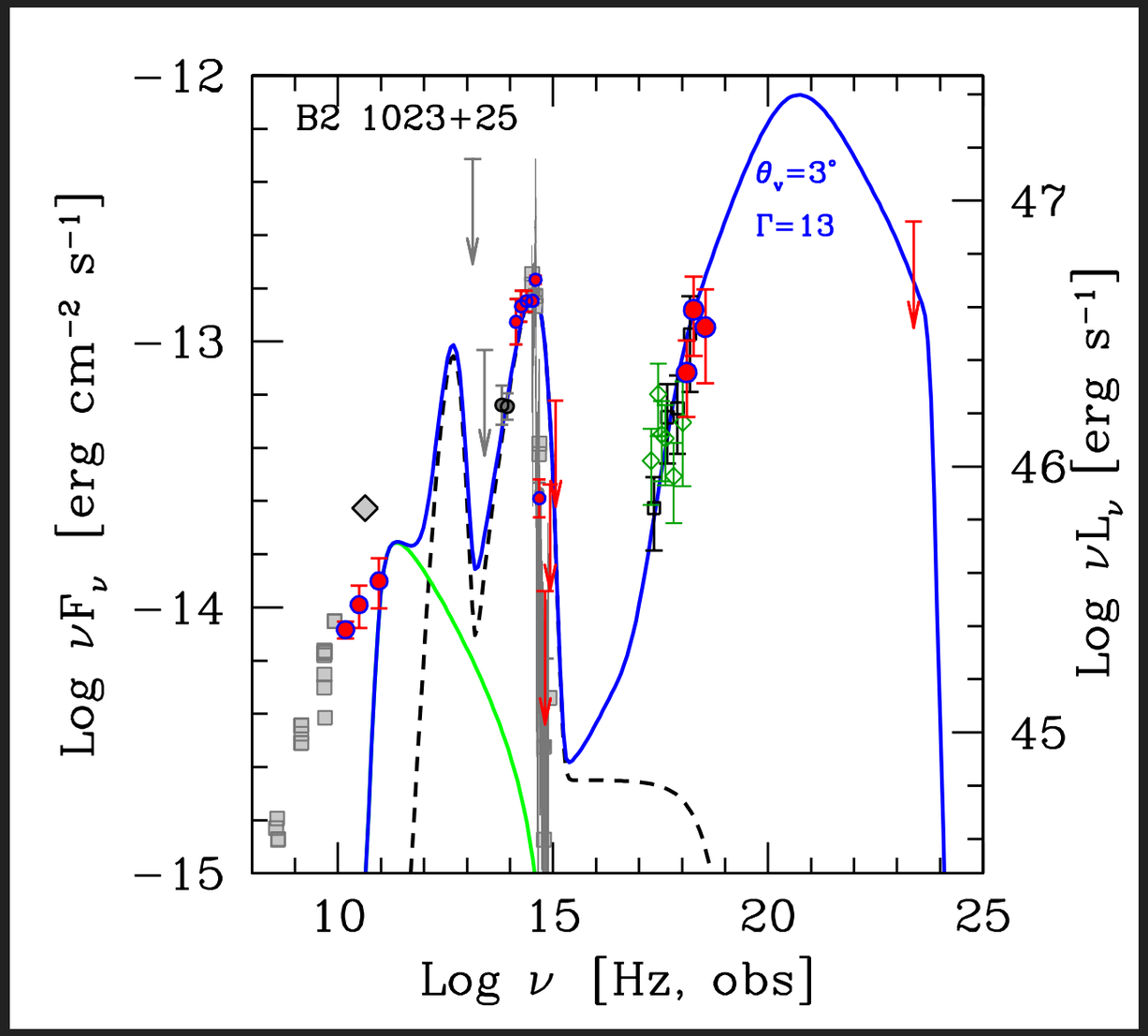
SUCCESSFUL CLASSIFICATIONS

B2 1023+25: seen under viewing angle smaller than beaming angle

$$\left.\begin{array}{l}\theta_{\rm v} = 3^\circ \\ \Gamma = 13\end{array}\right\} \theta_{\rm v} < 1/\Gamma \longrightarrow 2\Gamma^2 = 338$$

BUT: SDSS+FIRST covers ~1/4 of the sky

by classifying B2 1023+25 we can infer the presence of at least **~1540 analogous jetted quasars, randomly oriented**



Sbarrato et al. 2012; 2013b

WHAT CAN WE LEARN?

HOW MANY SMBHS DO THEY TRACE?

SDSS+FIRST @ z>4: 8 blazars

expected parents in SDSS+FIRST: **~2700 jetted quasars**

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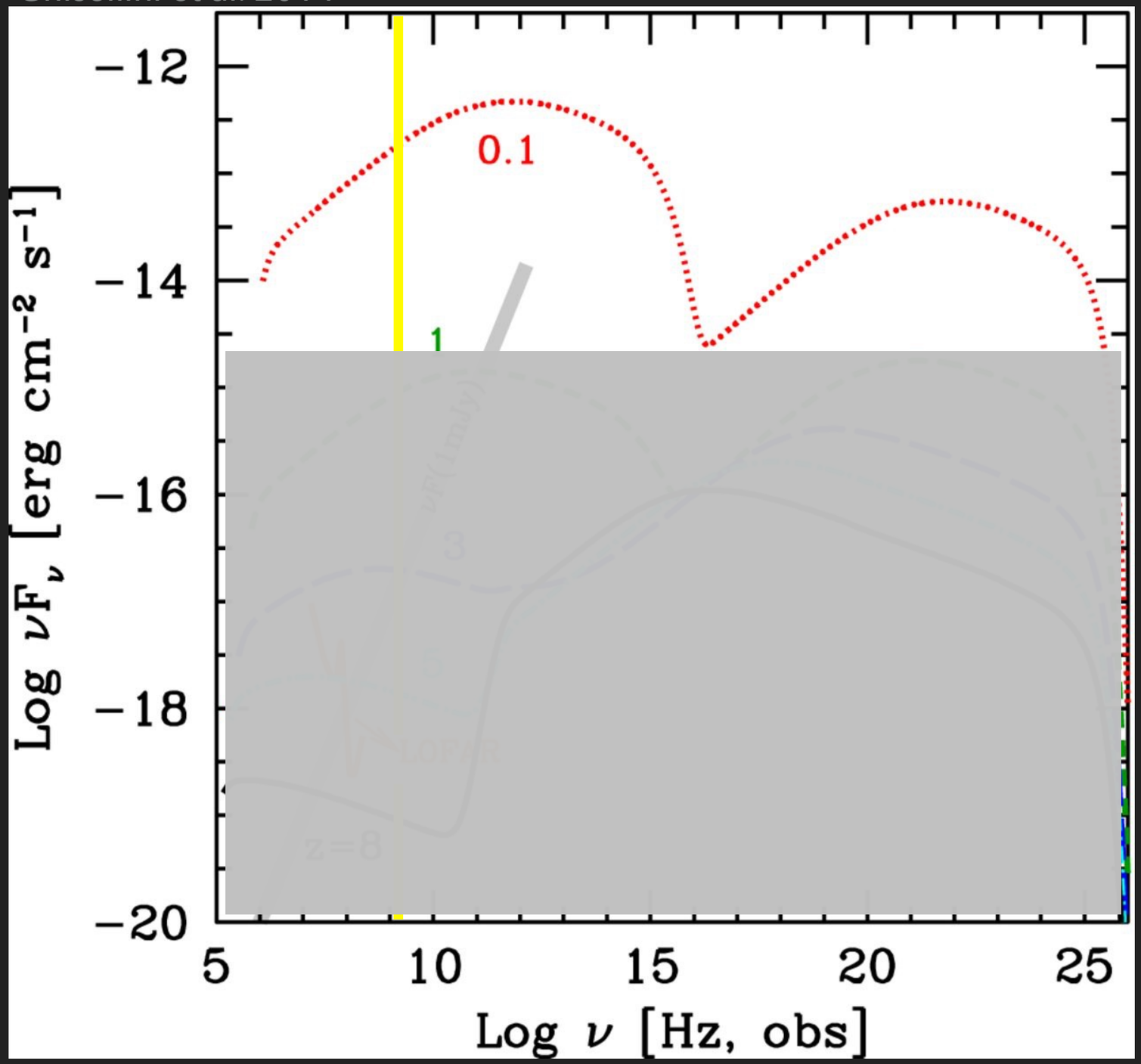
WHY DON'T WE SEE THE PARENT POPULATION?

WHAT CAN WE LEARN?

CMB QUENCHING

Ghisellini et al. 2014



$$U_{\rm CMB} \propto (1+z)^4$$

CMB energy density at z~3 becomes competitive with magnetic energy density of quasar lobes

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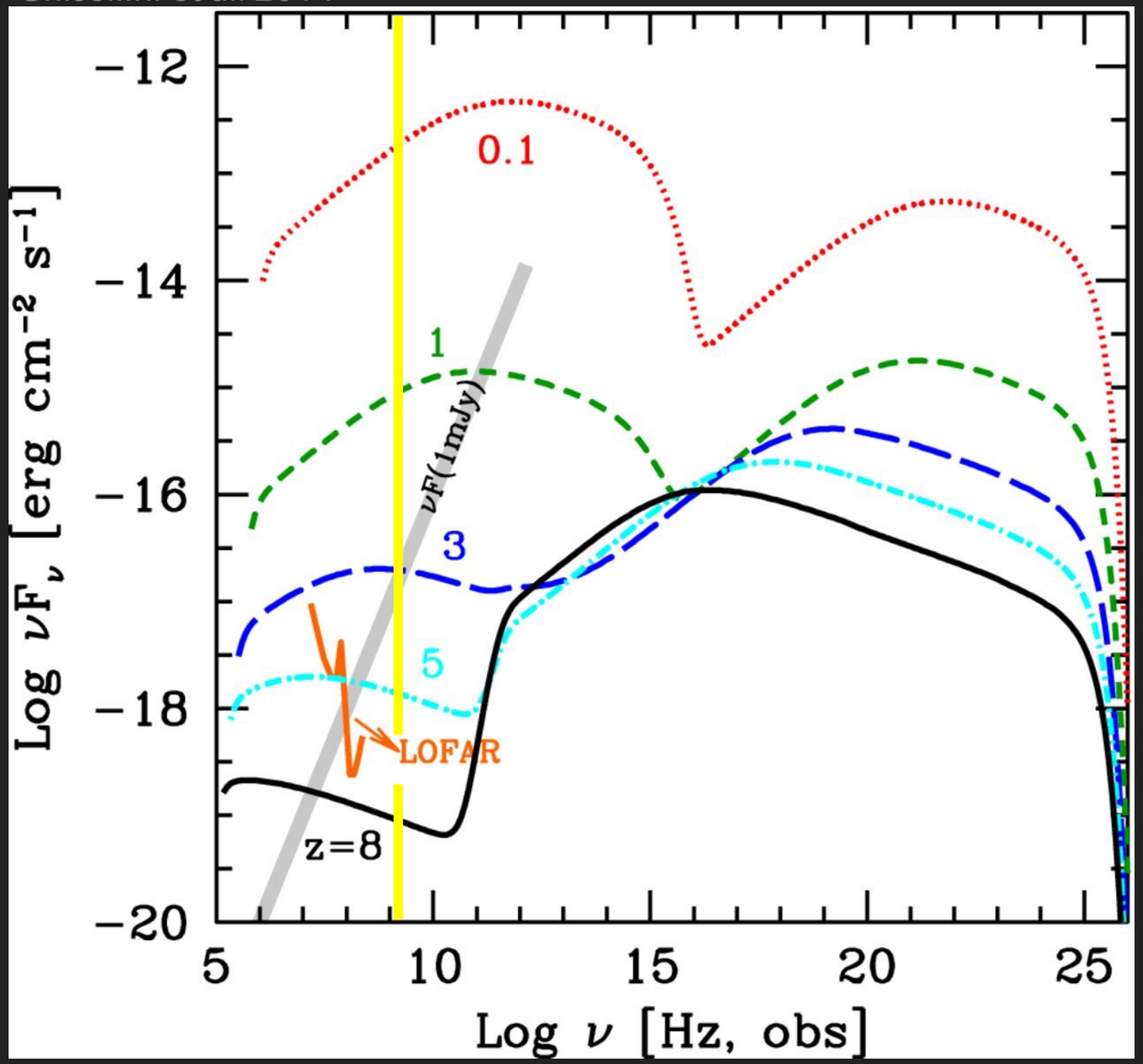

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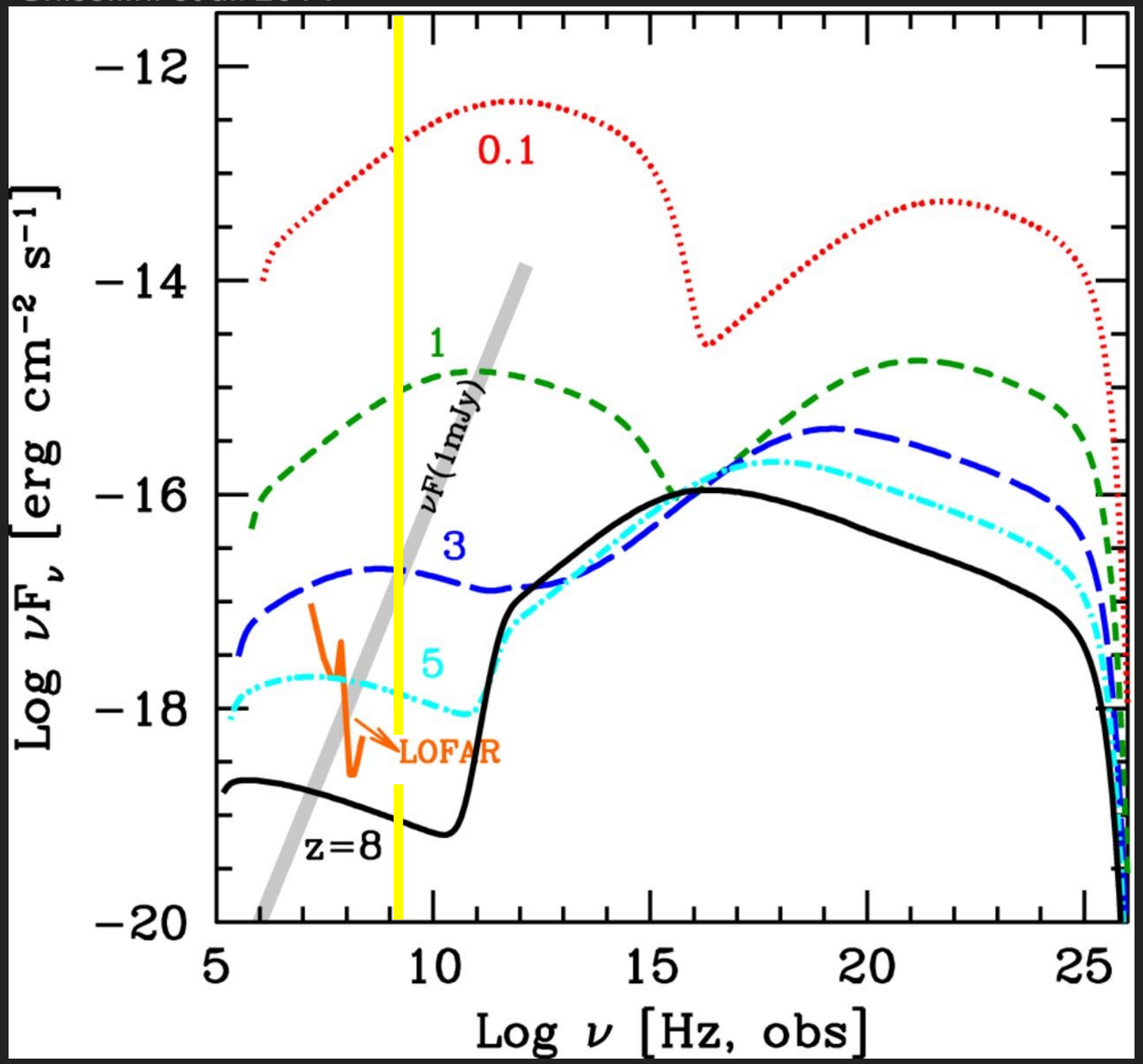

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RADIO EMISSION IS QUENCHED!

blazars:
best tracer for
jetted quasars!

WHAT CAN WE LEARN?

SLIGHTLY MISALIGNED JETS

"inner" jet is not quenched by CMB

for each blazar observed, we should see

$$2\left[\frac{F_{\rm blazar}}{F_{\rm lim}}\right]^{1/p} - 1$$

analogous objects slightly misaligned, until their radio flux reaches the survey limit

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it's independent of Γ !!!

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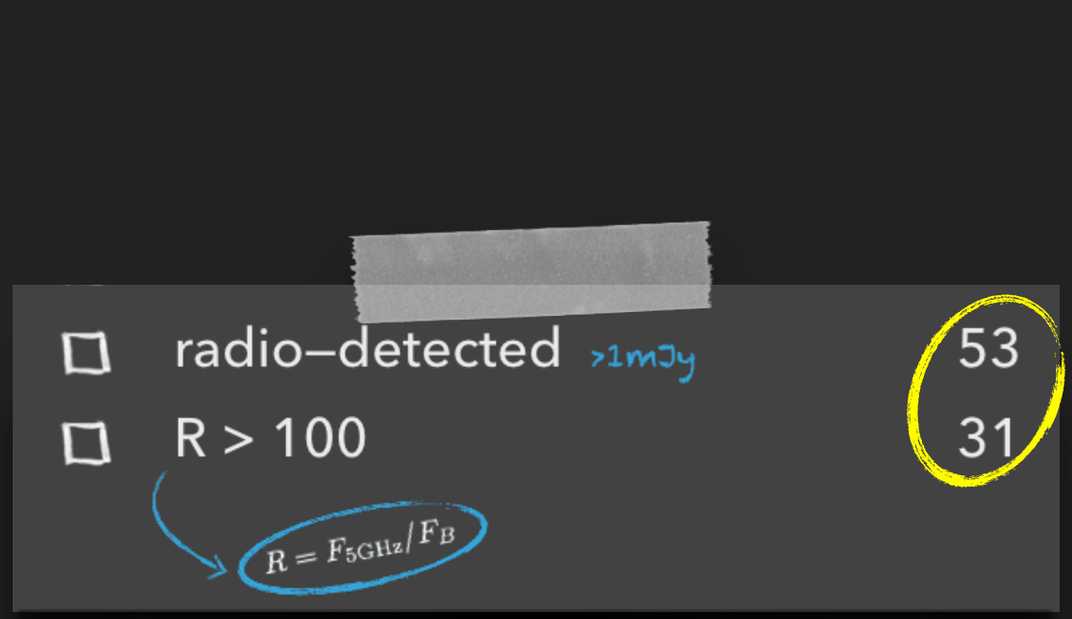
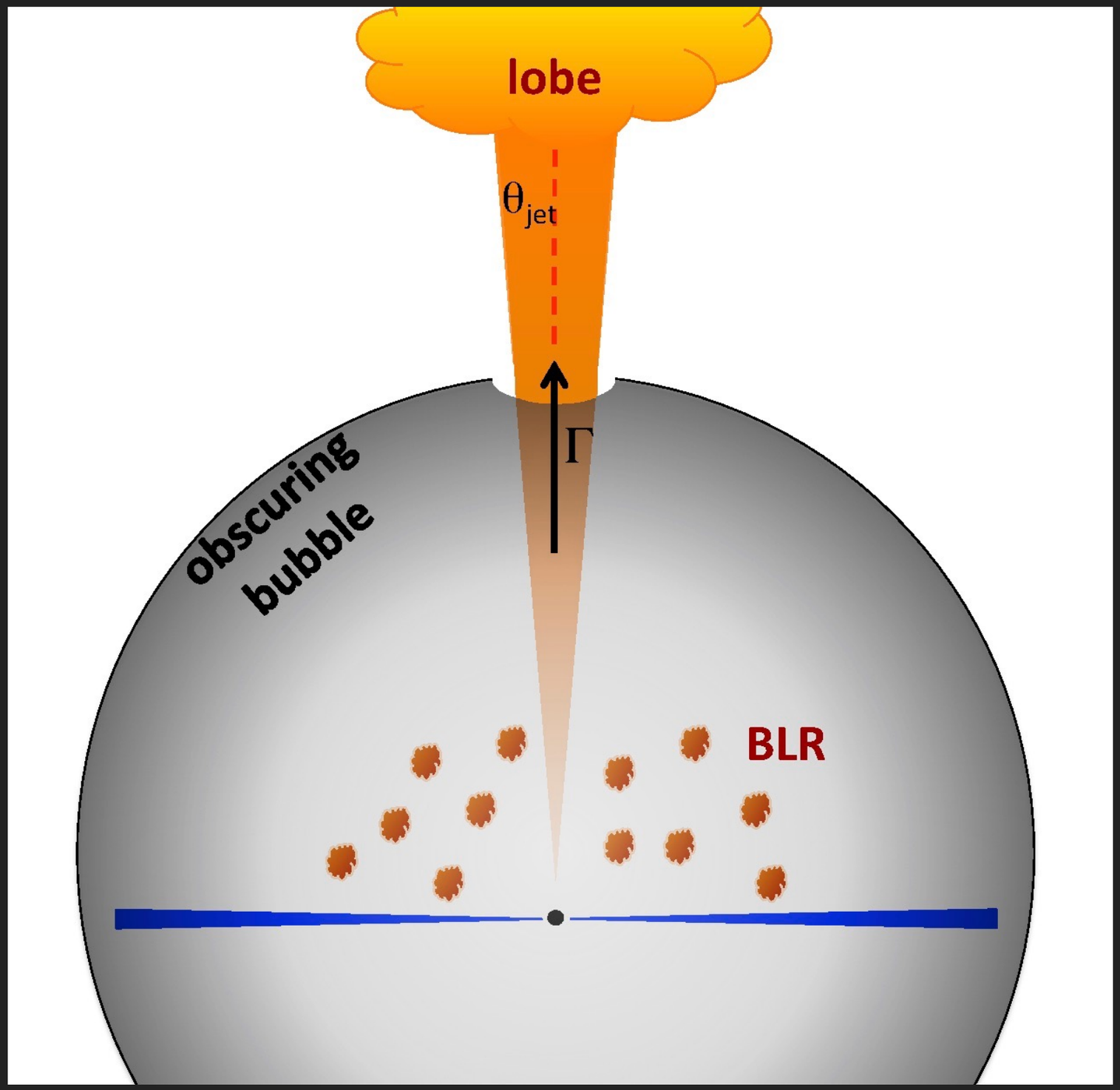


CMB QUENCHING IS NOT ENOUGH!

WHAT CAN WE LEARN?

DARK BUBBLES



Ghisellini & TS, 2016

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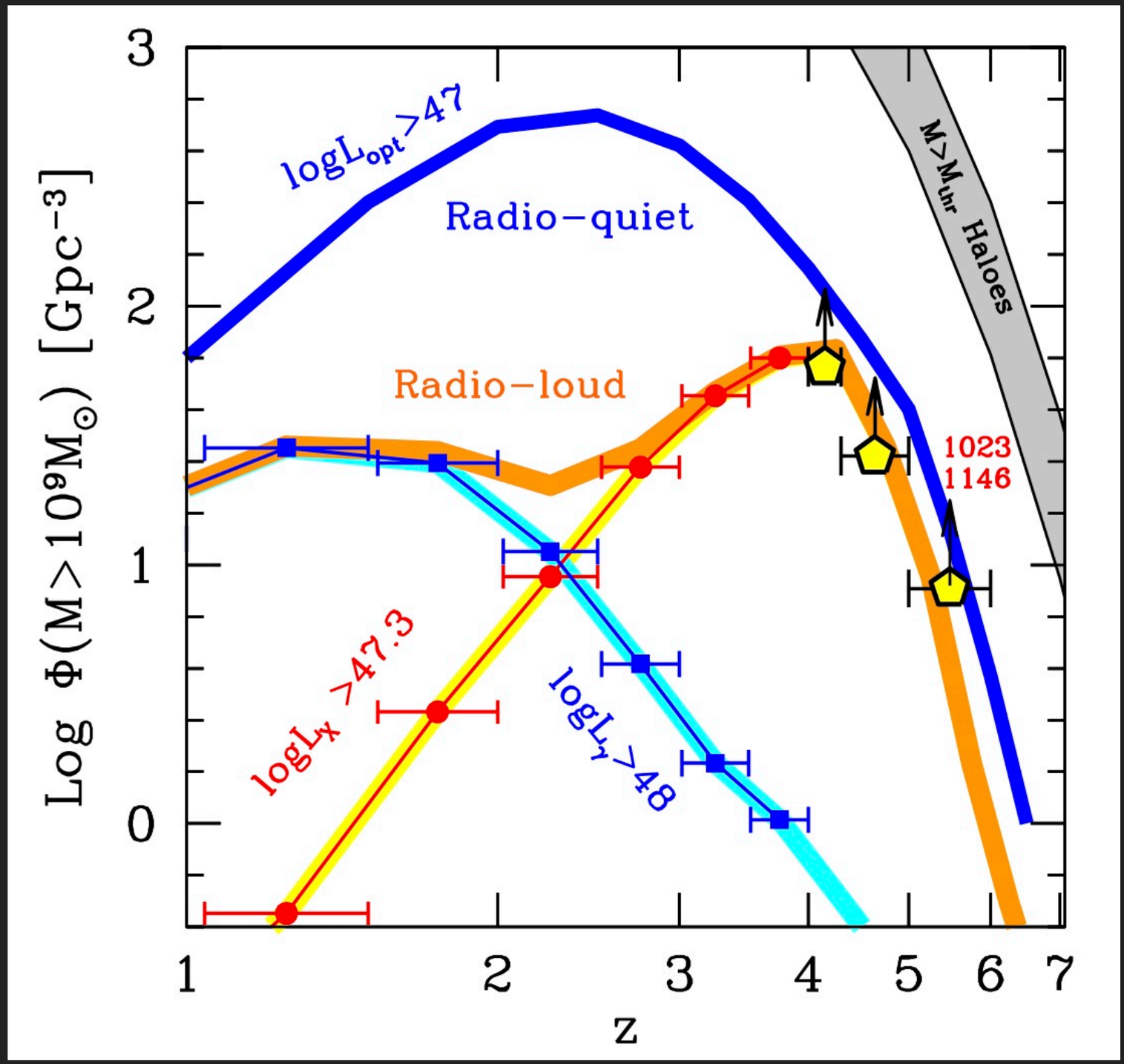


updated from
Sbarrato et al. 2015

WHAT CAN WE LEARN?

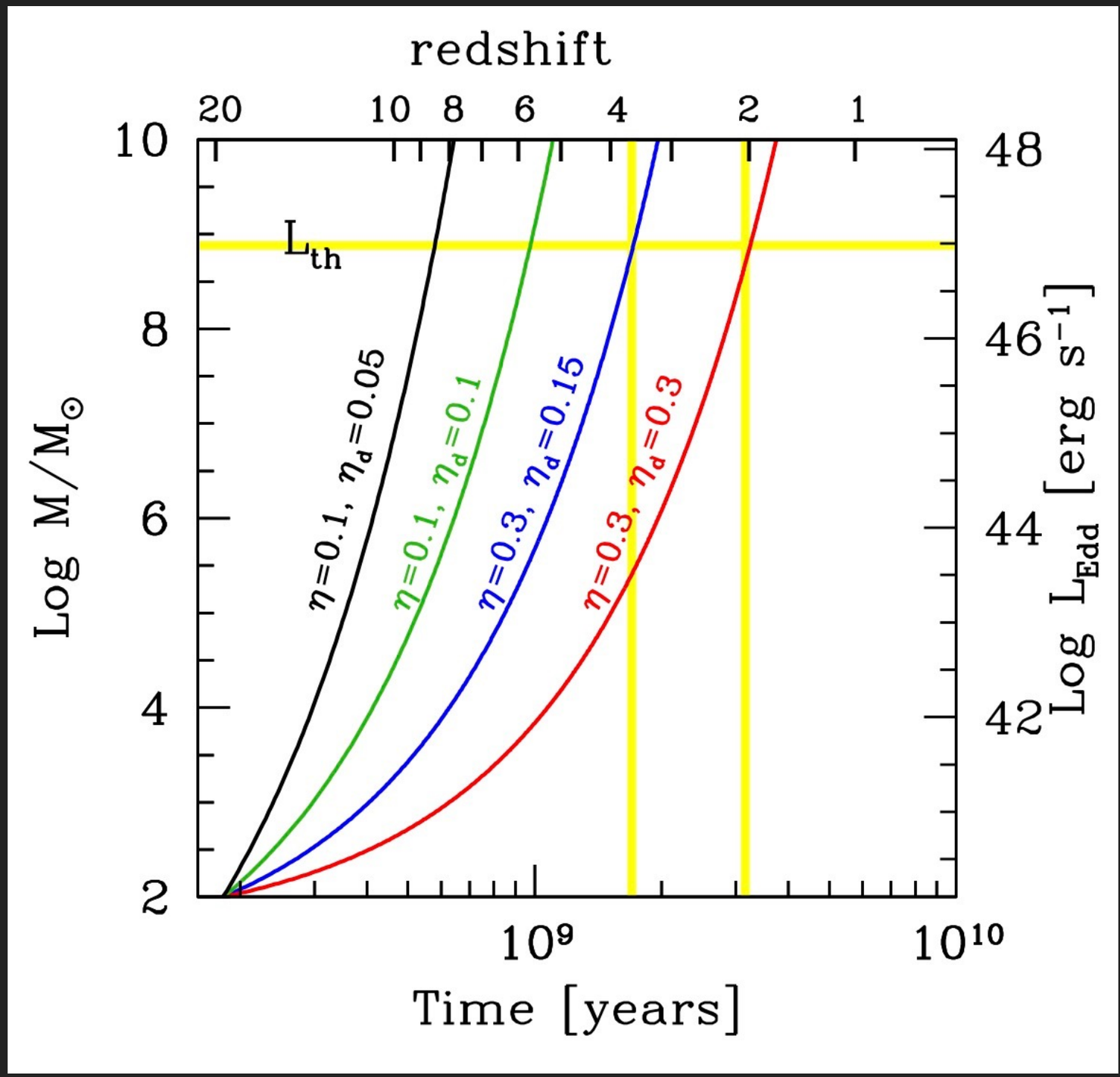
HIGH MASSES AT HIGH REDSHIFT!

standard accretion
at Eddington rate

$$L_{\rm d} = \eta_{\rm d} \dot{M} c^2$$

… but what about the jet?

$$\eta = \eta_{\rm d} + \eta_{\rm B}$$



Ghisellini & TS, 2016

CONCLUSIONS

- **blazars** are efficient tracers of jetted AGN hosting **extremely massive BHs at high redshift**
- **two different formation epochs** for highly massive BHs: **jetted systems** preferentially form at **z ~ 4**
  non-jetted systems at *z ~ 2-2.5*
- it's **hard to form** such massive BHs in the early Universe
  ↳ the presence of a **jet speeds up** the process
- huge **lack** of misaligned AGN:
  CMB quenching?
  Dark bubbles? *Ghisellini & Sbarrato 2016*