Demography and evolution of distant supermassive black holes in the J1030 field

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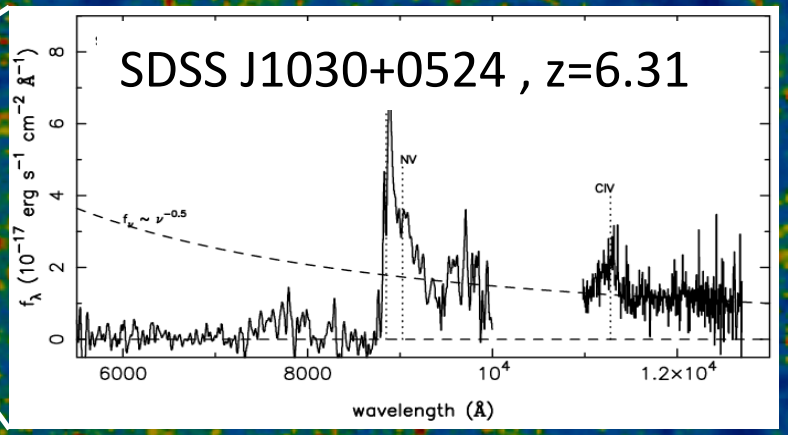
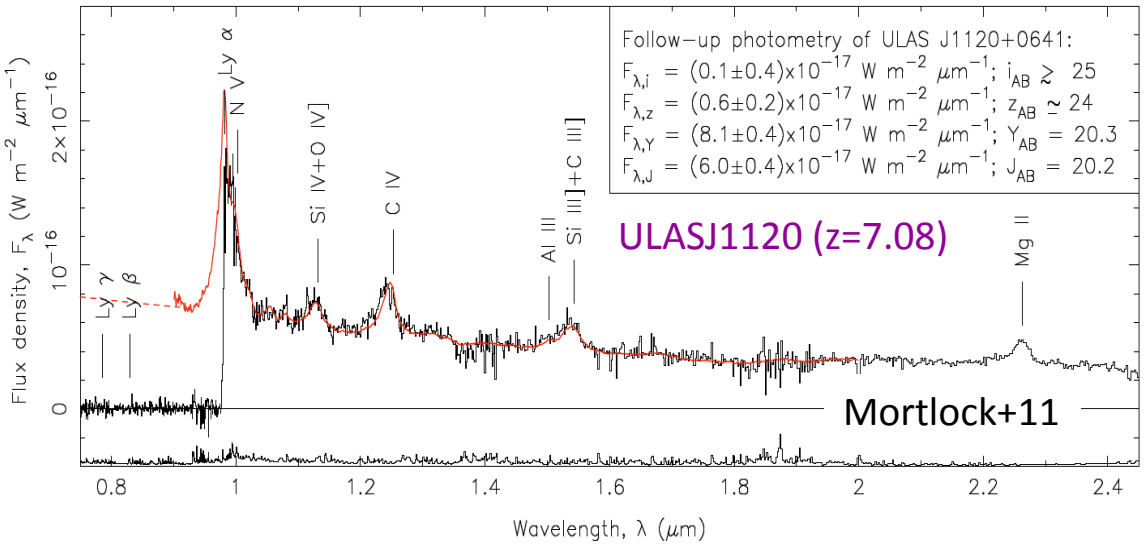


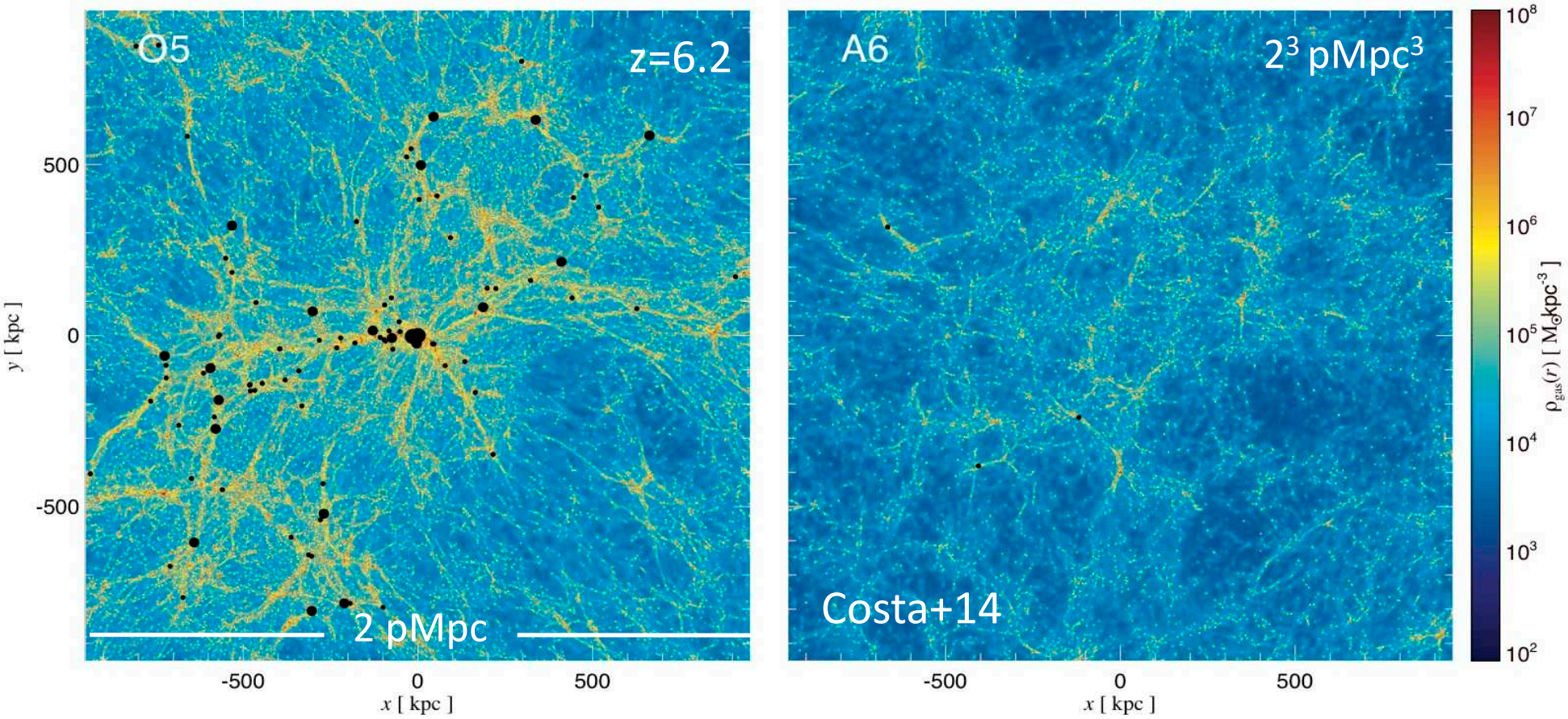
The challenge of luminous z>6 QSOs

i.e. SMBHs grown to 10^9 M_{sun} in less than 1 Gyr

- When, where, and how did they form and grow?
- What is their origin (seeds)?



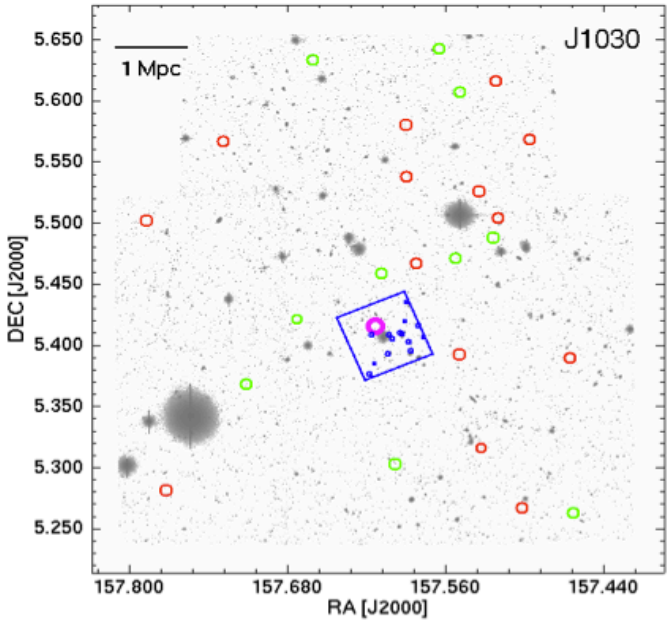
Efficient fueling needs dense environments

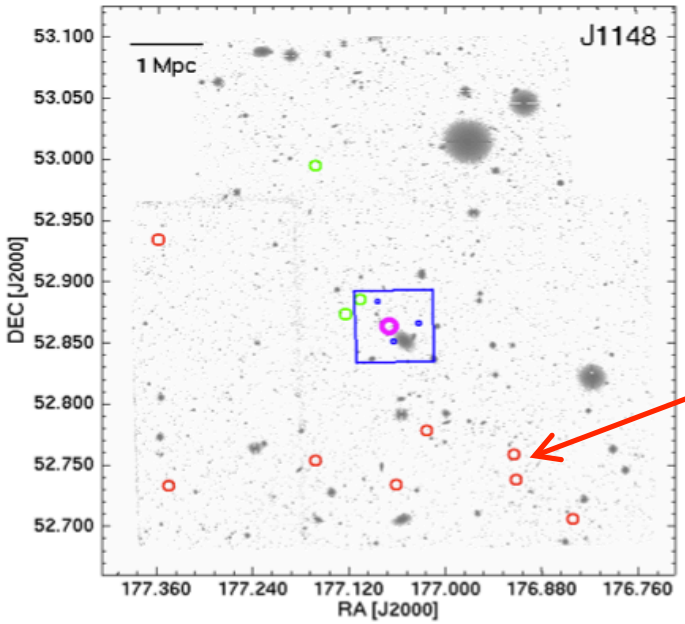


Rare and big: early SMBHs can only form in the most overdense regions

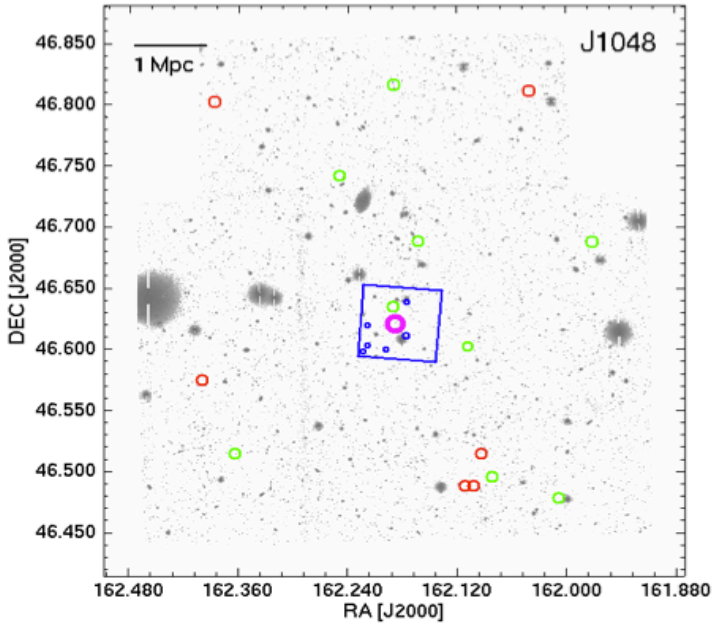
(Overzier+09, Di Matteo+12, Dubois+13, Costa+14, Barai+17)

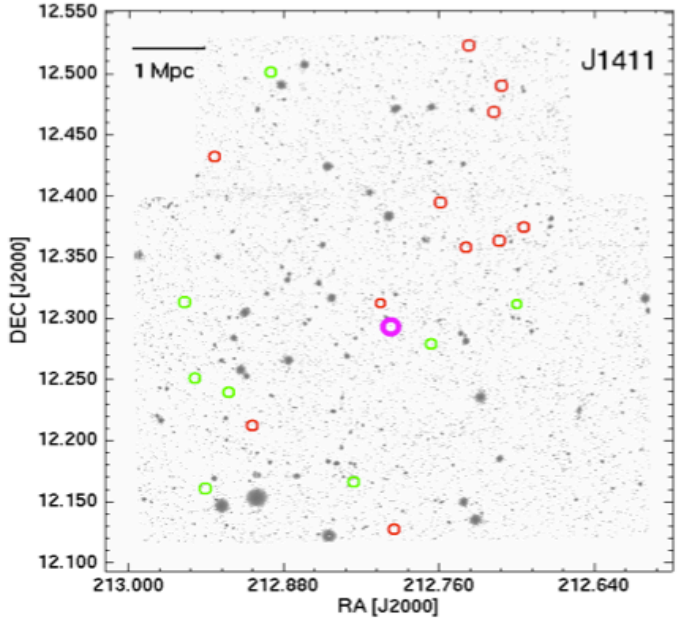
LBT/LBC *riz* imaging around four z~6 QSOs





galaxy candidates
at z~6





Overdensity significant
at ~4σ (combined)

Morselli+14

SDSS J1030+0524: the most promising overdensity around a z~6 QSO

Stack of 20 z~6 gal. cand.

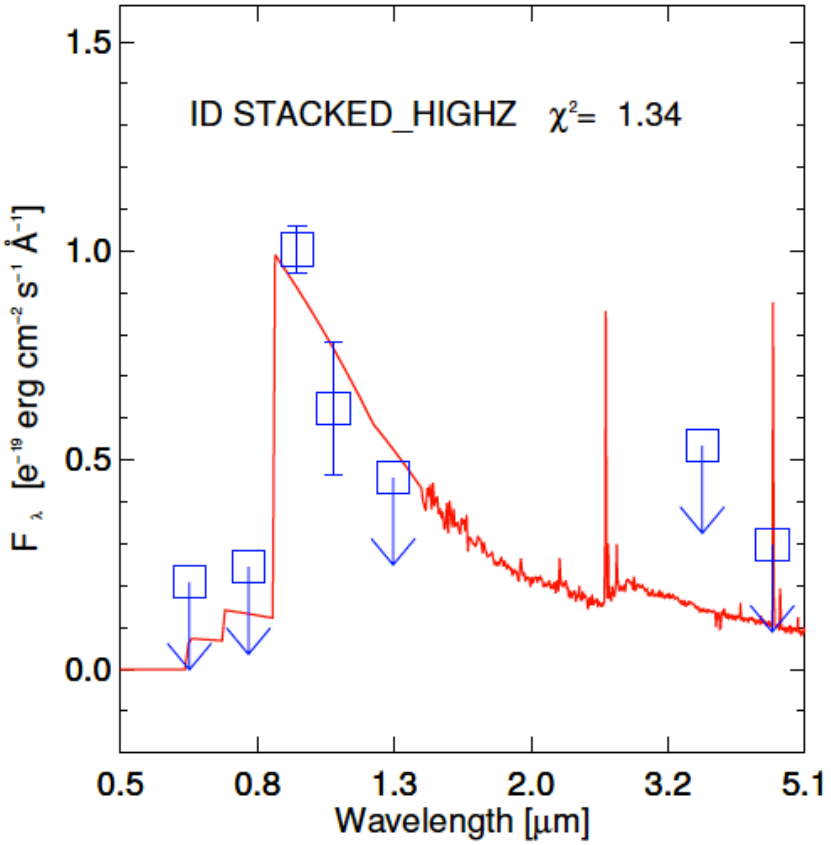
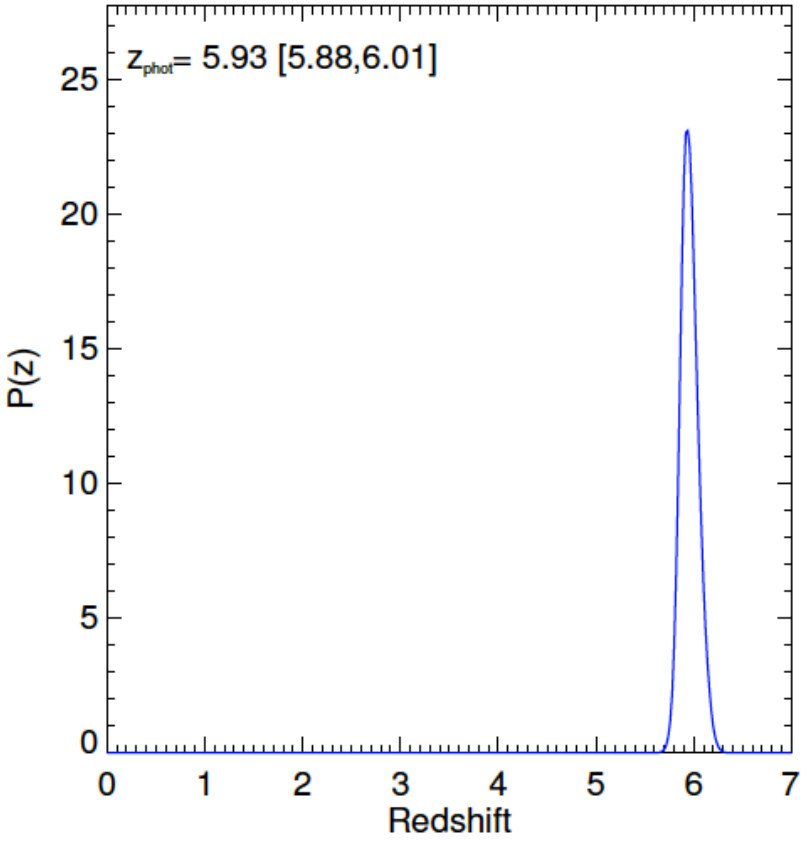


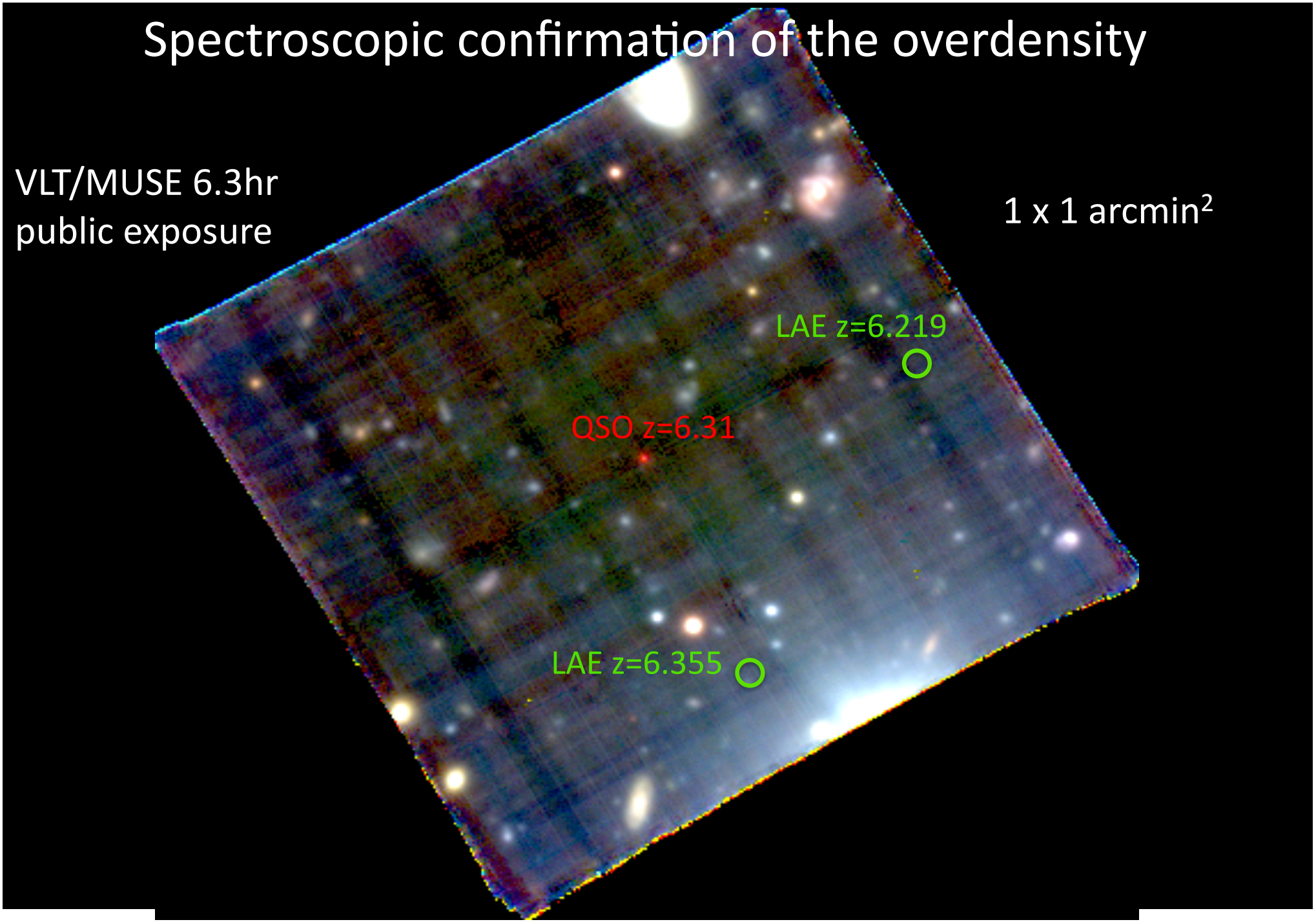
Photo-z of the stack



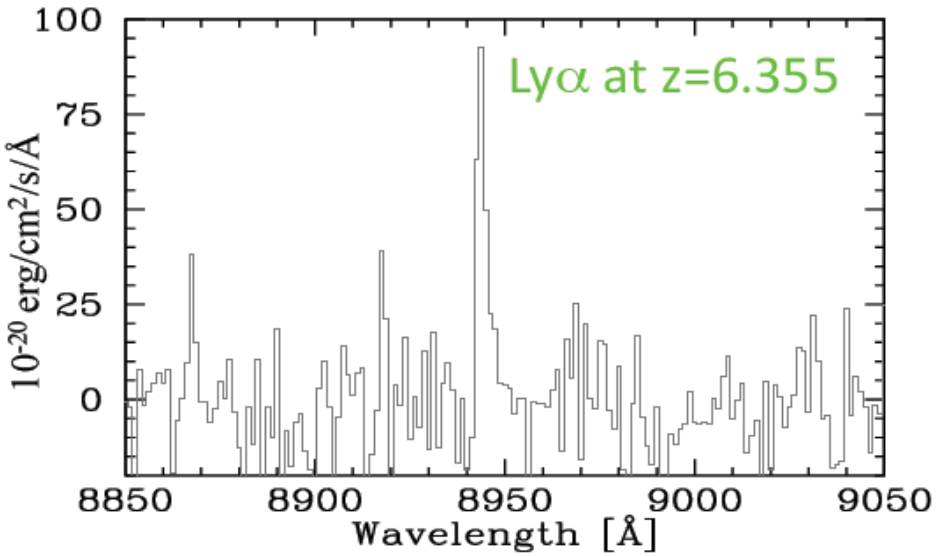
overdensity confirmed and reinforced after near-IR imaging (Y and J)

Balmaverde+17

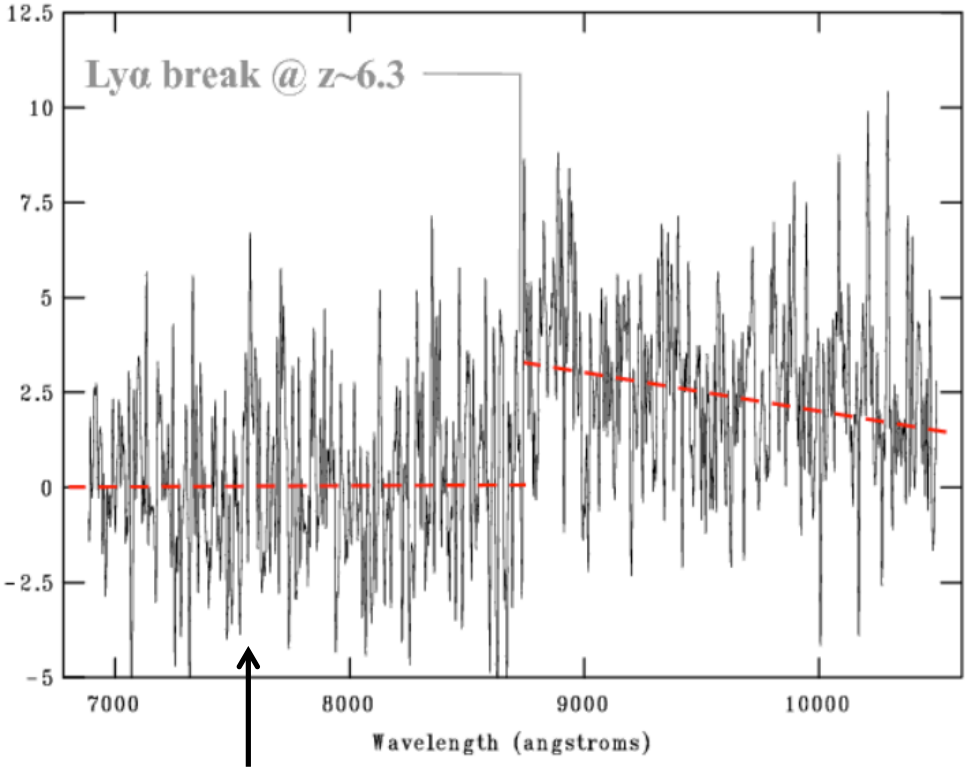
Spectroscopic confirmation of the overdensity



MUSE Lyman Alpha Emitter



Keck Lyman Break Galaxy



[CII]-based redshift determination planned with NOEMA (PI R. Decarli)

New run at Keck on Dec 15th

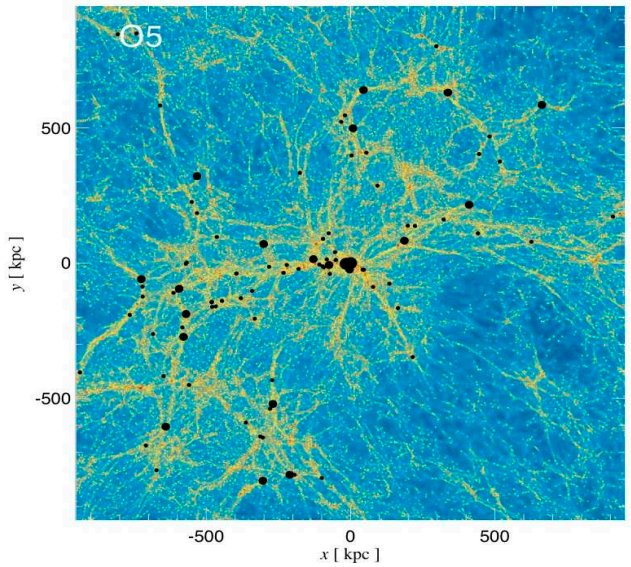
Multi-band coverage of the SDSS J1030 field

Band	Survey/Instr.	Area	Depth (5σ)	Status/Refs/Notes
Radio – 1.4GHz	VLA	30’ FWHM	75μJy	Petric+03, reanalyzed
Radio – 1.4GHz	VLA	30’ FWHM	7.5μJy	filler 2017 - PI Prandoni
FIR - 1.2mm	ALMA	0.2’ FWHM	48μJy	Decarli+17
FIR – 1.2mm	ALMA	1’x1’	55μJy	filler Cycle5 - PI Gilli
MIR 24μm	Spitzer/MIPS	21’x14’	[24]=19.5	IRSA archive
MIR 3.4÷8.0μm	Spitzer/IRAC	21’x14’	[3.4]=22.7	IRSA archive
NIR - Y J	WIRCAM/CFHT	24’x24’	m_{AB}~24	Balmaverde+17
NIR – JHK	MUSYC Deep	10’x10’	m_{AB}=23	Quadri+07
NIR – K	MUSYC Wide	30’x30’	m_{AB}=21	Blanc+08
NIR – H	HST/WFC3	2’x2’	m_{AB}=27.5	HST archive
NIR - spectroscopy	LBT/LUCI	17’x17’	m_{AB}=24	Strategic program
Opt - UBVRiz	MUSYC Wide	30’x30’	m_{AB}=25-26	Blanc+08
Opt – riz	LBT/LBC	23’x25’	m_{AB}=25,26,27.5	Morselli+14
Opt – riz	Subaru/Suprime	27’x24’	m_{AB}=26-28	Diaz+14
Opt – iz	HST/ACS	3.3’x3.3’	m_{AB}=27.5	Stiavelli+05,Kim+09
Opt - em. lines	MUSE	1’x1’	2e-18 erg/cm2/s/A	ESO archive, reanalyzed
Opt. spectroscopy	Keck/DEIMOS	23’x25’	1e-17 erg/cm2/s/A	PI Cappelluti
Opt. spectroscopy	LBT/MODS	17’x17’	1e-17 erg/cm2/s/A	Strategic program
X-ray 0.5-7 keV	Chandra/ACIS-I	17’x17’	1.7e-16 erg/cm2/s	Nanni+18 in prep
X-ray 0.3-10 keV	XMM	30’ diameter	1.0e-15 erg/cm2/s	Farrah+04

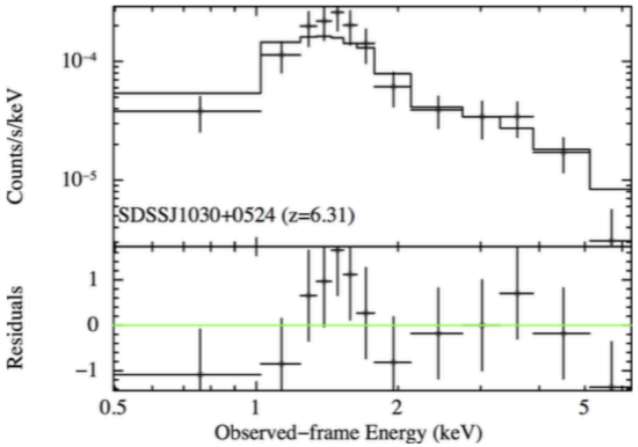
500ks Chandra Large Program
Deepest X-ray observation of a z>6 QSO

Goals

detect faint and/or
obscured satellite AGNs

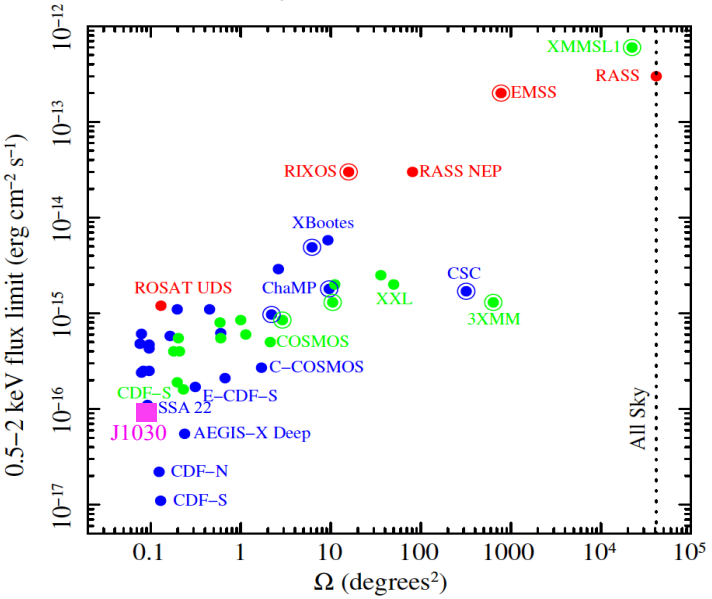


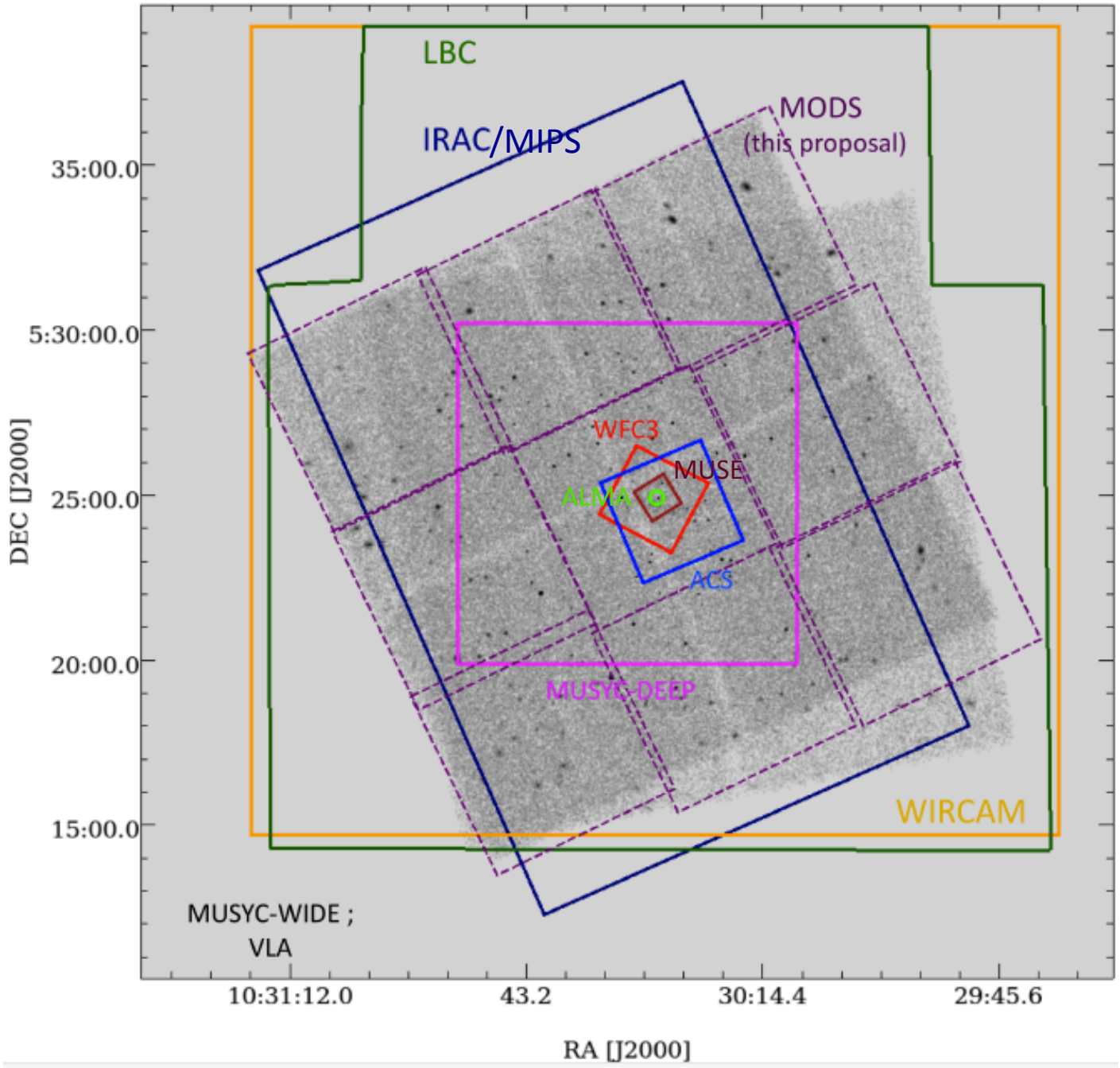
get best spectrum
of a z>6 QSOs



Nanni+18

perform deep X-ray survey;
4th deepest to date





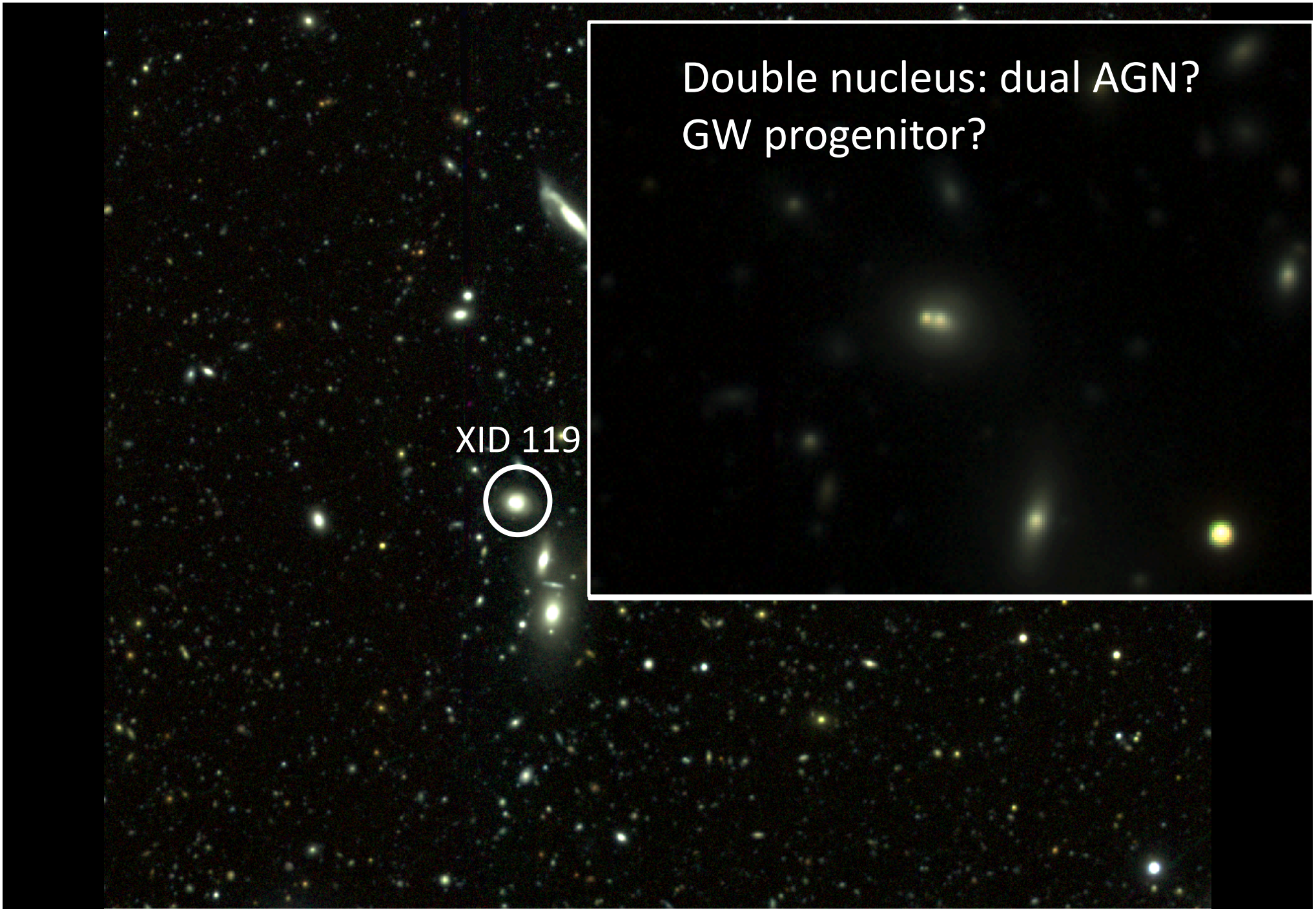
Chandra image 0.5-7 keV

>200 X-ray sources
(mainly obscured AGN)

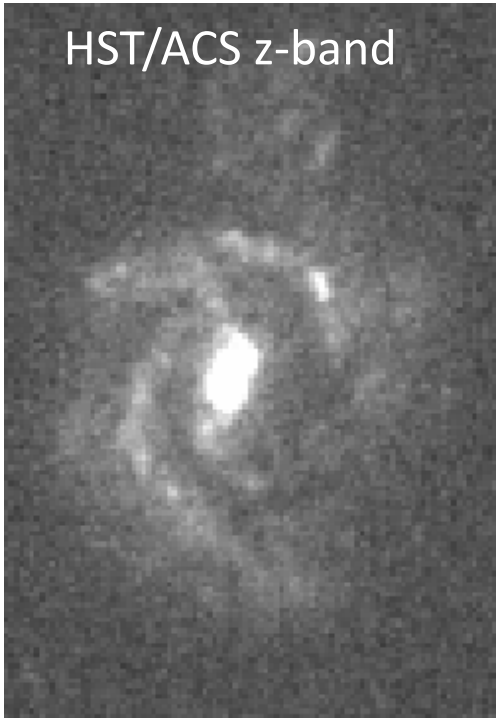
O/NIR spec. of X-ray sources and z~6 galaxy candidates with Keck, VLT/MUSE and LBT

LBT strategic program (52hrs) with MODS+LUCI
Obs. from Jan 2018

~180 redshifts expected: AGN demography and evolution

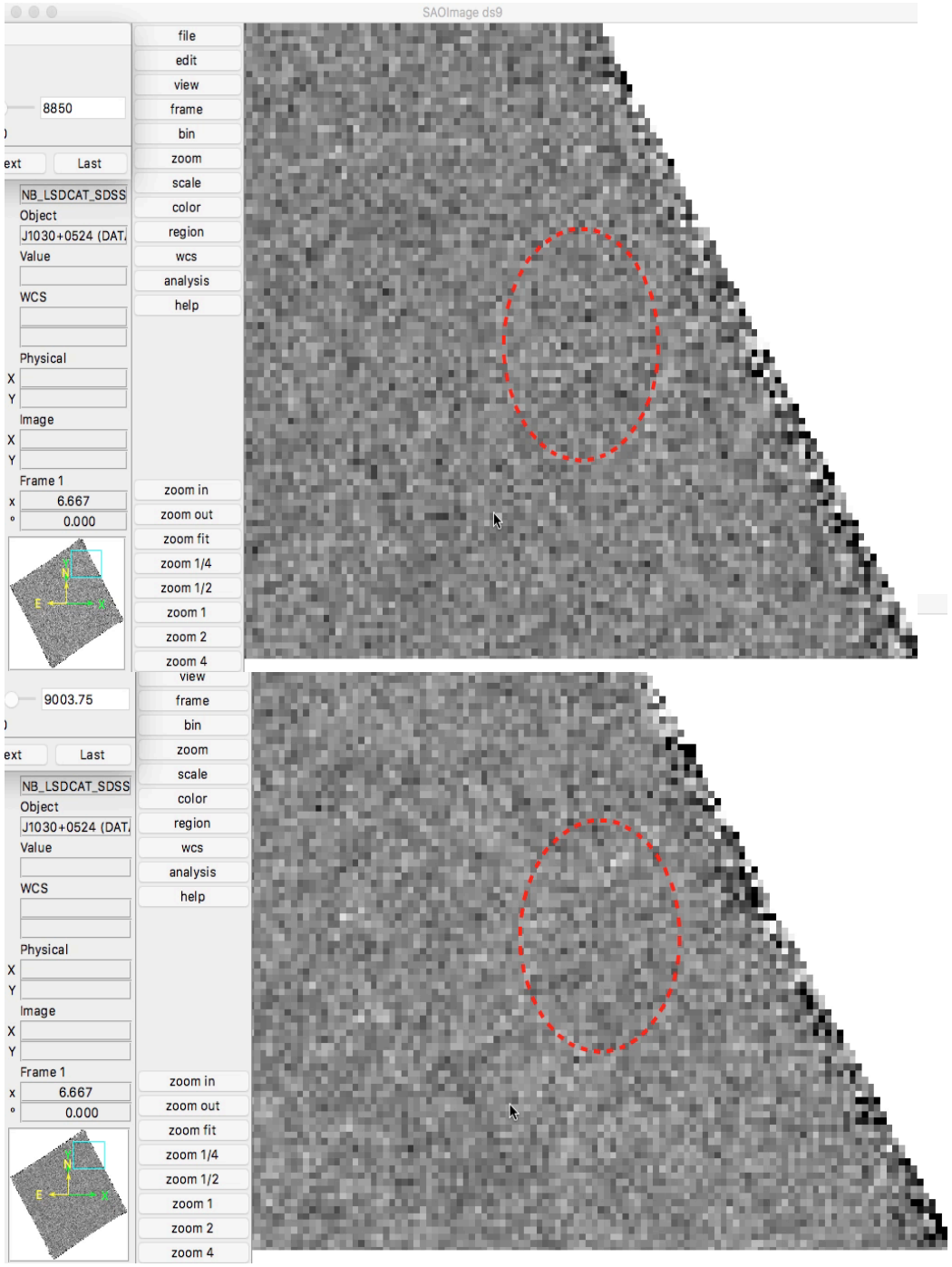

Double nucleus: dual AGN?
GW progenitor?
XID 119

MUSE obs. of XID145: a type 2 AGN at z=0.826 in 3D



Hβ

[OIII]



Past/current master and PhD Theses on this project

Laura Morselli (now PhD at MPE Garching)
Discovery of a large-scale galaxy overdensity around SDSS J1030
Optical Imaging, LBT data - Morselli et al. 2014

Riccardo Nanni (on-going PhD at UniBo)
Physics of SDSS J1030 and its close environment
X-ray analysis, Chandra data – Nanni et al. 2018, in preparation
X-ray survey

Alessandro Peca (on-going master thesis at UniBo)
Search and physical characterization of distant, obscured AGN
Chandra & multiband data (optical/IR)

Master Theses available on this project

• O/IR spectroscopic follow-up of X-ray sources.
Analysis and interpretation of LBT data (MODS+LUCI strategic program)

• Optical spectroscopic follow-up of z~6 galaxy candidates.
Analysis and interpretation of Keck (DEIMOS) + NOEMA data

• Individual multi-band AGN studies:
- AGN in galaxy cluster with double nucleus (Chandra, LBT, +…)
- Dynamics and gas excitation in a nearby Seyfert 2 galaxy (MUSE, HST, Chandra..)
- other (e.g. powerful high-z FRII radiogalaxy)

• mm deep field around SDSS J1030.
Analysis and interpretation of ALMA data (in collaboration with ARC)

References, contacts and websites

Morselli et al. 2014, A&A, 568, A1
Balmaverde et al. 2014, A&A, 606, A23
Nanni et al. 2018, A&A, in preparation

http://oabo.inaf.it/~LBTz6

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