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 $\rightarrow z>4$

jet physics in early Universe?

do jets affect accretion

of first SMBH?

LET'S TRY WITH BLAZARS!
Why blazars?

\[ \theta_b = \frac{1}{\Gamma} \]

\[ \theta_v < \frac{1}{\Gamma} \]

Viewing angle: analogously jetted AGN, randomly oriented:

\[ 2\Gamma^2 \sim 340 - 450 \]
Why blazars?

Ghisellini et al. 2017

Tagliaferri et al. 2015
Why blazars?

Ghisellini et al. 2017

Tagliaferri et al. 2015
Looking for blazar candidates

Blazars can be found in optical quasar catalogs:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDSS + FIRST quasar catalog</td>
<td>105783</td>
</tr>
<tr>
<td>z &gt; 4</td>
<td>1248</td>
</tr>
<tr>
<td>Radio-detected &gt;1 mJy</td>
<td>53</td>
</tr>
<tr>
<td>R &gt; 100</td>
<td>31</td>
</tr>
</tbody>
</table>

$R = \frac{F_{5\text{GHz}}}{F_{B}}$
blazars (up to now!): 15

4900 jetted quasars

Paper in preparation
High masses at high redshifts

![Graph showing high masses at high redshifts.](image-url)
$L_d = \eta_d \dot{M} c^2$

$\eta = \eta_d + \eta_B$

- $\eta=\eta_d=0.3$
- $\eta=0.3 \eta_d=0.07$
- $\eta=\eta_d=0.1$
do we have other options?
Standard accreting disc

Shakura & Sunyaev 1973

\[ L_d = \eta_d \dot{M} c^2 \]

\[ \log \left( \frac{M_{BH}}{M_\odot} \right) = 8.5 \]

\[ \log L_d = 46.1 \]
Super-Eddington accreting disc

\[ R_{pt} = \frac{3}{2} \frac{\dot{M}}{\dot{M}_{Edd}} R_g h \]

photon trapping radius:

Ohsuga et al. 2002

all models: i=30deg, eta=0.083
- ph-trap: LogM=8.5, Ledd, Rin=12Rs
- SS73: LogM=8.5, Ledd, Rin=3Rs

AGN13 - 12 October 2018
Super-Eddington accreting disc?

SEE POSTER BY
Massimo Dotti

z = 6.0
Log(M/Msun)=9
close to Eddington transition

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...