How to assemble extremely massive black holes in a very short quasar life-time

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High-z quasars

tracers of the first supermassive black holes

non-jetted

~200 quasars

with $M_{BH} > 10^9 M_\odot$

CLOSE TO EDDINGTON LIMIT?

at z>5.7

(Banados+2016)

jetted

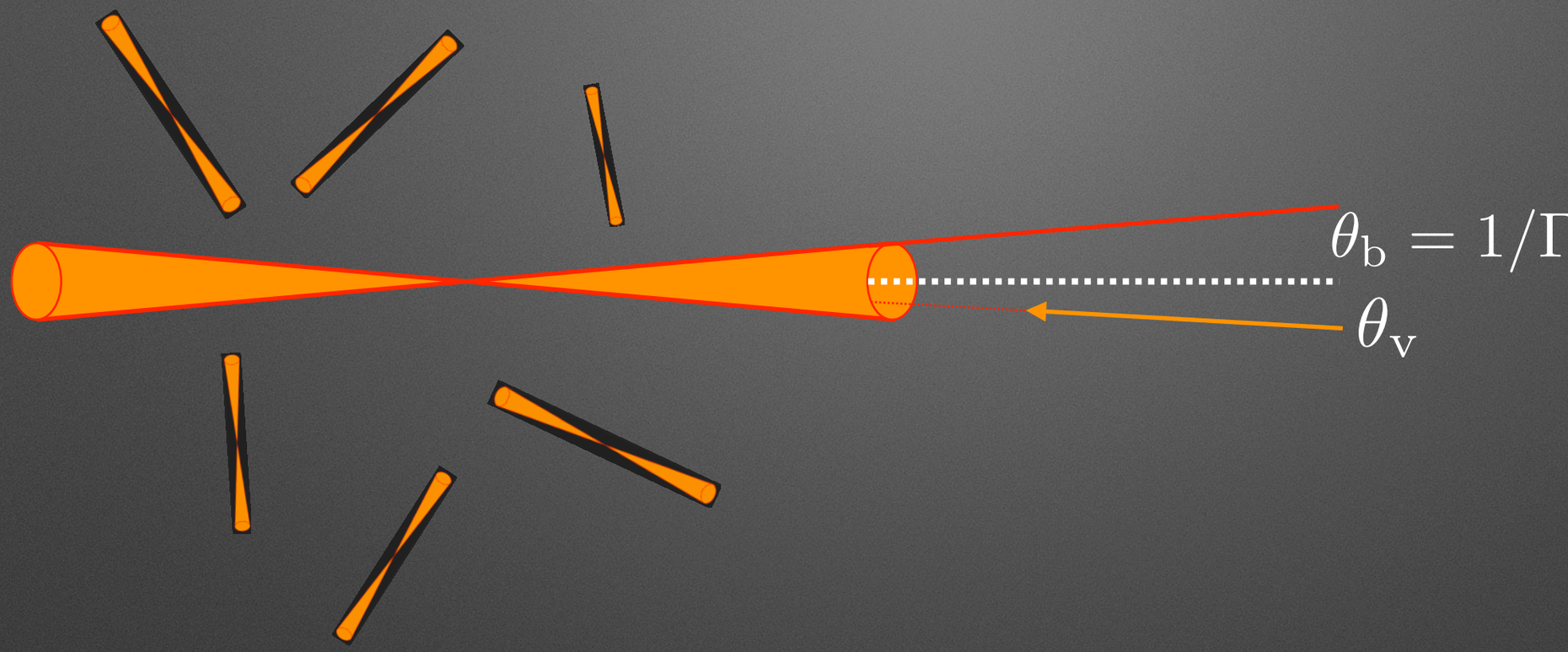
rare sources —> z>4

jet physics in early Universe?

do jets affect accretion of first SMBH?

LET'S TRY WITH BLAZARS!

Why blazars?



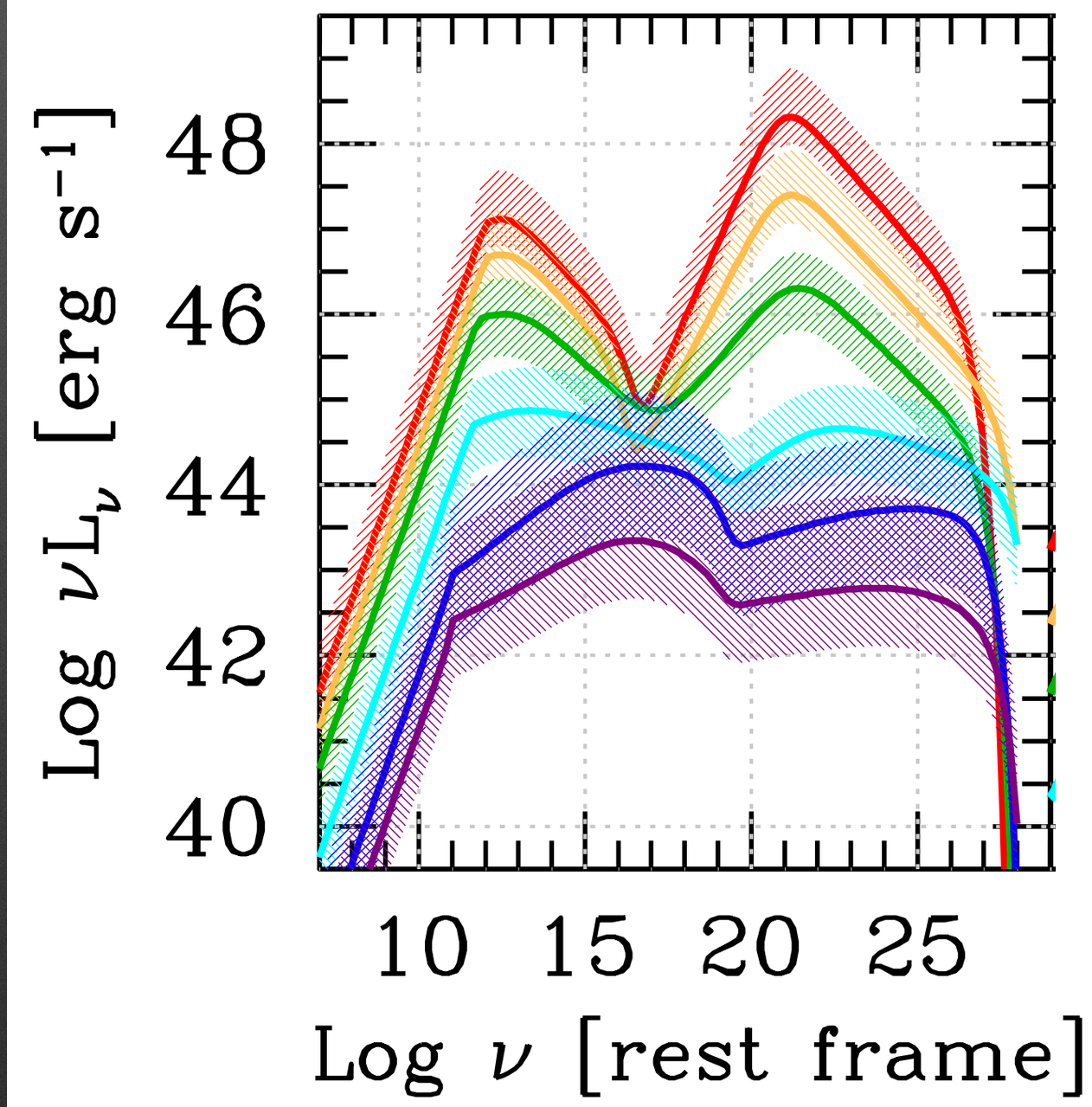
viewing angle:
$\theta_{\rm v} < 1/\Gamma$

→

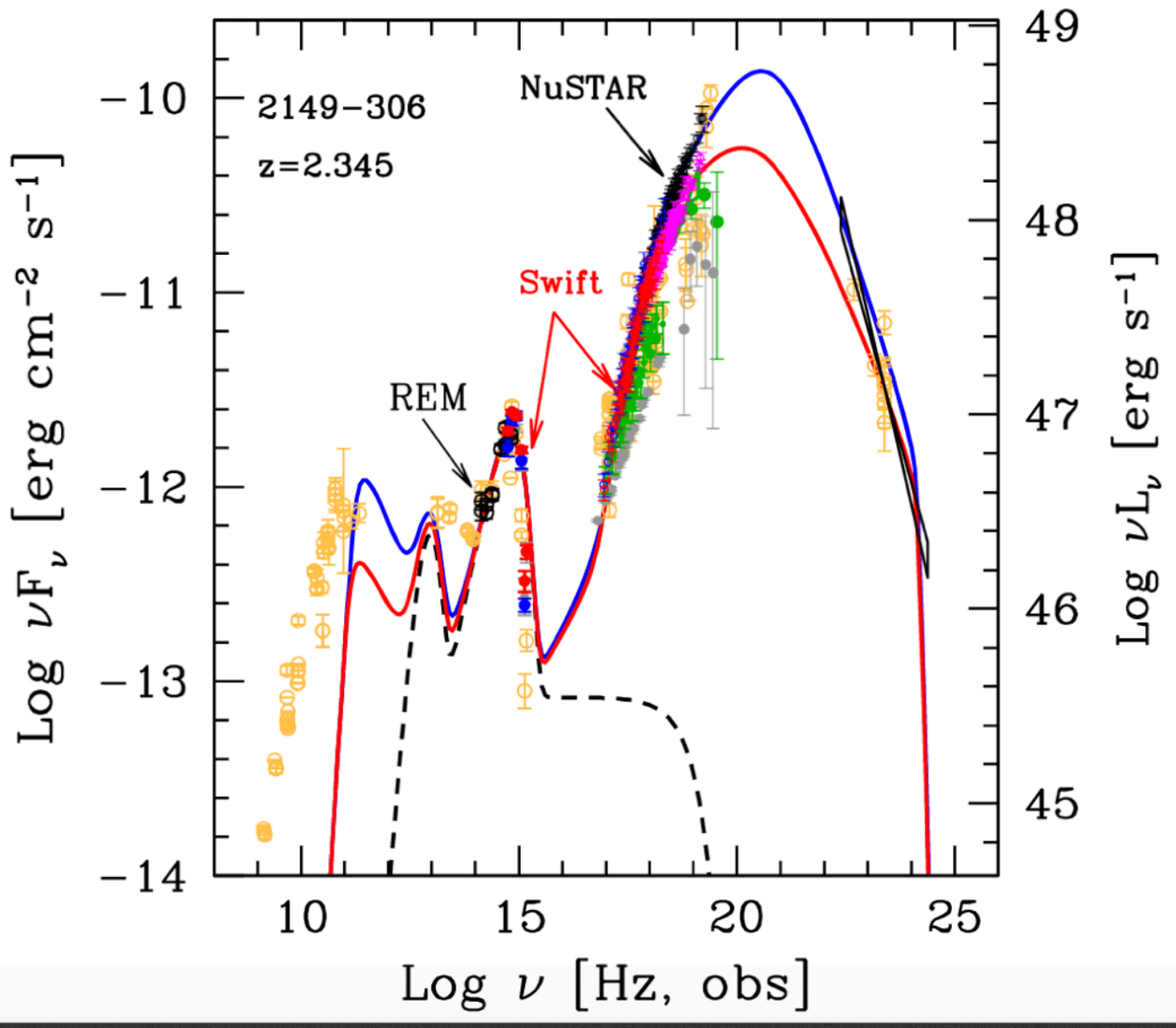
analogous jetted AGN, randomly oriented:
$2\Gamma^2 \sim 340 - 450$

Why blazars?

Ghisellini et al. 2017



Tagliaferri et al. 2015



Why blazars?

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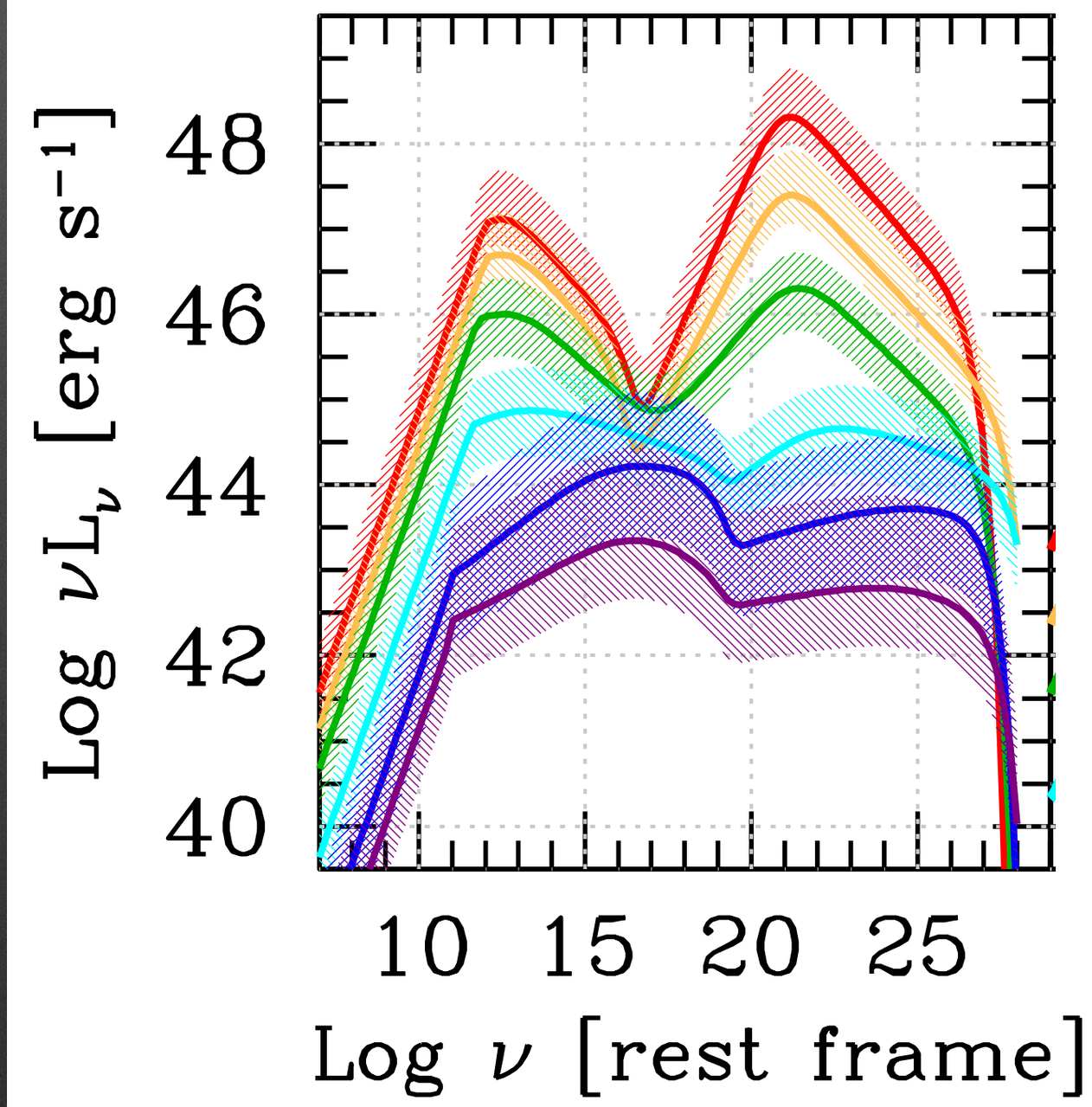

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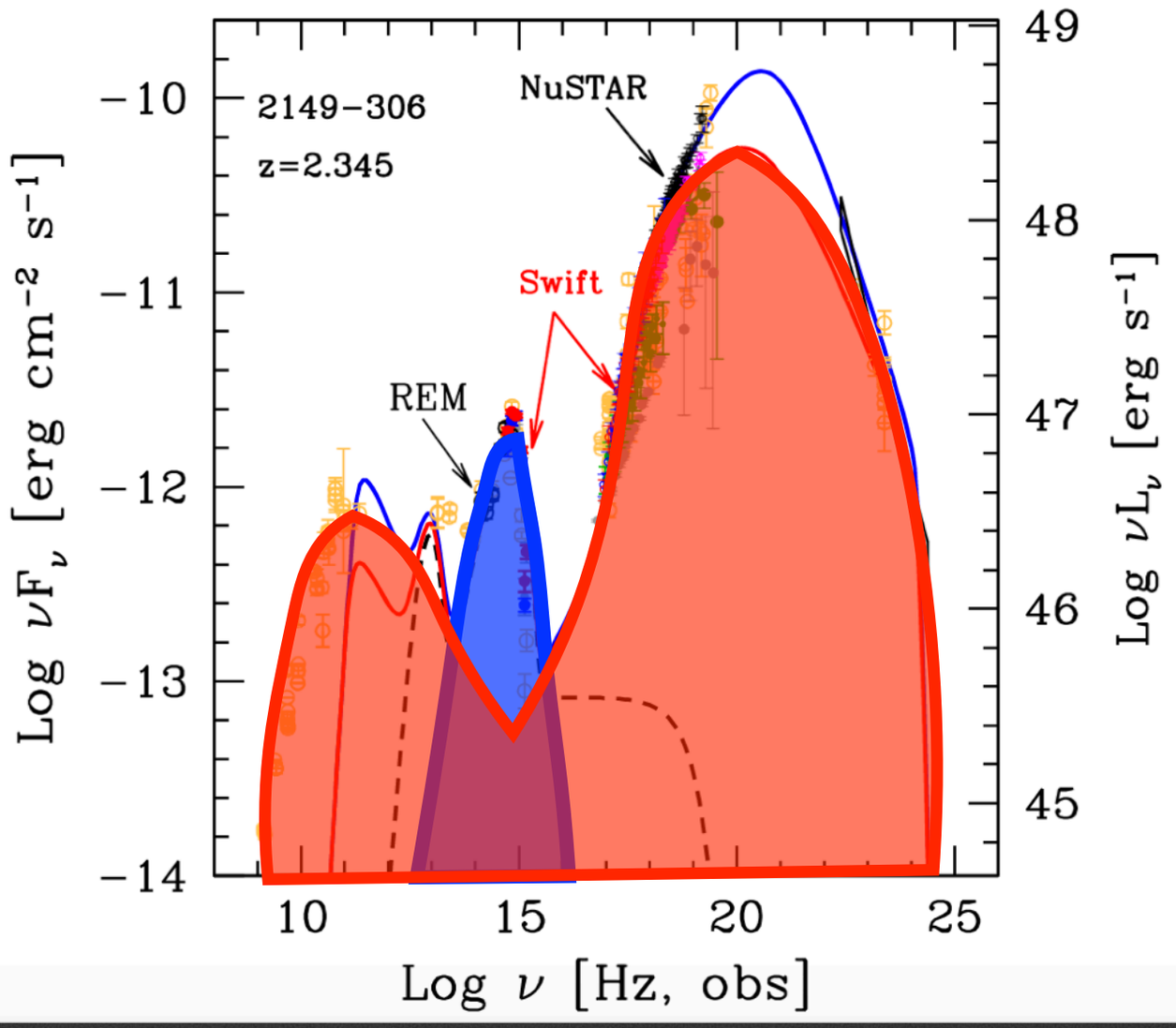


Looking for blazar candidates

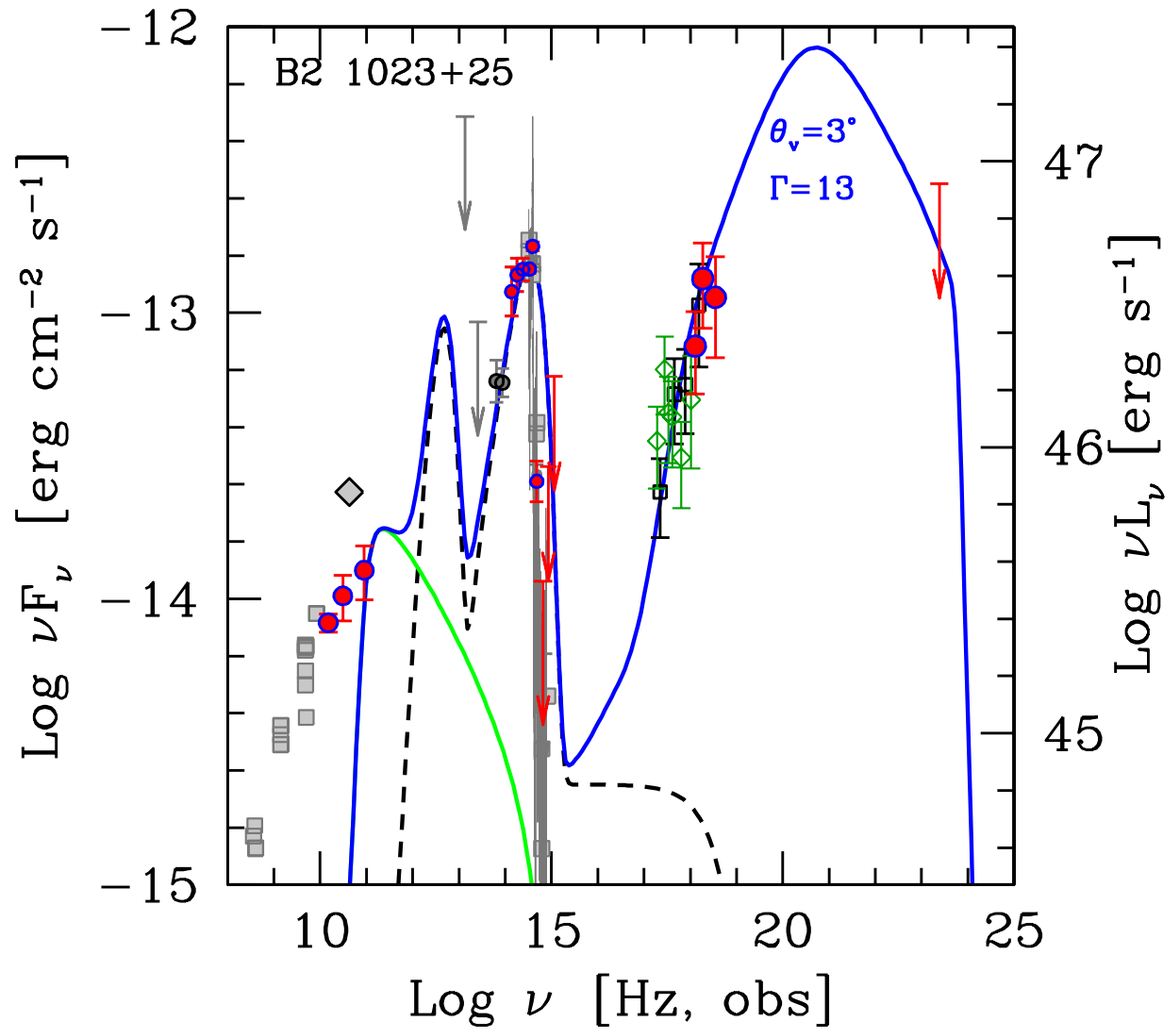
blazars can be found in optical quasar catalogs:

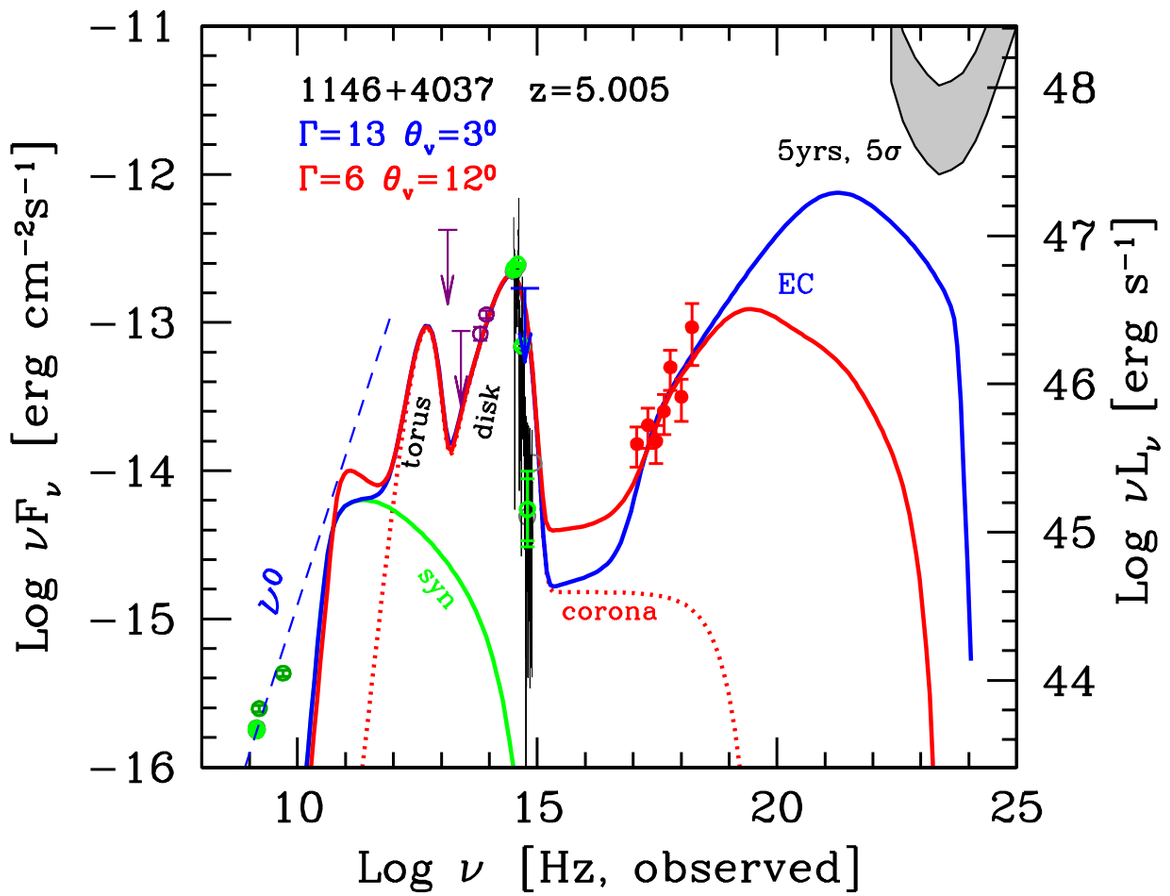
SDSS + FIRST quasar catalog	105783
▶ z > 4	1248
▶ radio–detected >1mJy	53
▶ R > 100	31

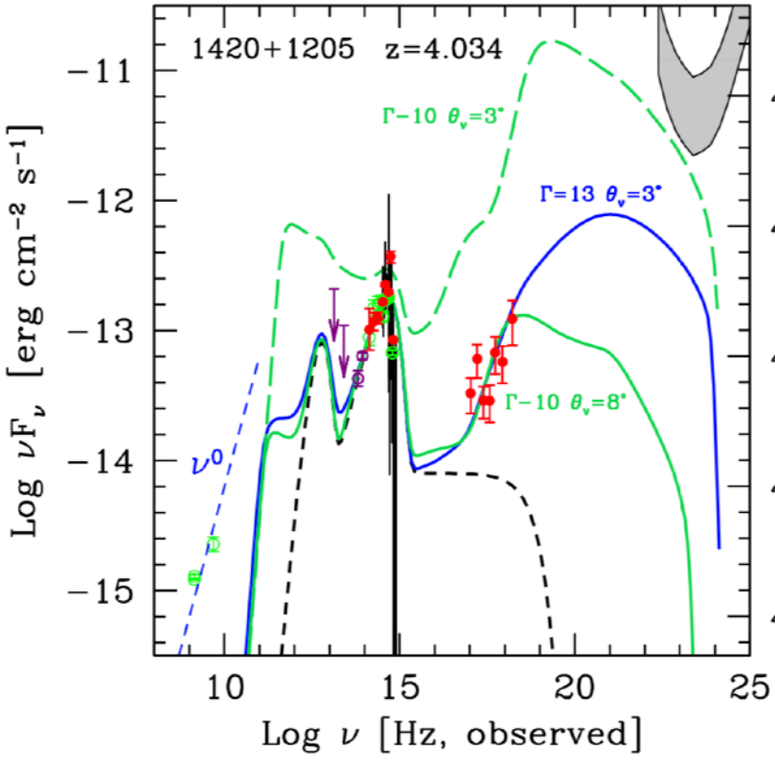
$$R = F_{5\mathrm{GHz}} / F_{\mathrm{B}}$$

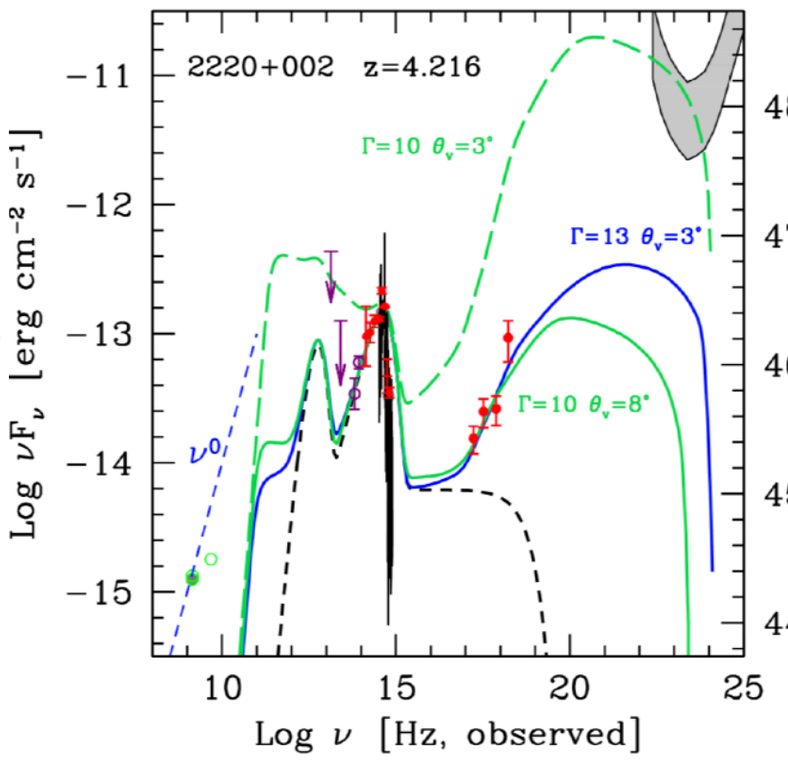
SEE TALK BY SILVIA BELLADITTA ON HOW TO FIND YOUR OWN BLAZAR CANDIDATE

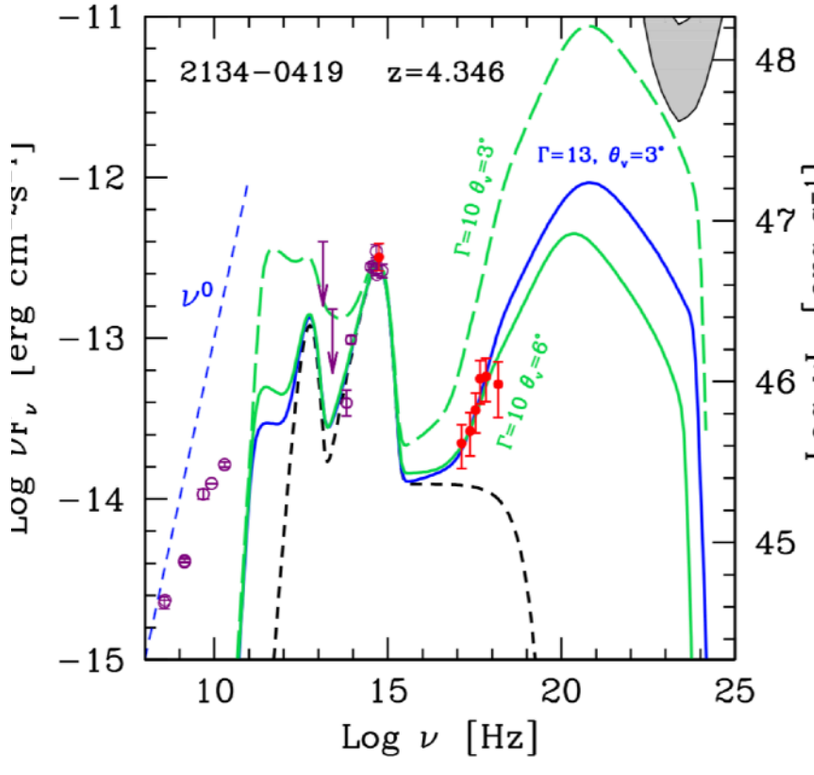
Sbarrato et al. 2012, 2013b, 2014; Ghisellini et al. 2014

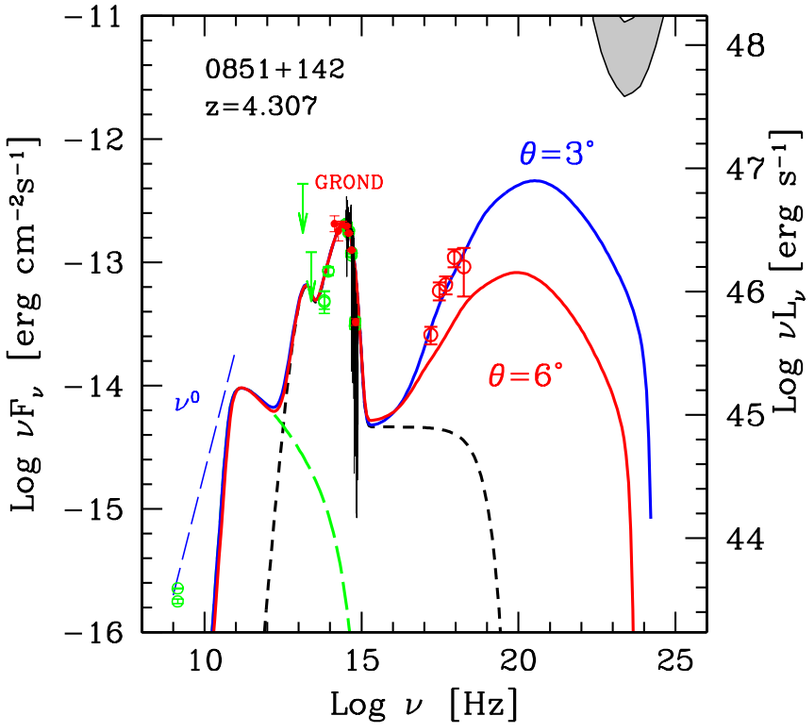


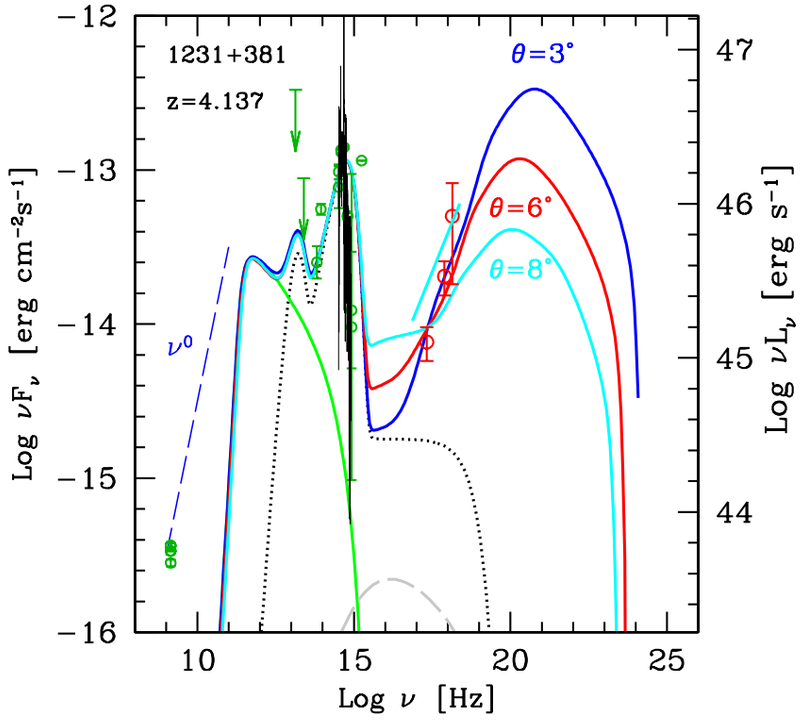


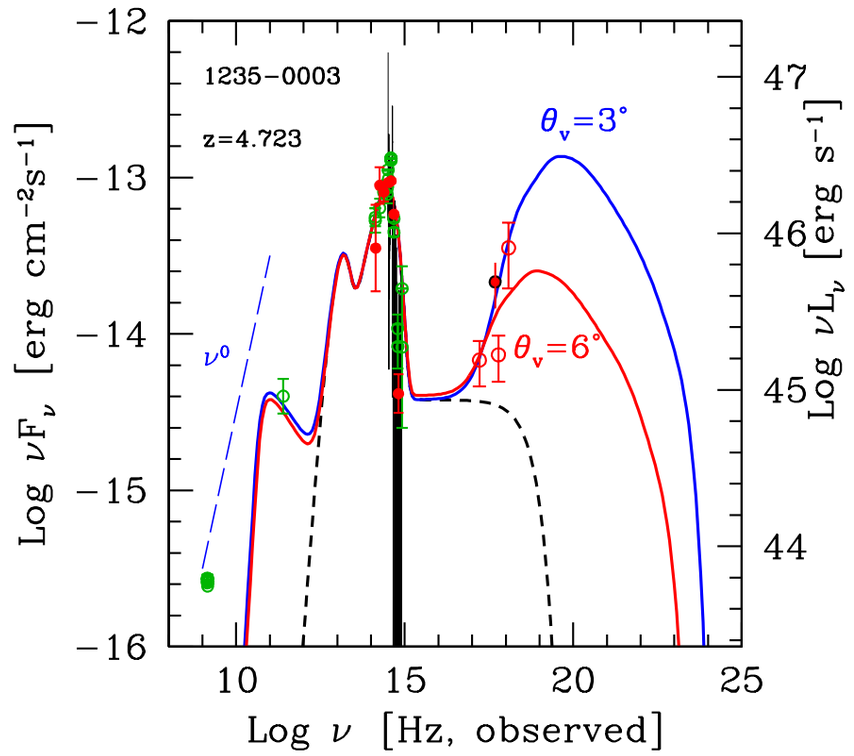


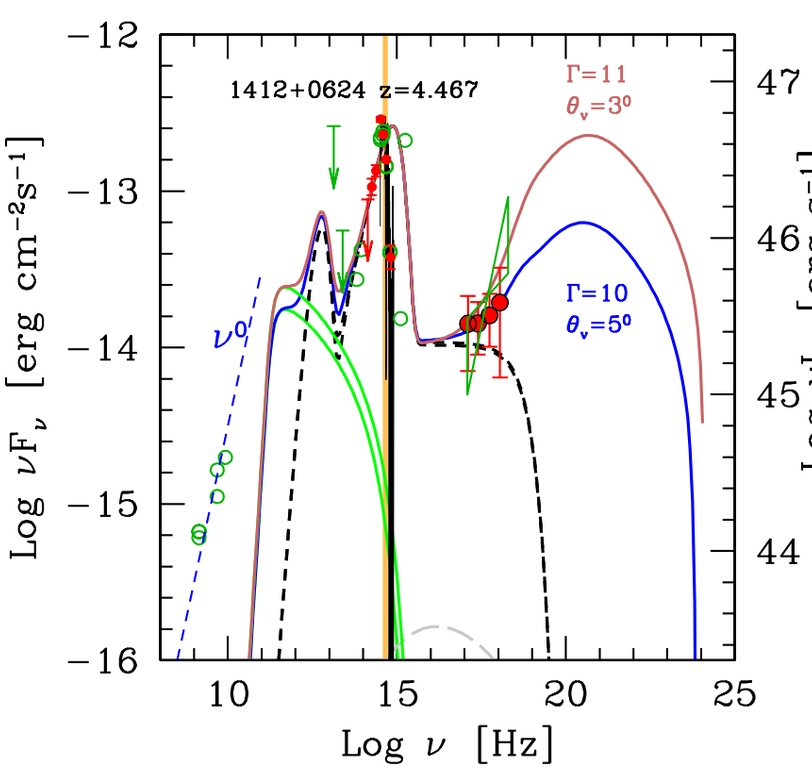


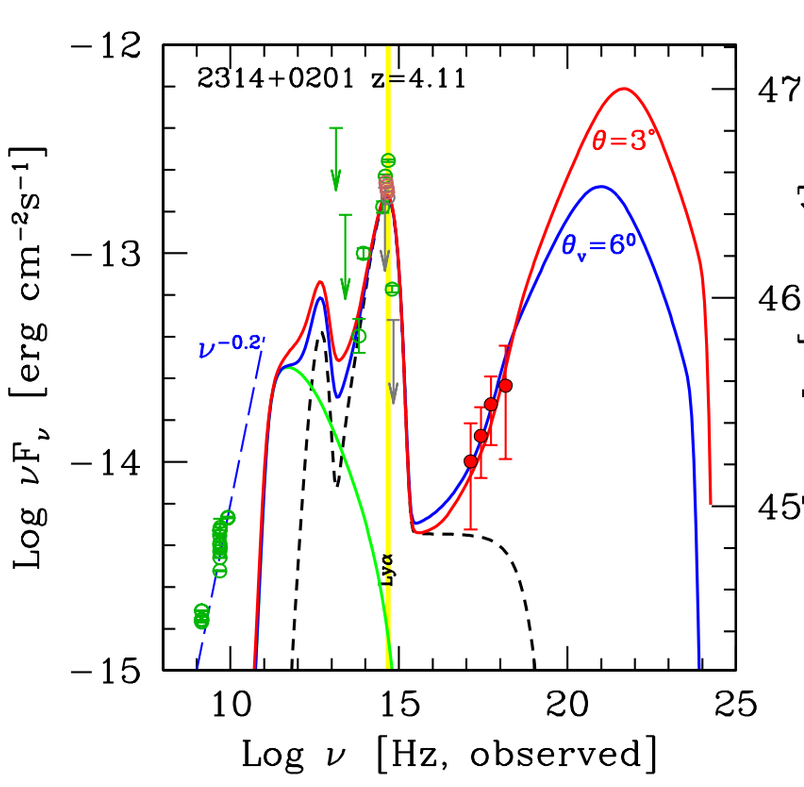


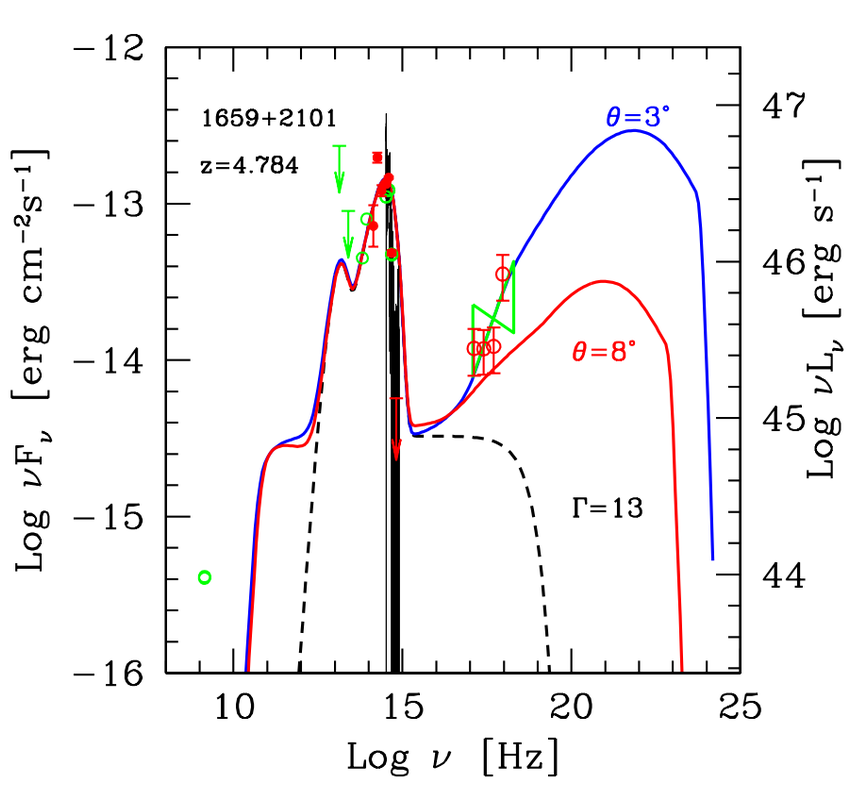

0851+142
z=4.307
GROND
θ=3°
θ=6°
ν⁰
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]

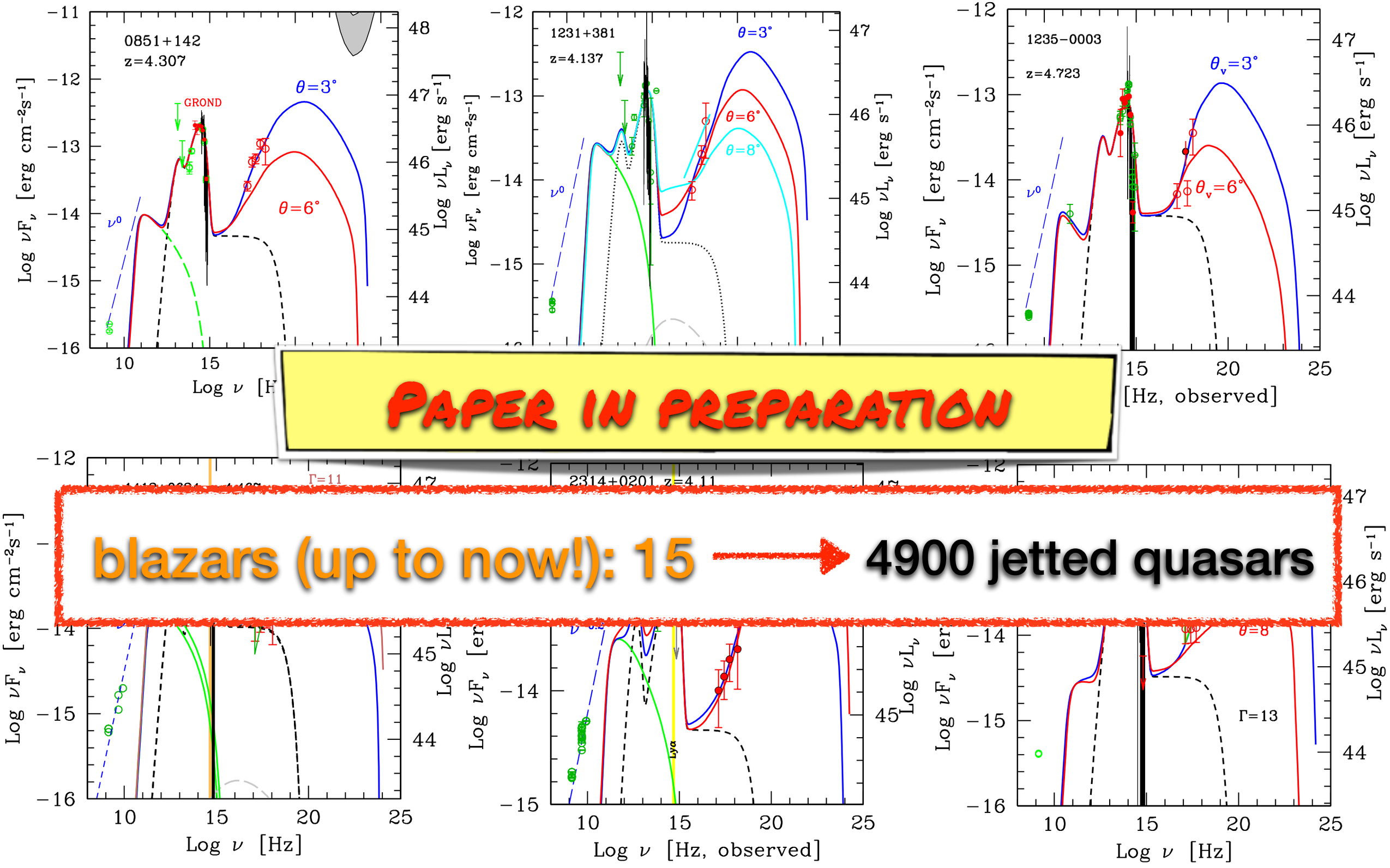

1231+381
z=4.137
θ=3°
θ=6°
θ=8°
ν⁰
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]


1235−0003
z=4.723
θ_v=3°
θ_v=6°
ν⁰
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz, observed]

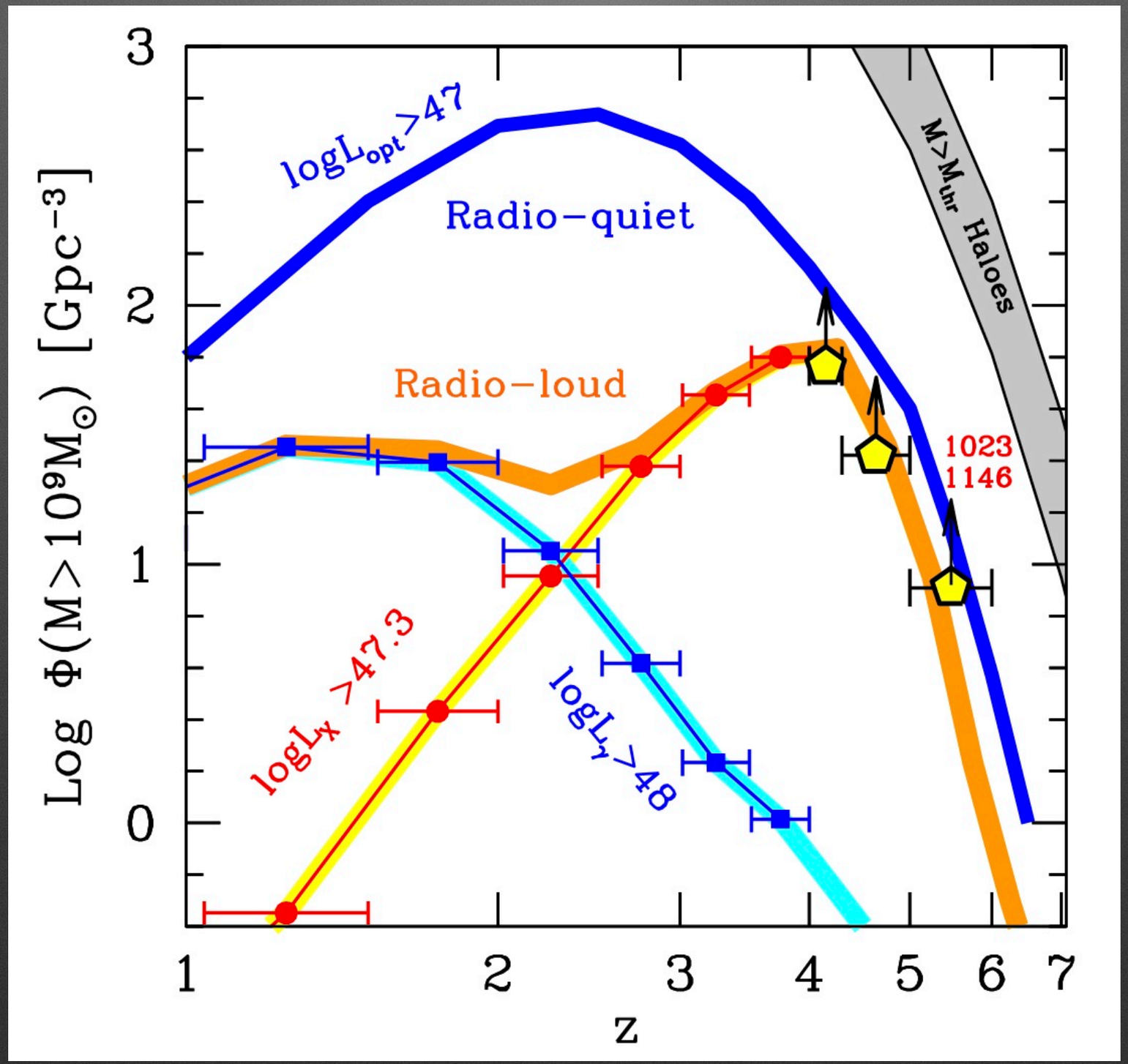

1412+0624 z=4.467
Γ=11
θ_v=3⁰
Γ=10
θ_v=5⁰
ν⁰
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]


2314+0201 z=4.11
θ=3°
θ_v=6⁰
ν^-0.2
Lyα
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz, observed]

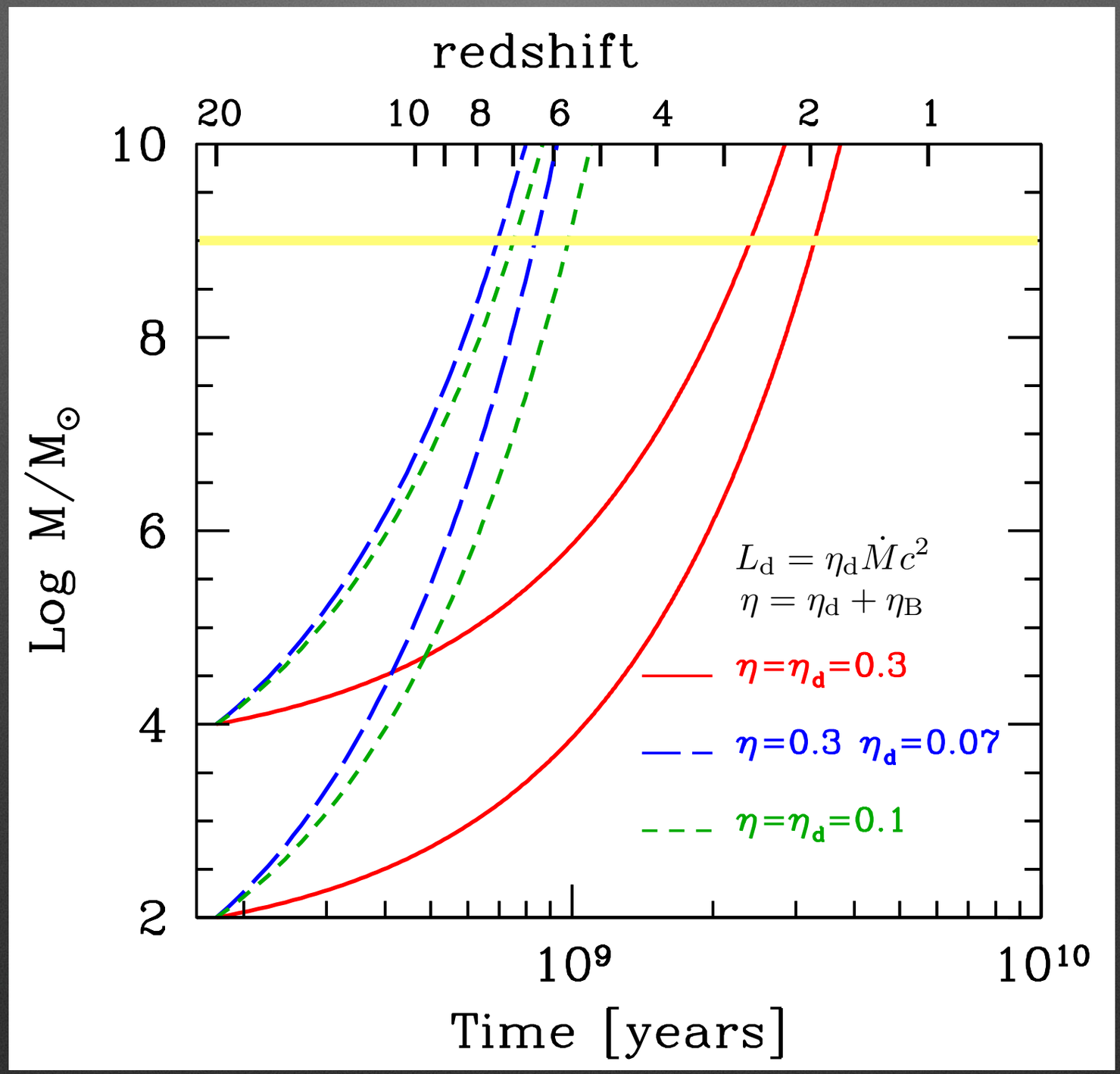

1659+2101
z=4.784
θ=3°
θ=8°
Γ=13
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]


0851+142
z=4.307
GROND
θ=3°
θ=6°
ν⁰
1231+381
z=4.137
θ=3°
θ=6°
θ=8°
1235−0003
z=4.723
θ_v=3°
θ_v=6°
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz, observed]
PAPER IN PREPARATION
blazars (up to now!): 15
4900 jetted quasars
Γ=11
2314+0201 z=4.11
Lyα
Γ=13
Log ν [Hz]

High masses at high redshifts

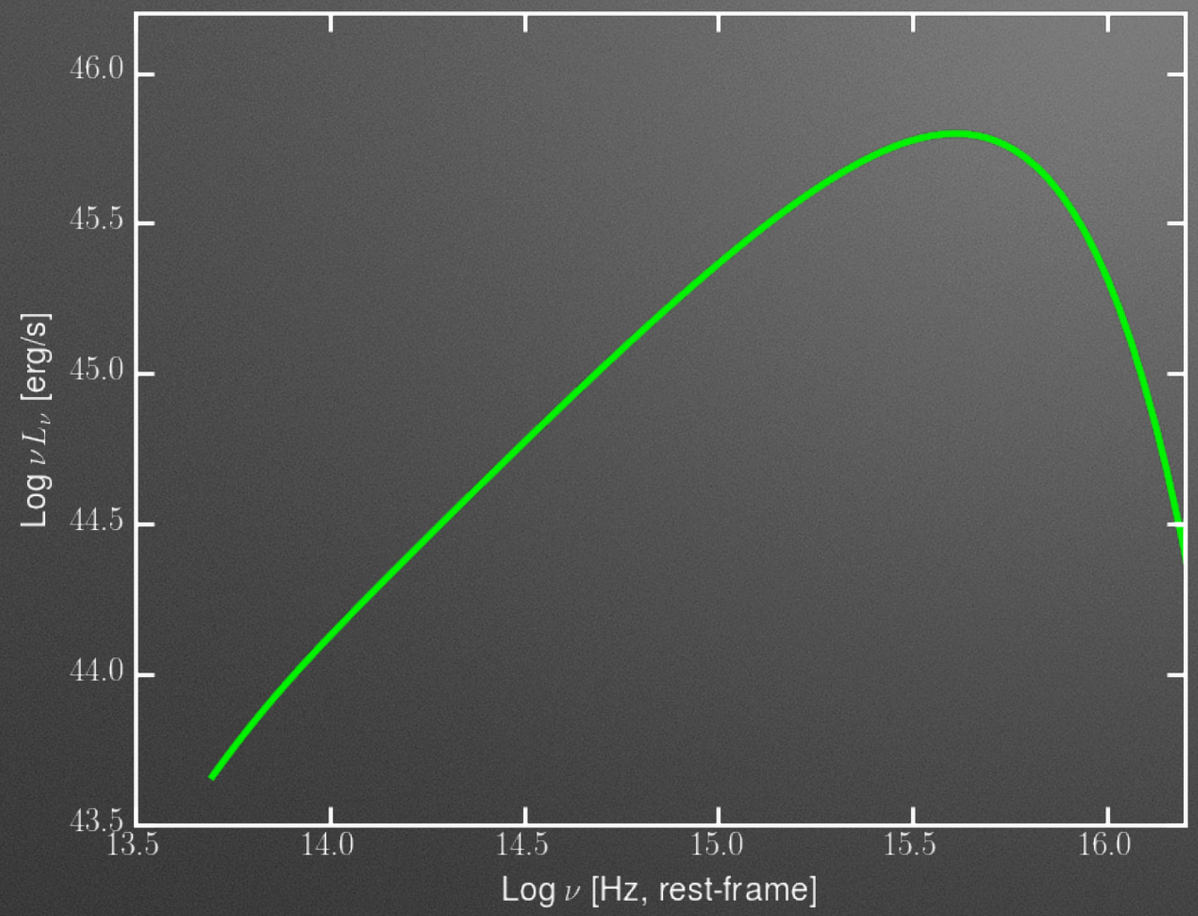


Formation time-scales



do we have other options?

Standard accreting disc

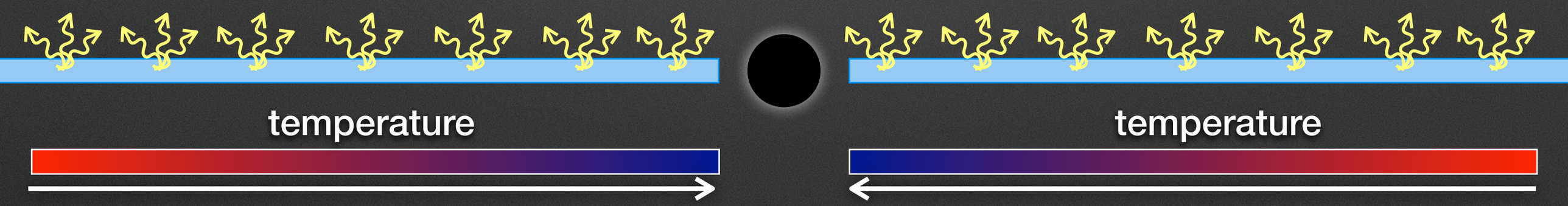


Shakura & Sunyaev 1973

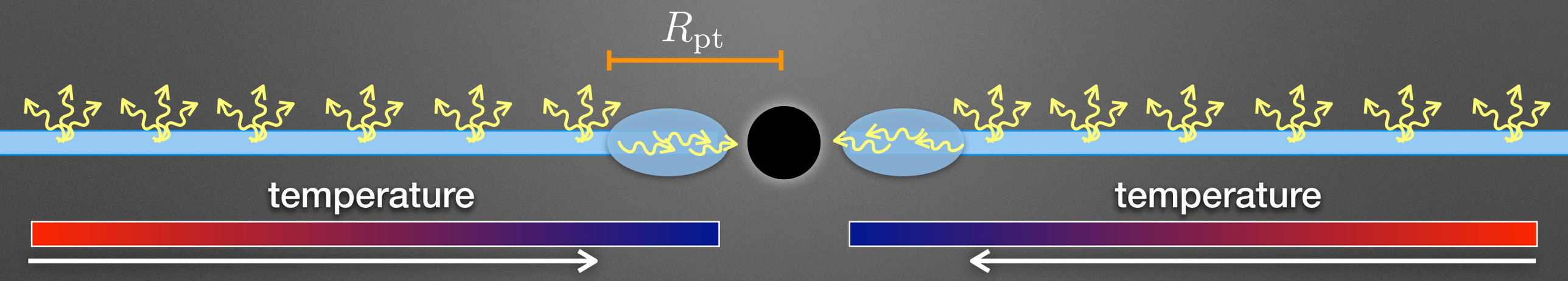
$$L_{\rm d} = \eta_{\rm d} \dot{M} c^2$$

$$\mathrm{Log}\left(\frac{M_{\rm BH}}{M_\odot}\right) = 8.5$$

$$\mathrm{Log} L_{\rm d} = 46.1$$



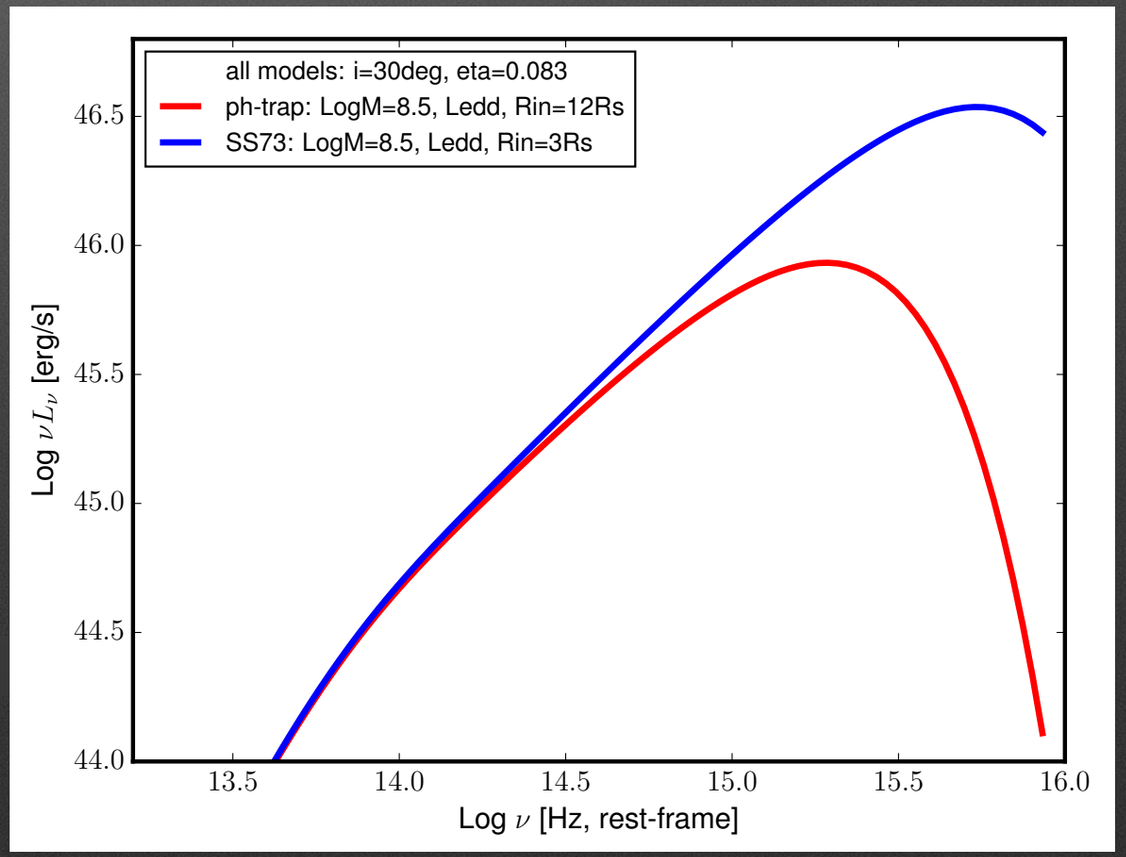
Super-Eddington accreting disc



photon trapping radius:

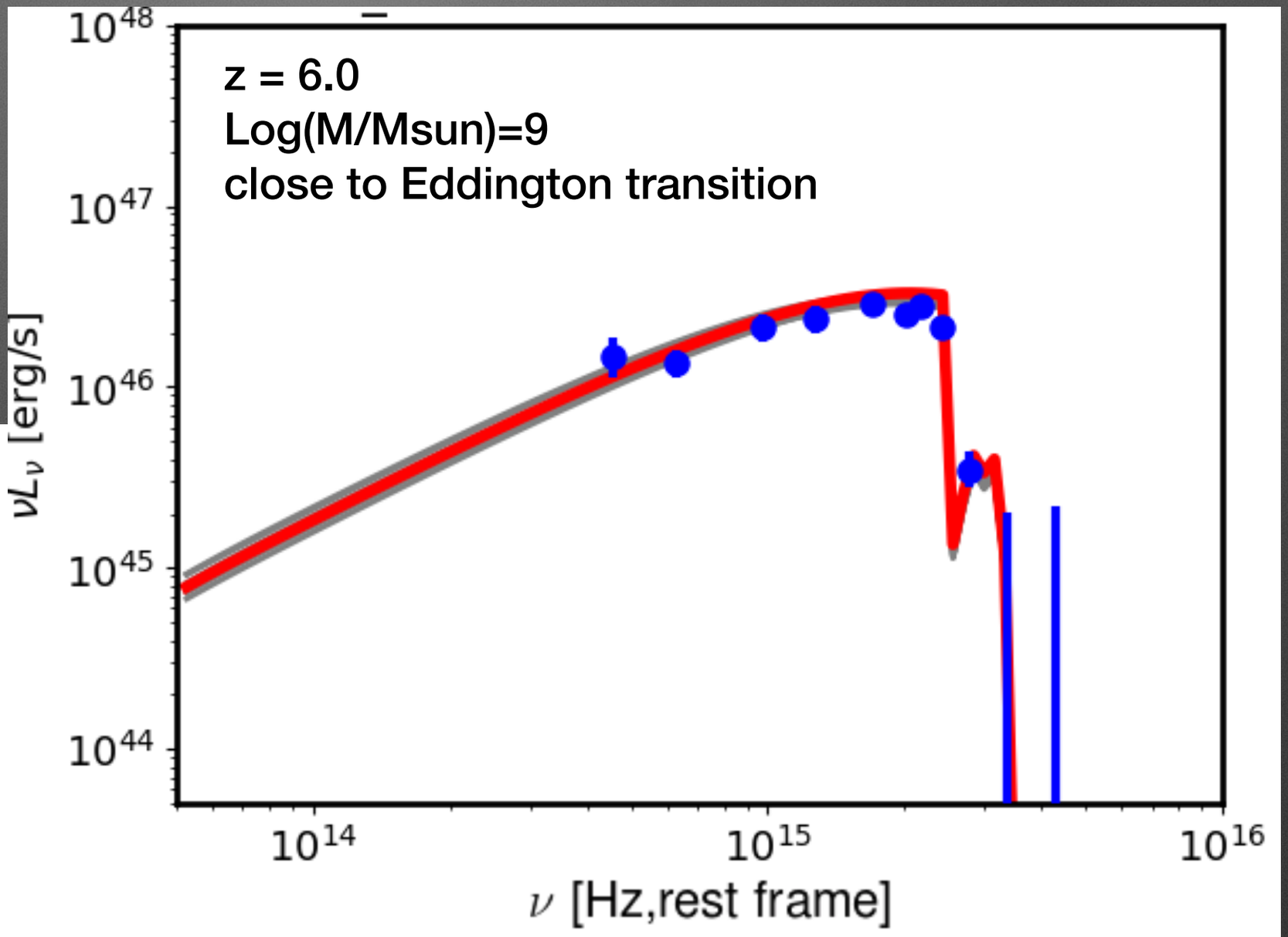
$$R_{\rm pt} = \frac{3}{2}\frac{\dot{M}}{\dot{M}_{\rm Edd}} R_{\rm g} h$$

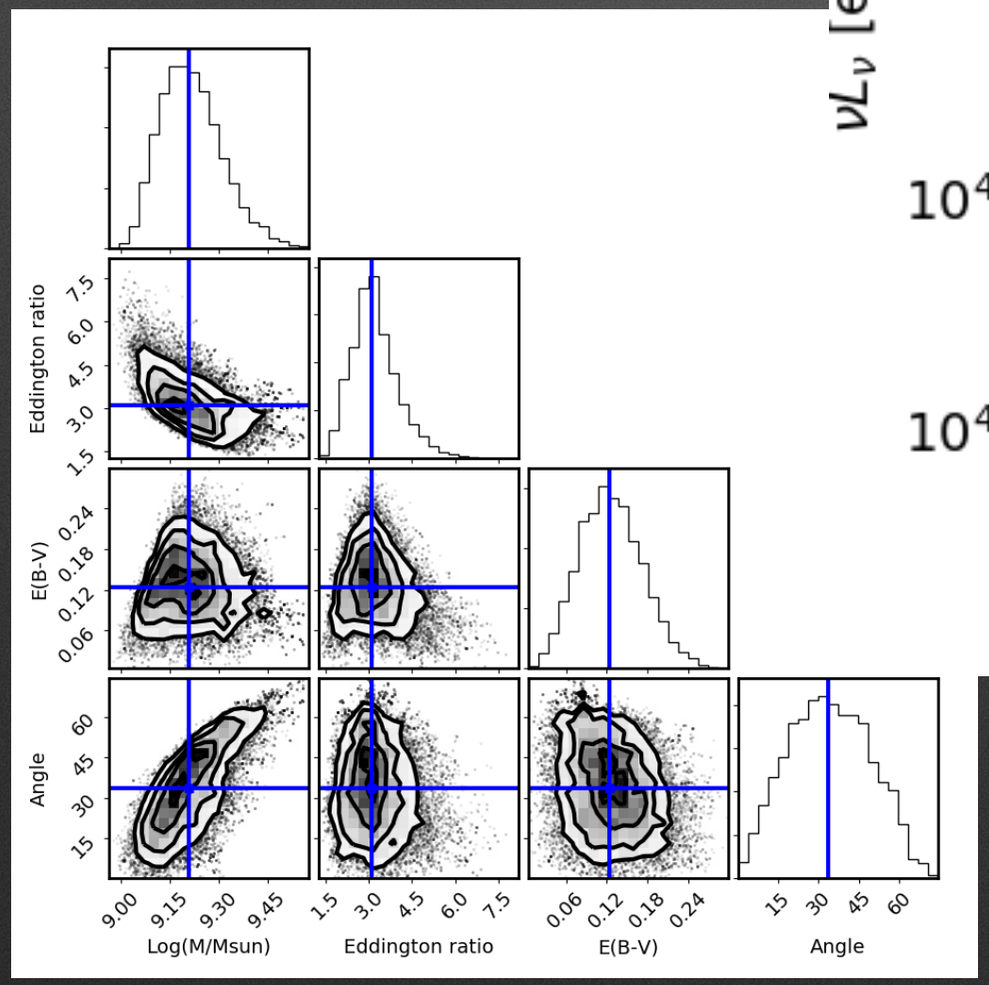
Ohsuga et al. 2002



Super-Eddington accreting disc?

SEE POSTER BY
MASSIMO DOTTI





WORK IN PROGRESS...

Summary

- we observe lots of extremely massive black holes in the early Universe

- most of them seem to host a jet!

- they need to accrete extremely fast

... BUT...

- do they look like Super-Eddington? they might be accreting faster than we think…