



The X-ray variability of z~6 J1030



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How many monsters do we have at z>6?

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>300 detected QSOs at $z \ge 5.5$



J1120+0641 z=7.09				
J0210-0456 z=6.44				
J1148+5251 z=6.42				
J2329-0301 z=6.42				
J1030+0524 z=6.31	1	man-		
J0050+3445 z=6.25		wyo		renter
J1048+4637 z=6.23			~~~~~~	- month
J1623+3112 z=6.22		~~~~		
J0136+0226 z=6.21				
J0227-0605 z=6.20				بورايين وروي
J1429+5447 z=6.18	· · · · · · · · · · · · · · · · · · ·	mylym	marinh	
J0221-0802 z=6.16	hun		minute	
J2229+1457 z=6.15				
J1319+0950 z=6.13	1 mm	****		۶
J1250+3130 z=6.13	~			
J0033-0125 z=6.13	and the second s	when the	Jan a way	
J2315-0023 z=6.12	\sim			
J1509-1749 z=6.12	- Andrew - Marine - M			
J1427+3312 z=6.12	- no	·····		
J2100-1715 z=6.09	have	min	maister	
J0842+1218 z=6.08	and the second			
J1602+4228 z=6.07				
J0303-0019 z=6.07				
J2054-0005 z=6.05	\sim	Λ_{0}	\sim	m
J1630+4012 z=6.05	\sim	when		m
J0353+0104 z=6.05	m			montion
J2318-0246 z=6.05	and man		and the second	
J1641+3755 z=6.05	mon			mederforently
J2310+1855 z=6.04				and the second s
J1137+3549 z=6.01	M			
J0216-0455 z=6.01		-		
J2356+0023 z=6.00	m			- Ma
8000	8500	9000 λ (Å)	9500	10 ⁴

Decarli et al. 2018

Fan et al. 2012

High-z QSO spectral properties



BH formation: simulations

Masses from 10⁸ to 10¹⁰ M_{sun}



Early SMBHs most likely form in the most overdense regions with extension up to 10 pMpc (e.g., Overzier et al. 2009; Costa et al. 2014; Barai et al. 2017)

BH formation: simulations



The evidence of overdense regions around z~6 QSOs is unclear. (e.g., Stiavelli et al. 2005; Willott et al. 2005; Kim et al. 2009; Mazzucchelli et al. 2017) Problem related to small scale observations? AGN feedback?

Wide-area LBT riz imaging around four z~6 QSOS





i-band dropouts (e.g., z~6 LBGs) selected down to z_{AB}~25

J1030 shows the best evidence for an overdense region

Morselli et al. 2014

J1030+0524 field



RA [J2000]

Chandra observation goals

Build a multi-wavelength survey with >200 X-ray sources expected down to $f_{0.5-2 \text{ kev}} \sim 10^{-16}$ erg/cm²/s Get high quality X-ray spectrum of J1030, the best ever obtained for a z>6 QSO

Detect faint and/or obscured satellite AGN (check for the overdensity)















Chandra image (0.5-7 keV), ~500ks, 256 detections Nanni et al. in prep.



~125 photons detected in 0.5-7 keV band

J1030 X-ray spectrum

Nanni et al. 2018



J1030 X-ray variability

Nanni et al. 2018



Take home messages

- 1) Primordial black holes should form and grow in overdense regions surrounded by fainter companions
- 2) The J1030 deep-field is likely the best place to study the properties and environment of $z\sim 6$ SMBHs
- 3) J1030 is the first evidence of a variable AGN in the primordial Universe



Do you want to collaborate with us or just be updated on this work?

Visit: http://www.oabo.inaf.it/~LBTz6/1030/

