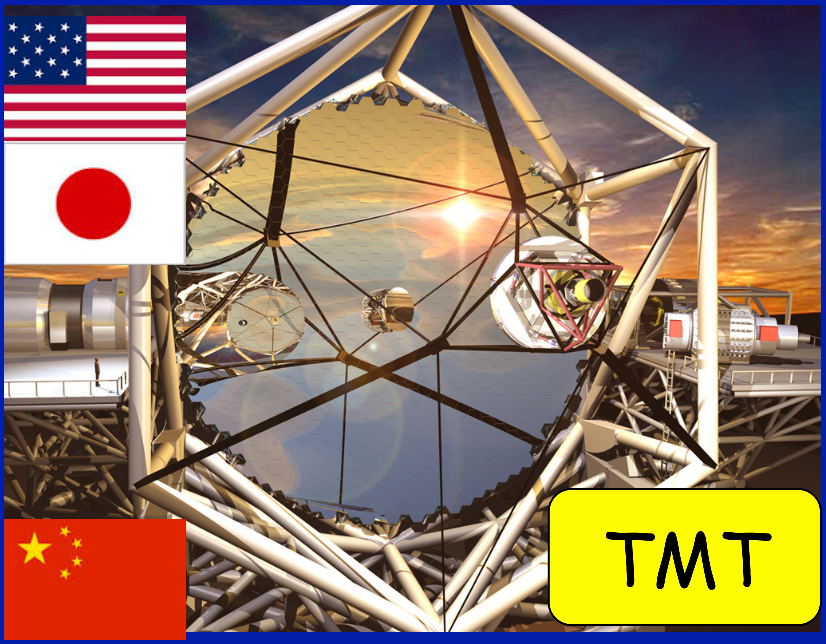
AGN studies in the ELTs era

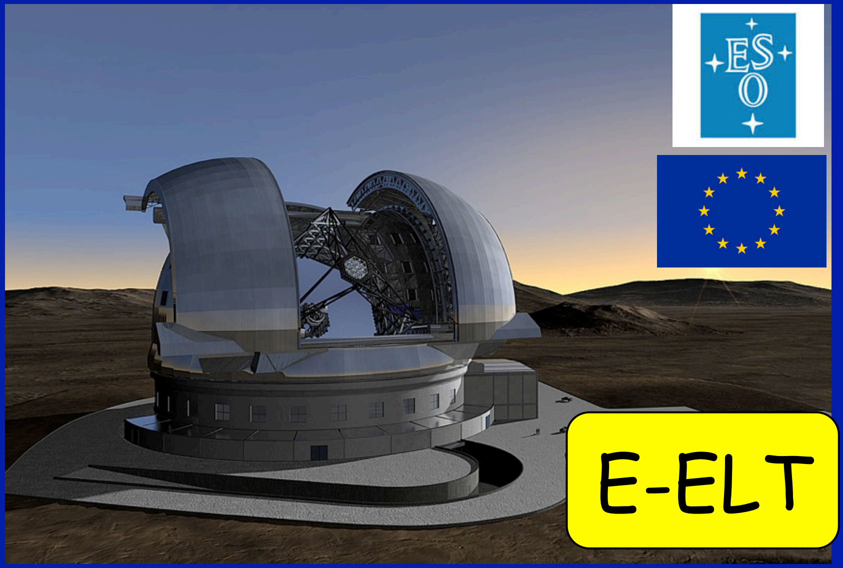
Renato Falomo

INAF – Osservatorio di Padova

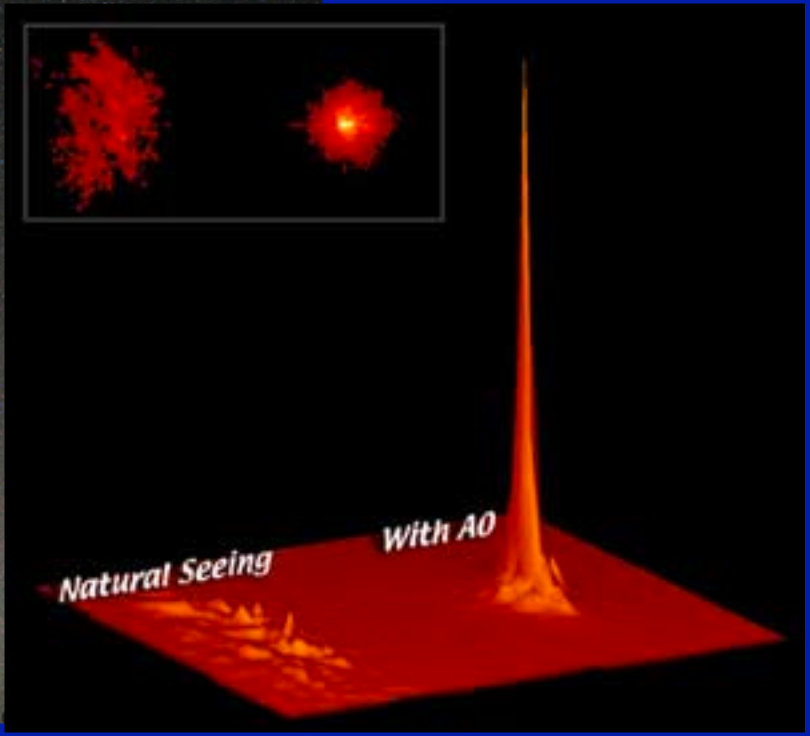
ELTs in the next decade

Worldwide Extremely Large Telescopes





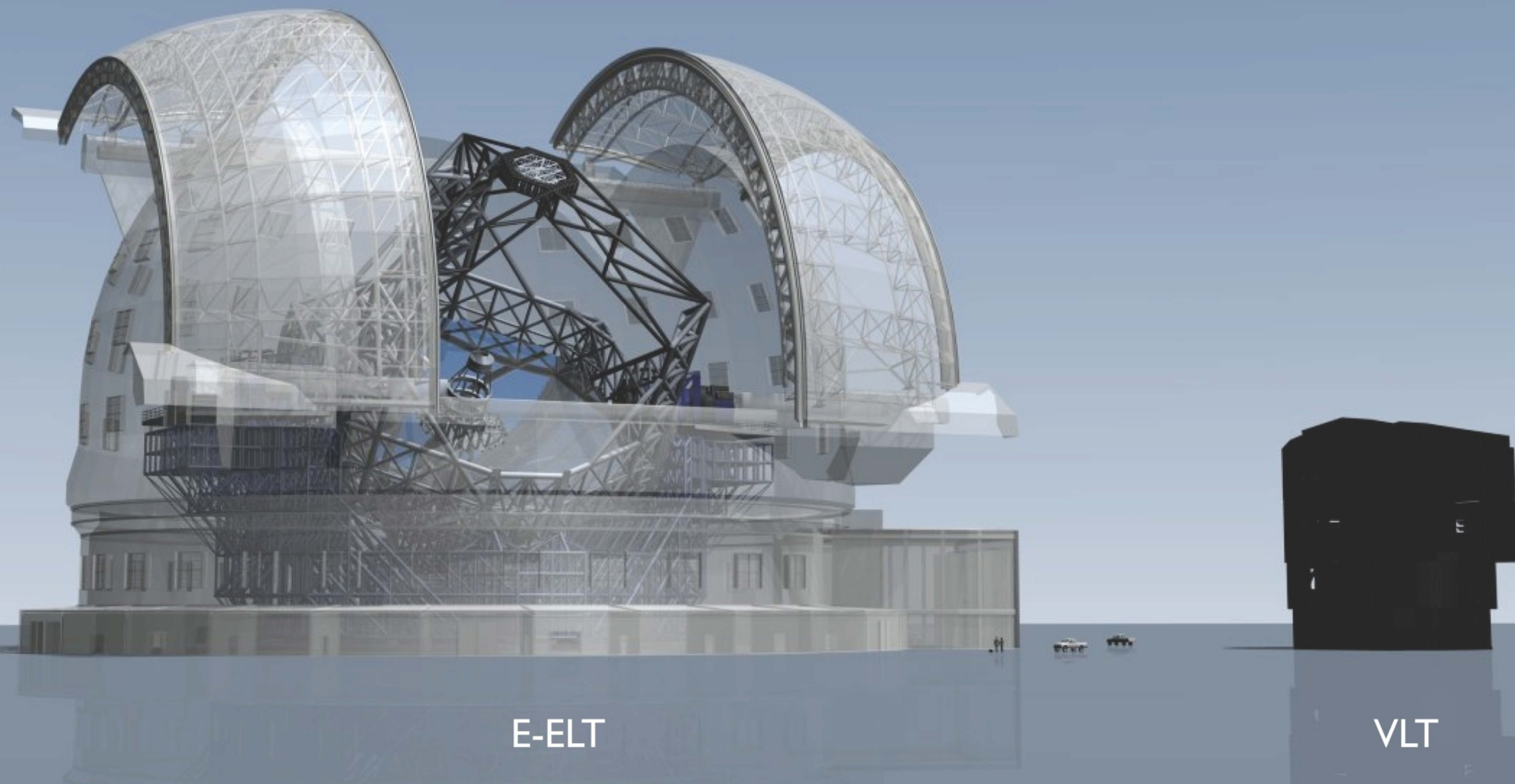
Adaptive optics using LGS



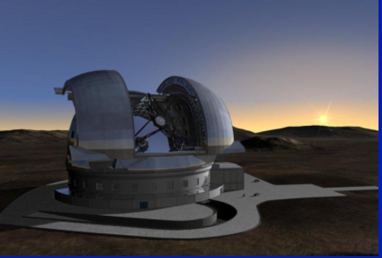
Close to diffraction limited images in the near-IR s

ESO
European Organisation for Astronomical Research in the Southern Hemisphere

The World's Biggest Eye on the Sky

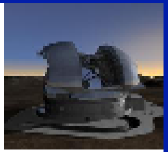


E-ELT First light in the next decade.



E-ELT - Instrumentation

E-ELT Instrumentation Project Office



Overview of the Ins Studies

ACRONYM (P.I.)	INSTRUMENT TYPE
EAGLE (J.G. Cuby)	Wide Field, Multi IFU NIR Spectrograph with MOAO
EPICS (M. Kasper)	Planet Imager and Spectrograph with XAO
MICADO (R. Genzel)	Diffraction-limited NIR Camera- AO assisted
HARMONI (N. Thatte)	Single Field, Wide Band Spectrograph - AO assisted
CODEX (L.Pasquini)	High Spectral Resolution, High Stability Visual Spectrograph
METIS (B. Brandl)	Mid Infrared Imager & Spectrograph –AO assisted
OPTIMOS (F.Hammer,- O.LeFevre)	Wide Field , Visual, MOS (fibre or slit-based)- AO assisted?
SIMPLE (L. Origlia)	High Spectral Resolution NIR Spectrograph –AO assisted
	POST -FOCAL ADAPTIVE OPTICS MODULES
MAORY (E. Diolaiti)	Multi Conjugate AO module (high Strehl, field up to 2')
ATLAS (T. Fusco)	Laser Tomography AO Module (high Strehl, narrow field)

MICADO – Main characteristics

Wavelength range : (0.6)-0.8 to 2.5 mic I, Y, J, H, Ks

Field of View : 53 x 53 arcsec

Pixel scale : 3 mas

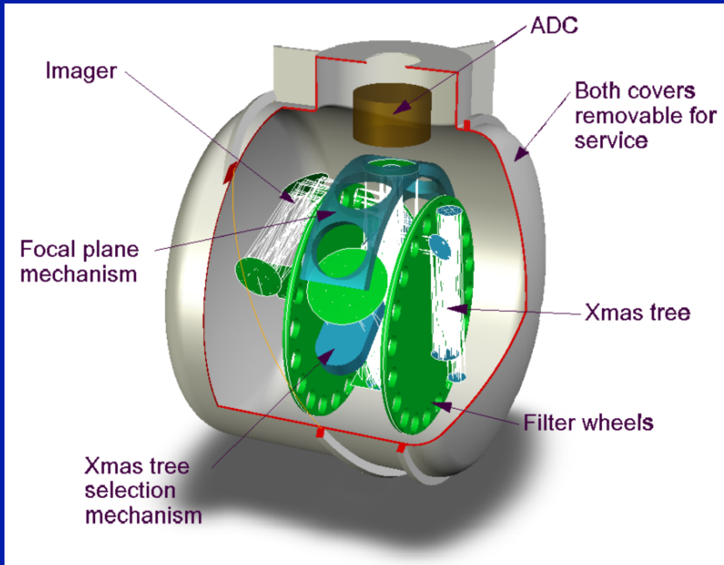
PSF : FWHM 6(J) , 10(Ks) mas

: EE(10mas) 0.10(J) 0.40(Ks)

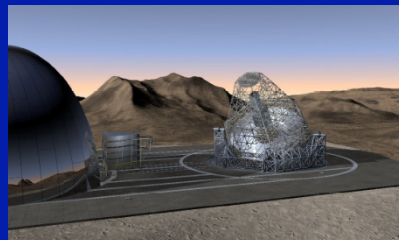
Overall Throughput

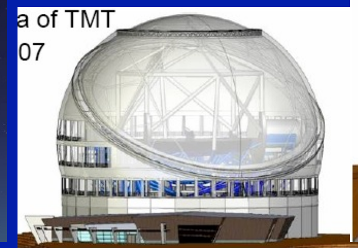
40 %

Telescope + instrument + detector



Future NIR Imaging cameras





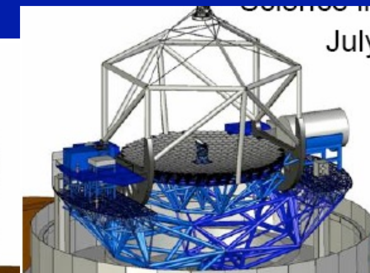
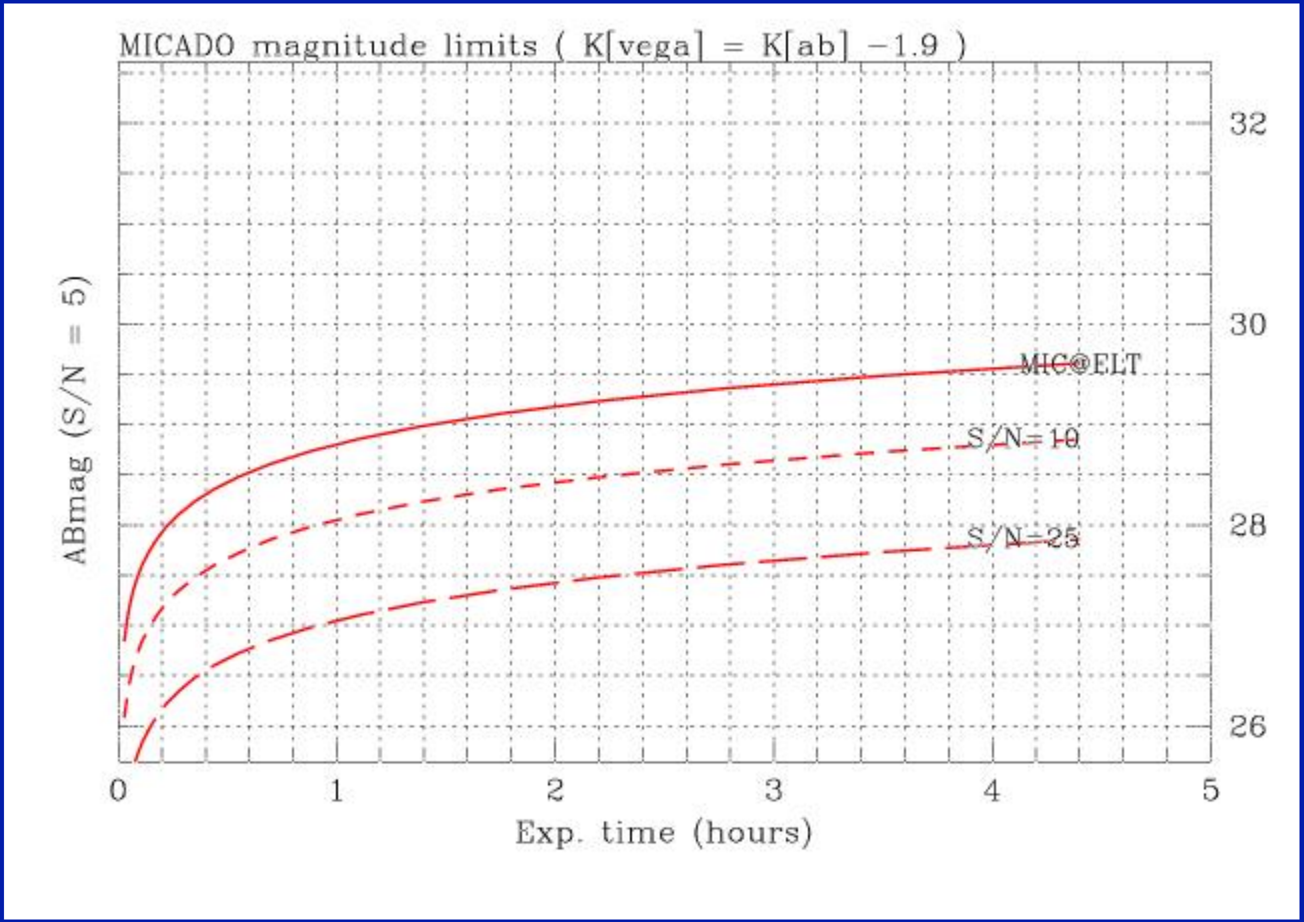


Table 2: Basic specifications for MICADO and its competitors

Instrument & telescope	MICADO / E-ELT	NIRCam (short arm) / JWST	IRIS / TMT	HRCAM / GMT
First light date	2018	Launch 2014	2018	2018
Wavelength	0.8-2.5μm	0.6-2.3μm	0.8-2.5μm	1.0-2.5μm
Field & sampling	53"×53" @ 3mas + 6"×6" @ 1.5mas	130"×260" @ 31.7mas	17"×17" @ 4mas	13"×13" @ 3mas, 40" ×40" @ 10mas
Resolution wrt MICADO	×1 (10mas @ 2.1μm)	×6.5	×1.4	×1.7
Number of filters	20 primary arm, 20 auxiliary arm	14 (of which 4 are narrow)	unspecified	unspecified
Additional modes	Slit spectroscopy (options: dual imager, high time resolution)	Long arm to 5μm	Integral field spectroscopy	Integral field spectroscopy

MICADO – Expected performance

AB mag limits for isolated point sources



J(AB) = 30 in 5h (S/N=5)

K(AB) = 29.5 in 5h (S/N=5)

MICADO@E-ELT

Sensitivity: spectroscopy

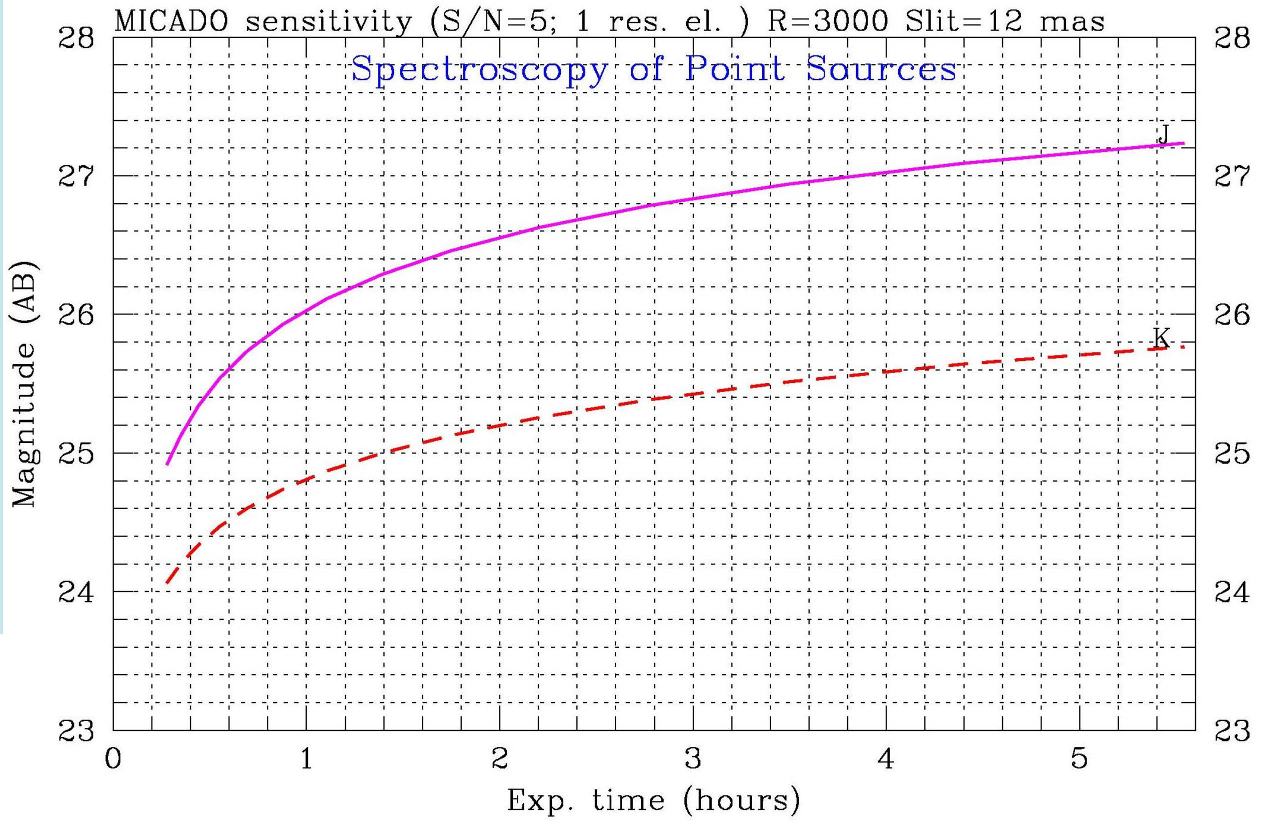
Sensitivity between OH in J & K bands

Slit losses included (PSF shape & diffraction effects)

narrow slit maximizes sensitivity (although it reduces throughput)

JH sensitivity for point sources is the same as HARMONI

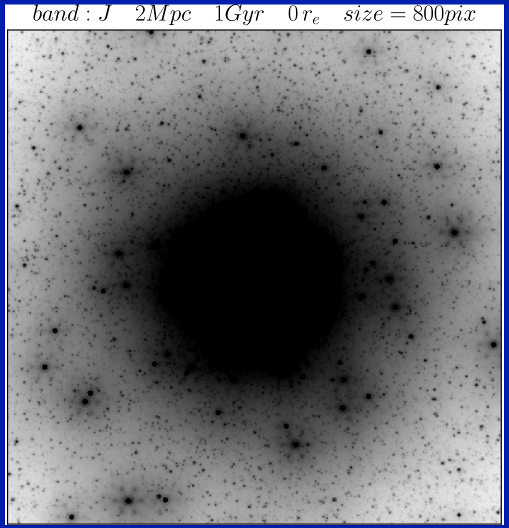
Isolated Point Sources to 5σ



5hrs, 5σ	J_{AB}	H_{AB}	K_{AB}
Spectroscopy (between OH)	27.2	27.2	25.7

E-ELT simulation of NGC 300 core

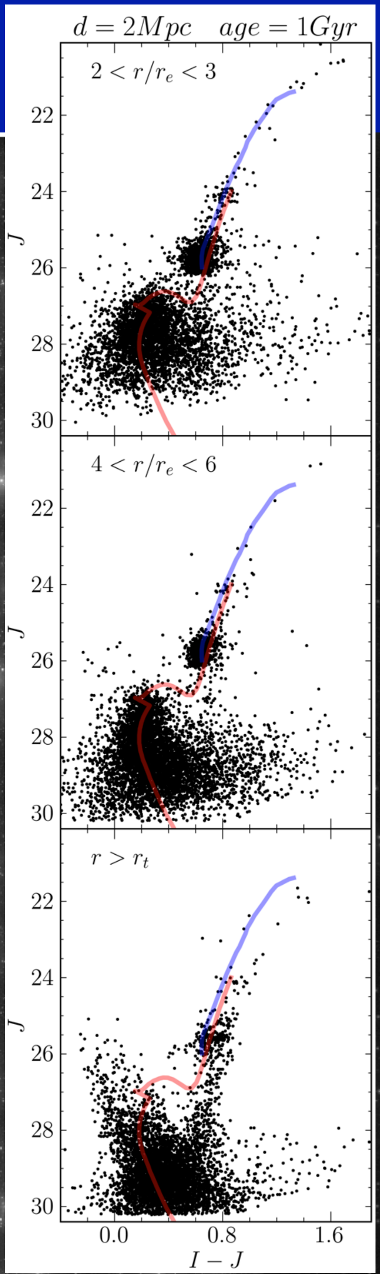
NGC 300
D = 2 Mpc
NSC (king profile)
Rc = 0.095“
Rt = 2.87”

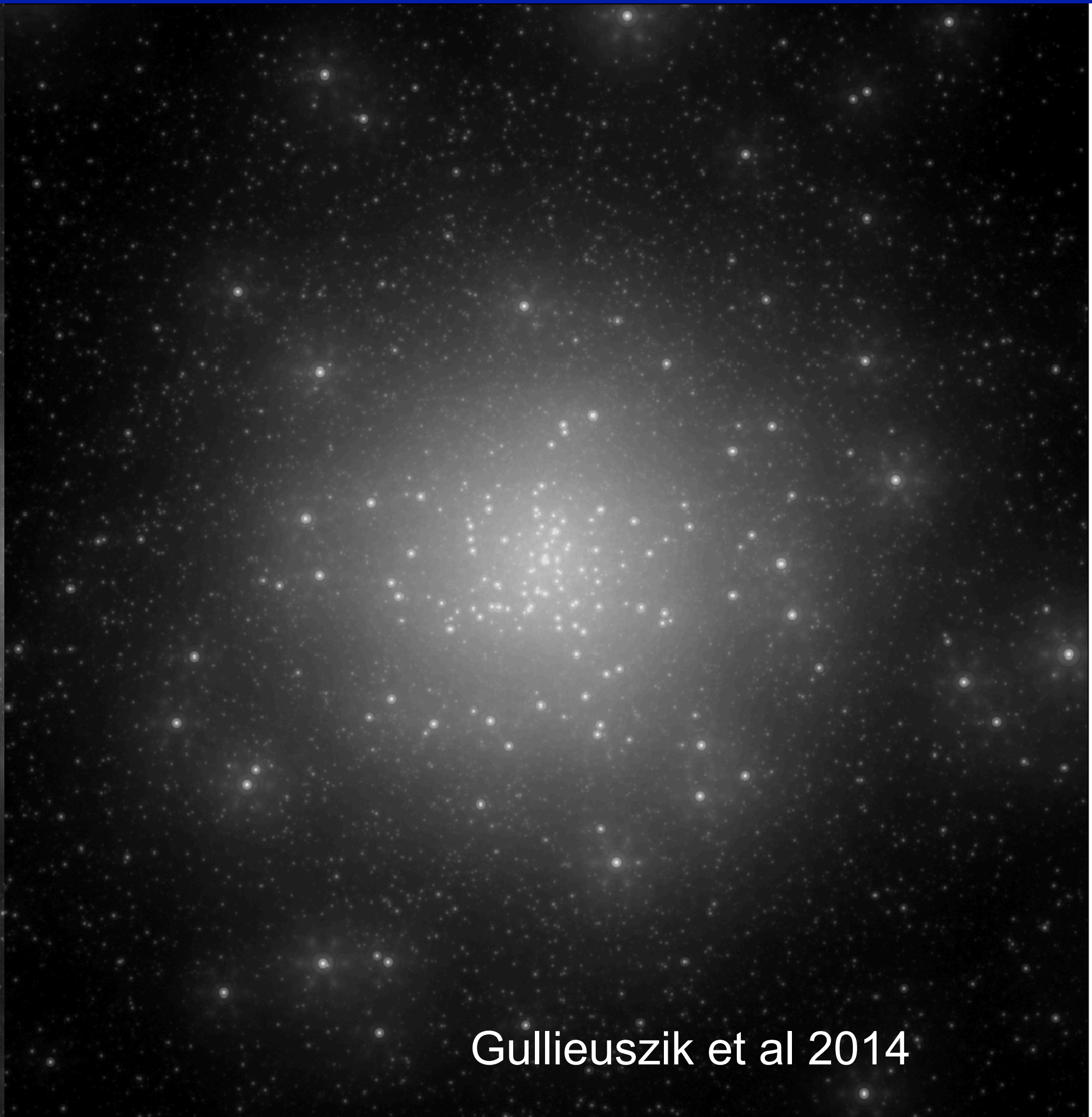


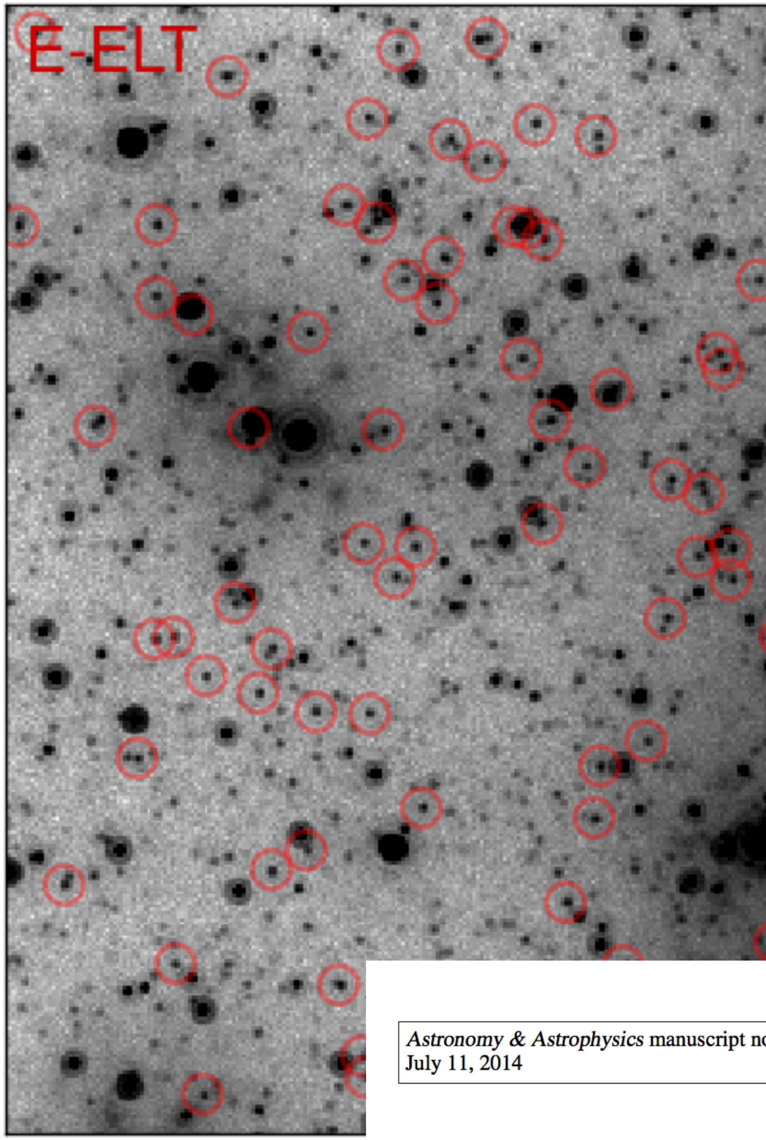
E-ELT + MICADO

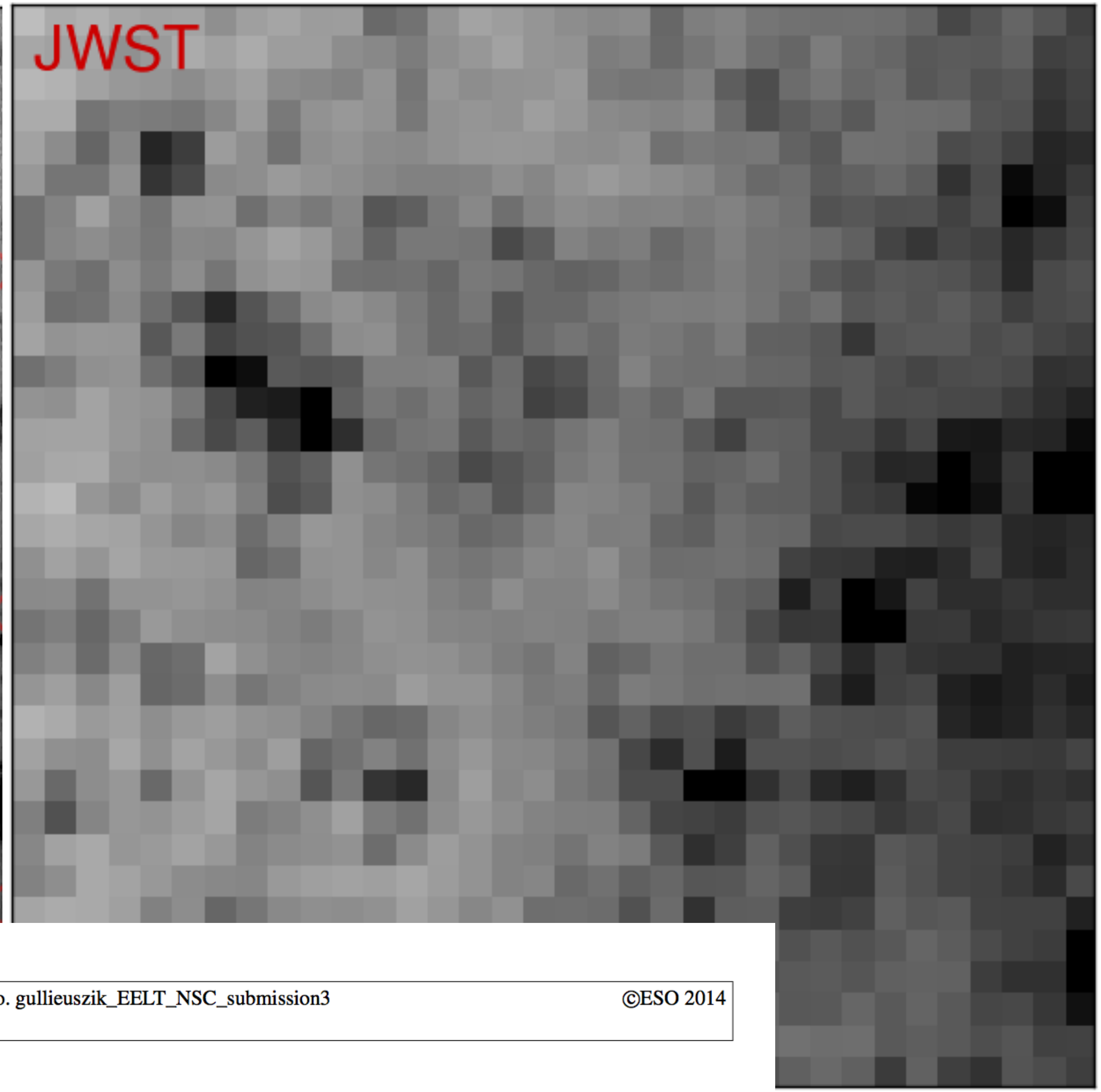
Exp = 3 h
Filter J

E-ELT simulation of NGC 300 core









Astronomy & Astrophysics manuscript no. gullieuszik_EELT_NSC_submission3
July 11, 2014

Probing the nuclear star cluster of galaxies with ELTs

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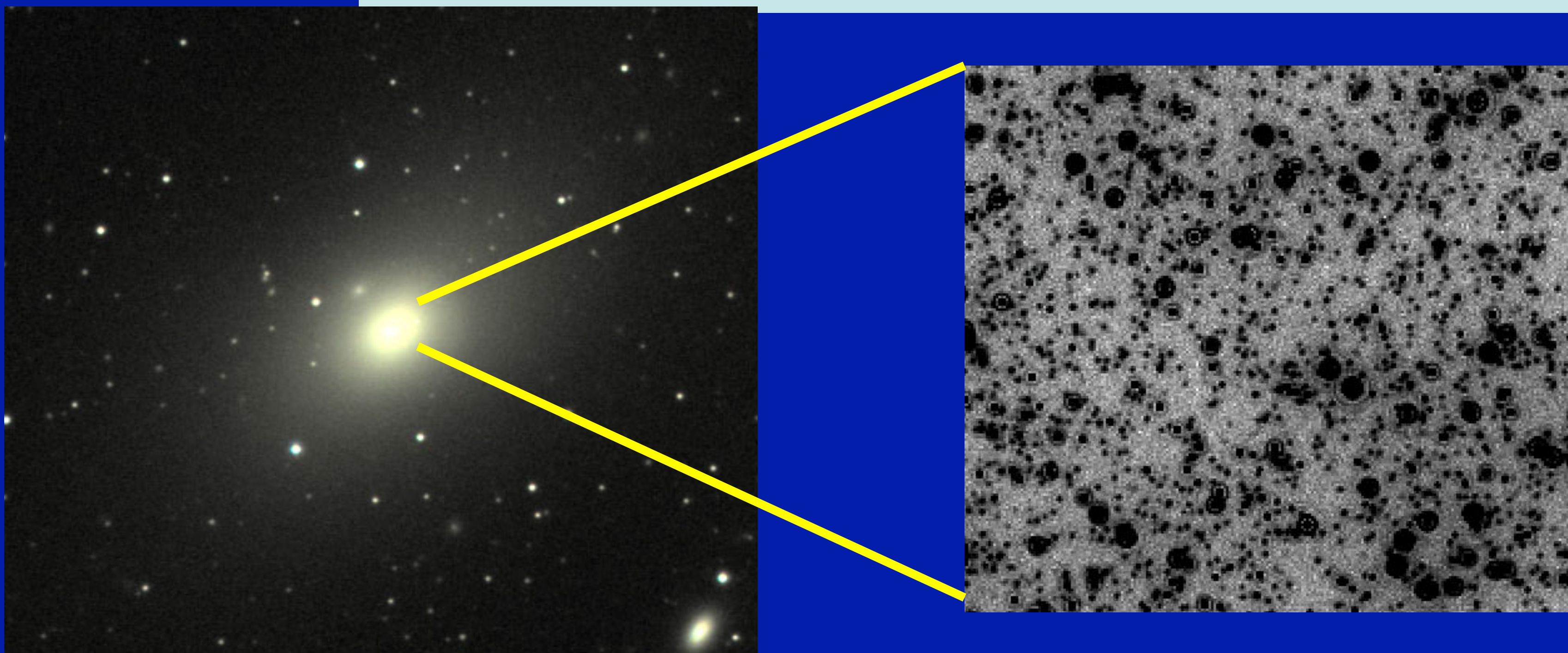
July 11, 2014

VIRGO - the closest rich cluster of galaxies

VIRGO cluster (DM = 31)

The study of the resolved stellar population in distant galaxies is one the main science drivers for the realization of ELTs



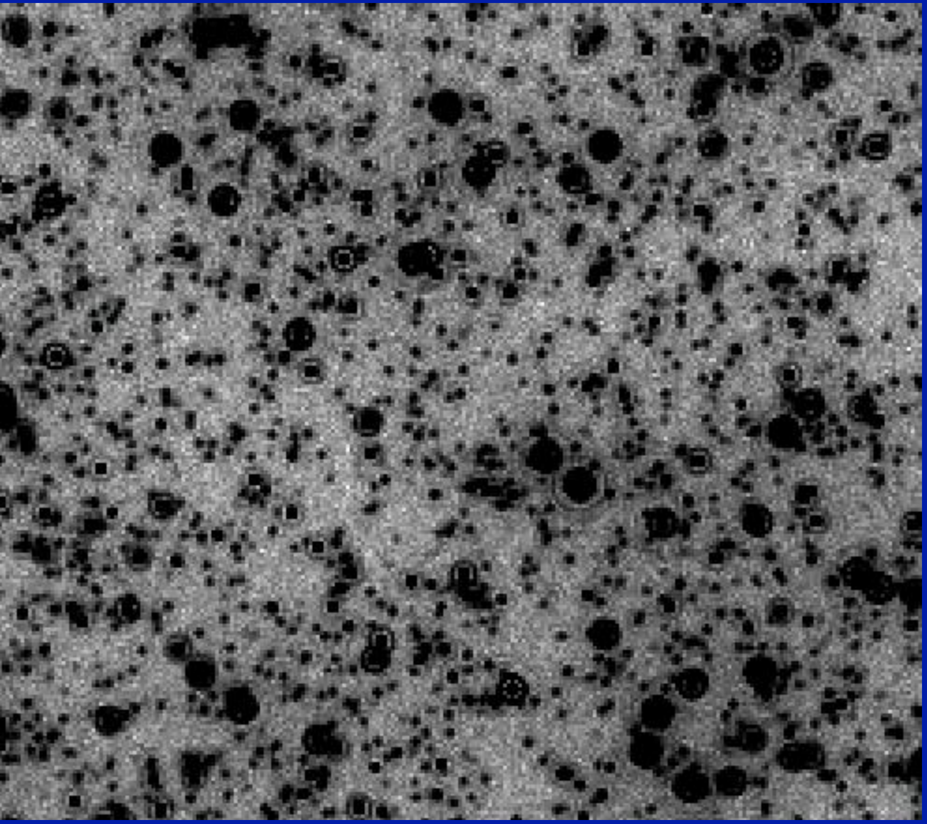
Reconstruction of the star formation history for a stellar system by analyzing its color-magnitude diagram (CMD) is a fundamental tool for understanding its age and chemical composition.

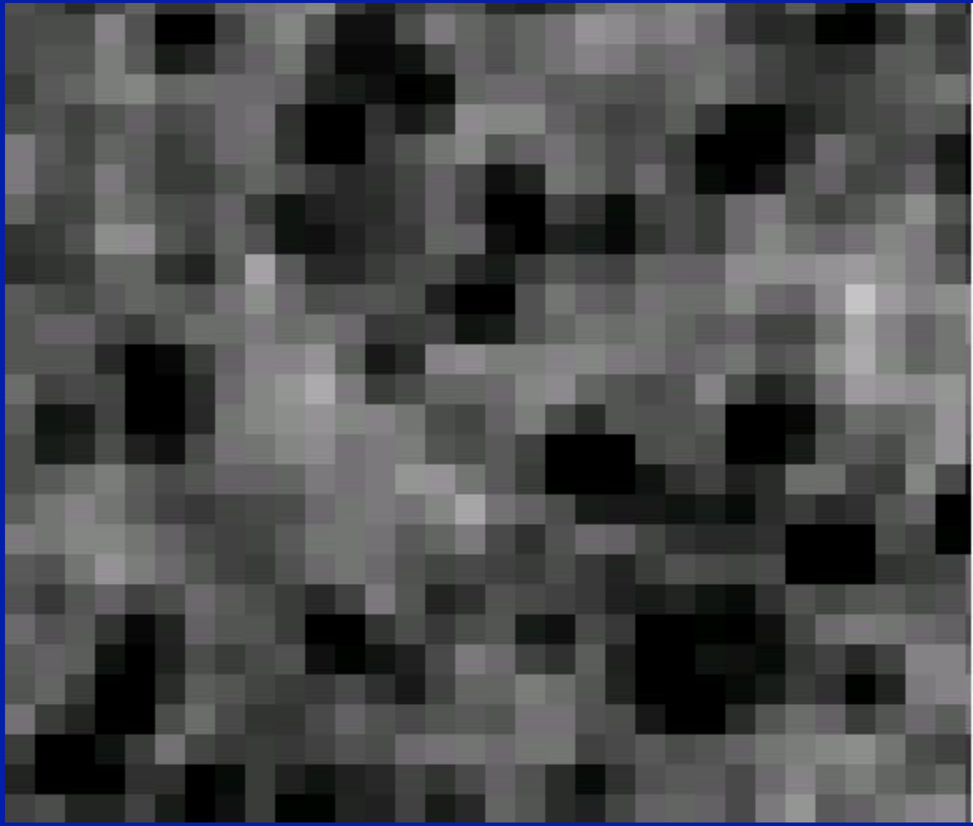
Greggio et al 2012, PASP 124, 653

The view of resolved of stellar populations

Elliptical galaxy (old SP) M(J) = -23 , HLR = 5 kpc

Distance = 18.3 Mpc   R/HLR = 1





MICADO E-ELT

FoV = 1''

NIRCam JWST

Greggio et al 2012

PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, **124**:653–667, 2012 July

Resolved Stellar Population of Distant Galaxies in the ELT Era

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Received 2012 February 07; accepted 2012 May 23; published 2012 August 6

ABSTRACT. The expected imaging capabilities of future Extremely Large Telescopes (ELTs) will offer the unique possibility to investigate the stellar populations of distant galaxies from the photometry of the stars in very
e two representative science cases
ıs of distant galaxies. Specifically,
distance of 4.6 Mpc) and case (2)
distance of 18 Mpc). We generate
entative instrumental setup, i.e., a
discussed in detail, showing how
it is approached. We find that (1)
wn to $I \sim 28.5$, $J \sim 27.5$, allowing
Virgo to within ~0.1 dex; (2) the
7.0, enabling reconstruction of the
xes. For the latter case, we discuss
istory from the analysis of their

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **437,** 2966–2979 (2014) doi:10.1093/mnras/stt2124
Advance Access publication 2013 November 30

Studying the metallicity gradient in Virgo ellipticals with European-Extremely Large Telescope photometry of resolved stars

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[1]*INAF, Osservatorio Astronomico di Bologna, Via Ranzani 1, I-40127 Bologna, Italy*
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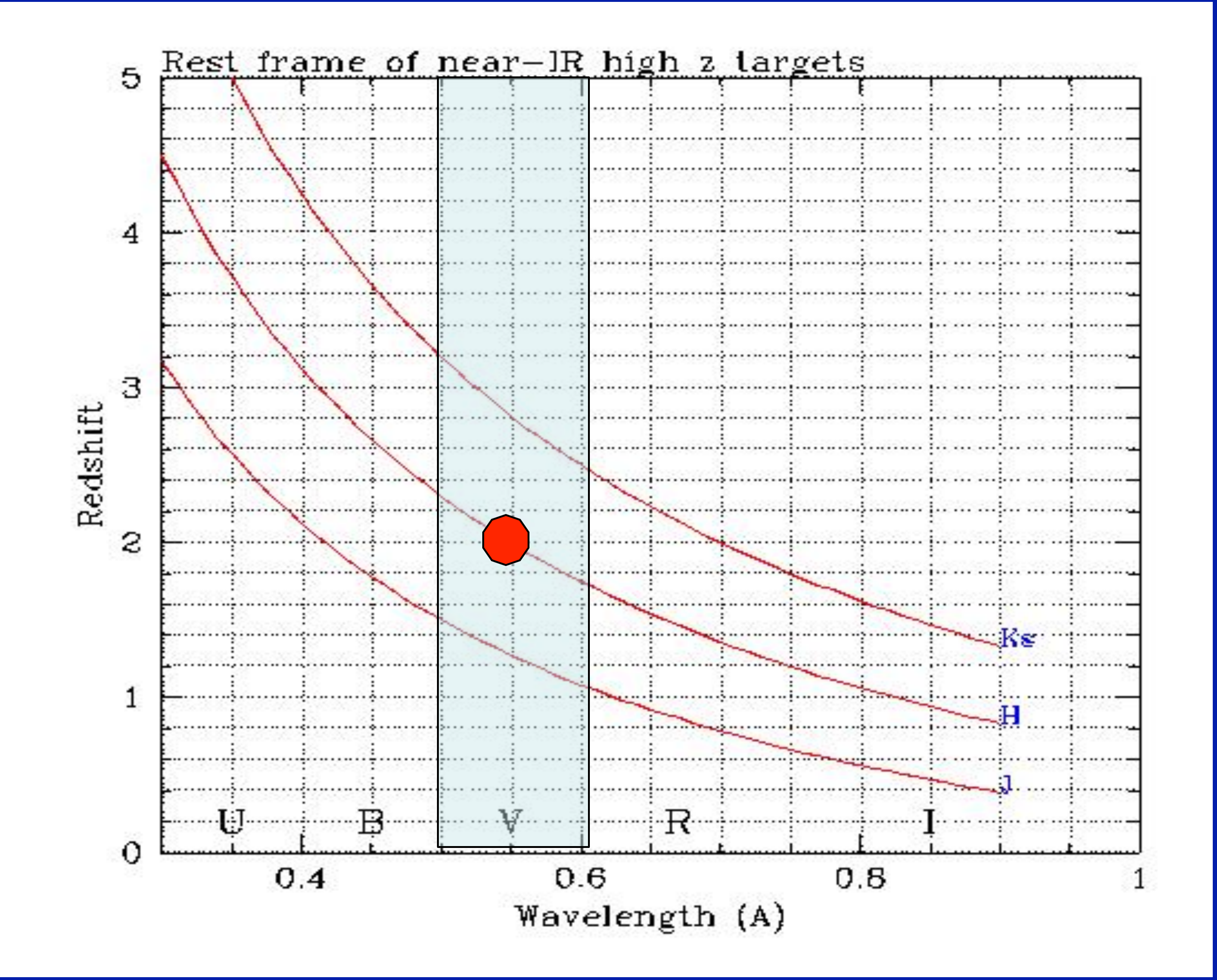
Schreiber et al 2014

Accepted 2013 October 30. Received 2013 October 30; in original form 2013 September 13

ABSTRACT

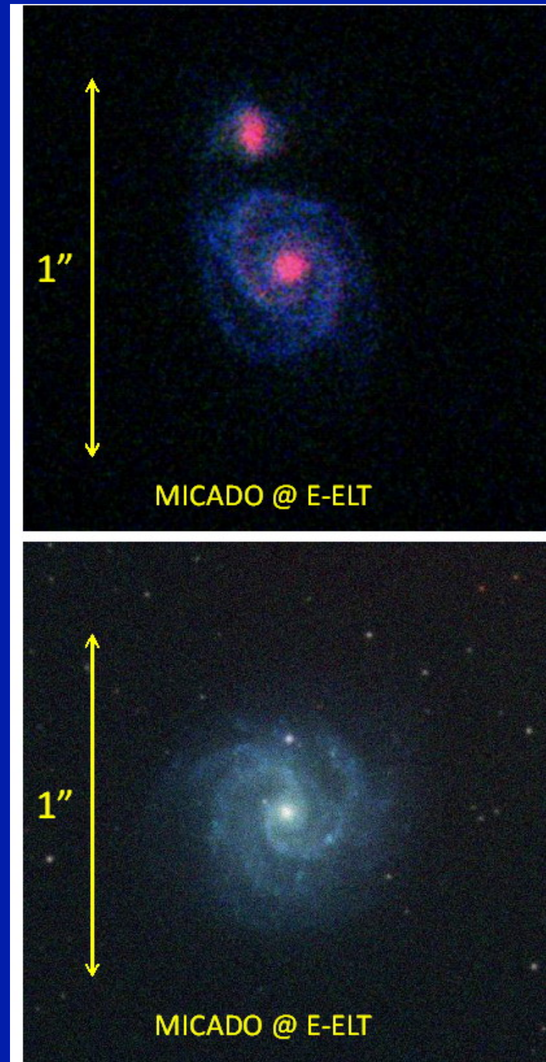
The next generation of large aperture ground-based telescopes will offer the opportunity to perform accurate stellar photometry in very crowded fields. This future capability will allow one to study in detail the stellar population in distant galaxies. In this paper we explore the effect of photometric errors on the stellar metallicity distribution derived from the colour distribution

MICADO view of high z galaxies



Color View of High Z Galaxies

AETC



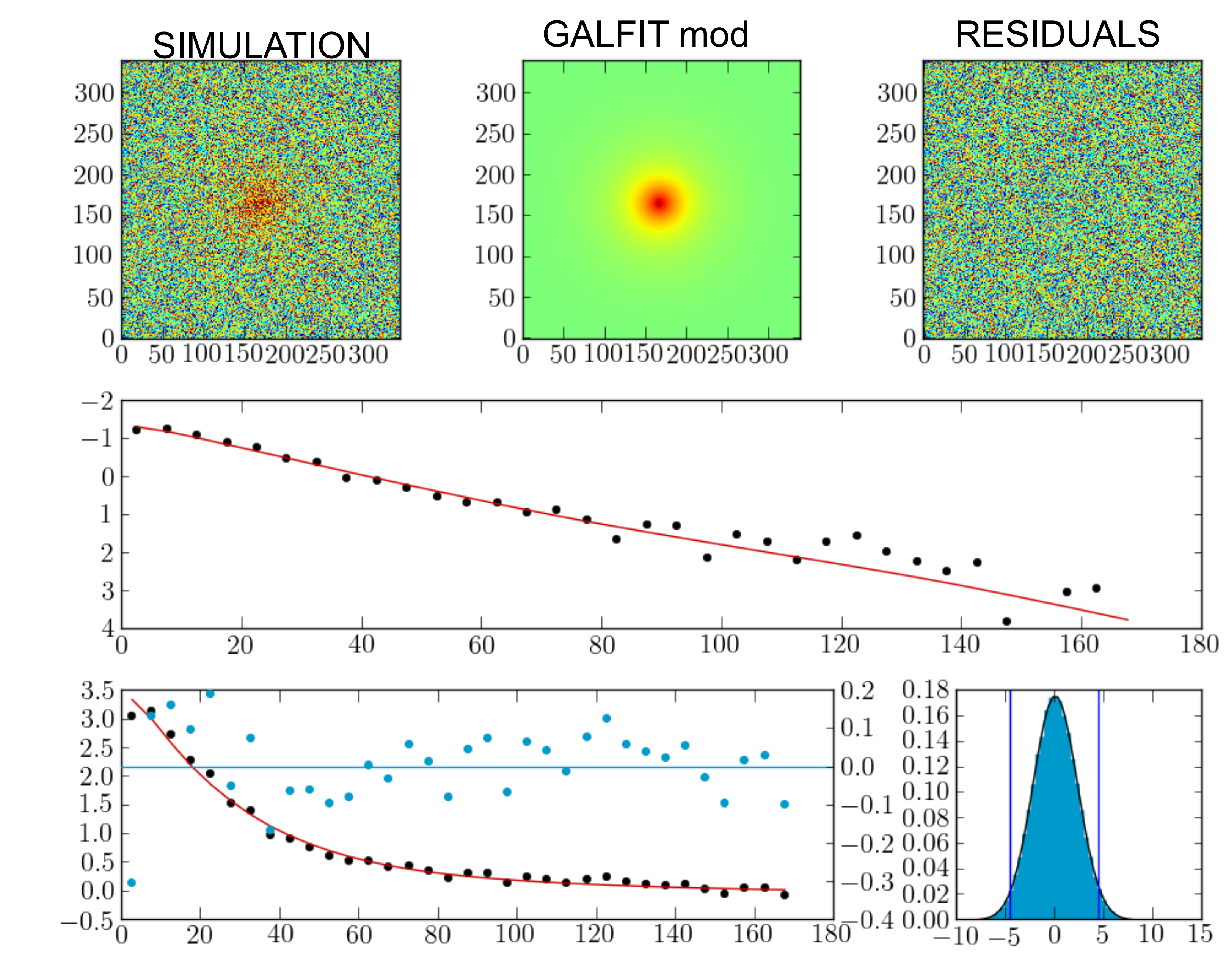
JWST will select samples & measure basic galaxy properties

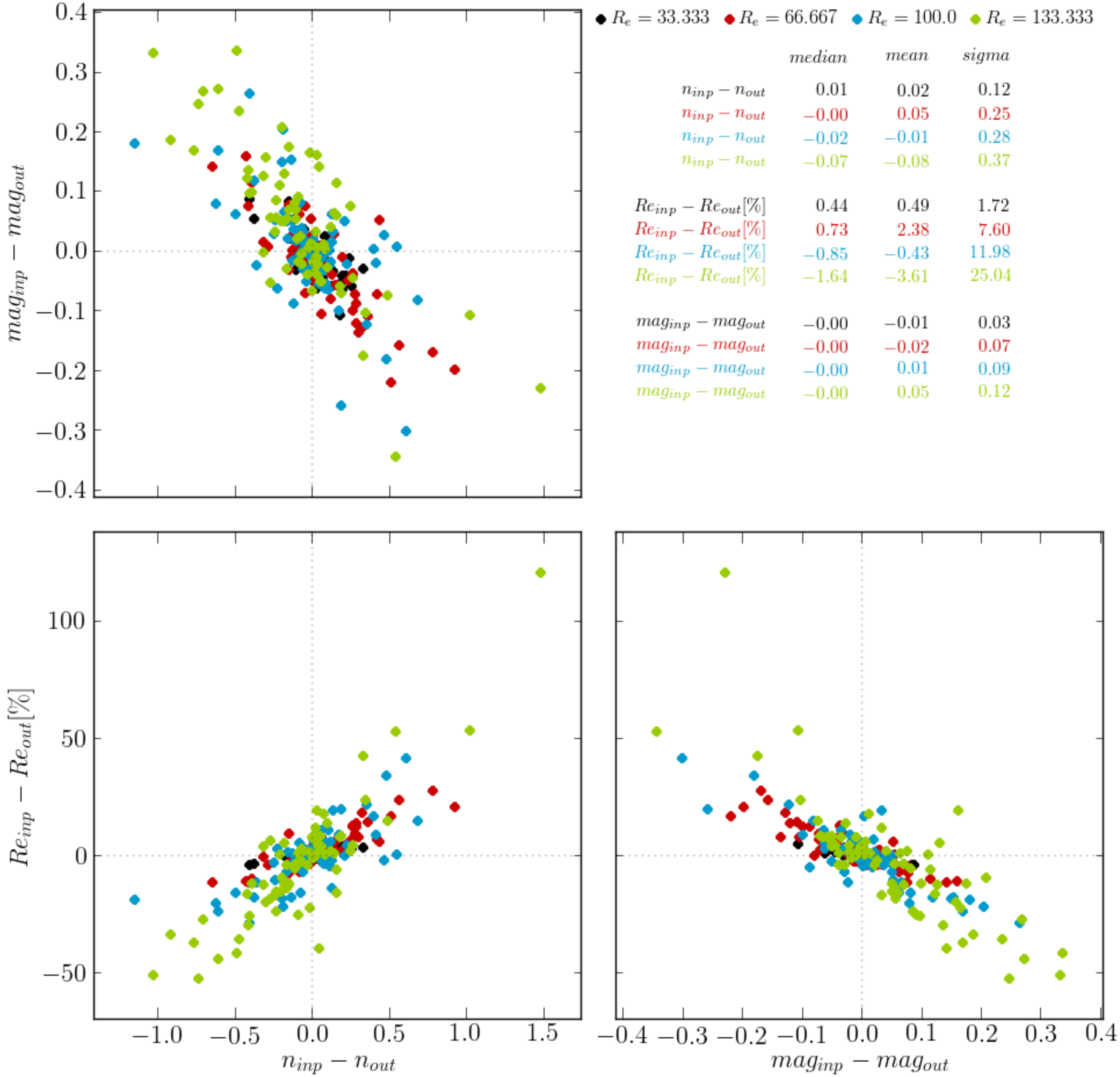
MICADO will provide the details of their structure to answer:
What are the physical processes driving their evolution?

obvious synergies with
ALMA
HARMONI
EAGLE
for kinematics (rotation curves, clump dispersions) & gas content

combined JHK images of local templates (BVR bands) shifted to z=2 (top) and z=1 (bottom), with R_{eff}=0.5” and Mv=-21.   5h integration.

SIMULATION Galaxy z = 2.2 J band 2 h , n=2.5

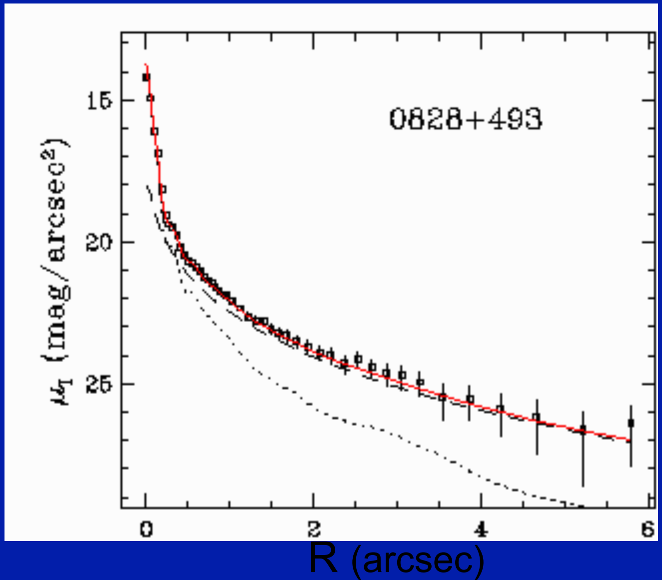




	median	mean	sigma
$n_{inp} - n_{out}$	0.01	0.02	0.12
$n_{inp} - n_{out}$	−0.00	0.05	0.25
$n_{inp} - n_{out}$	−0.02	−0.01	0.28
$n_{inp} - n_{out}$	−0.07	−0.08	0.37
$Re_{inp} - Re_{out}[\%]$	0.44	0.49	1.72
$Re_{inp} - Re_{out}[\%]$	0.73	2.38	7.60
$Re_{inp} - Re_{out}[\%]$	−0.85	−0.43	11.98
$Re_{inp} - Re_{out}[\%]$	−1.64	−3.61	25.04
$mag_{inp} - mag_{out}$	−0.00	−0.01	0.03
$mag_{inp} - mag_{out}$	−0.00	−0.02	0.07
$mag_{inp} - mag_{out}$	−0.00	0.01	0.09
$mag_{inp} - mag_{out}$	−0.00	0.05	0.12

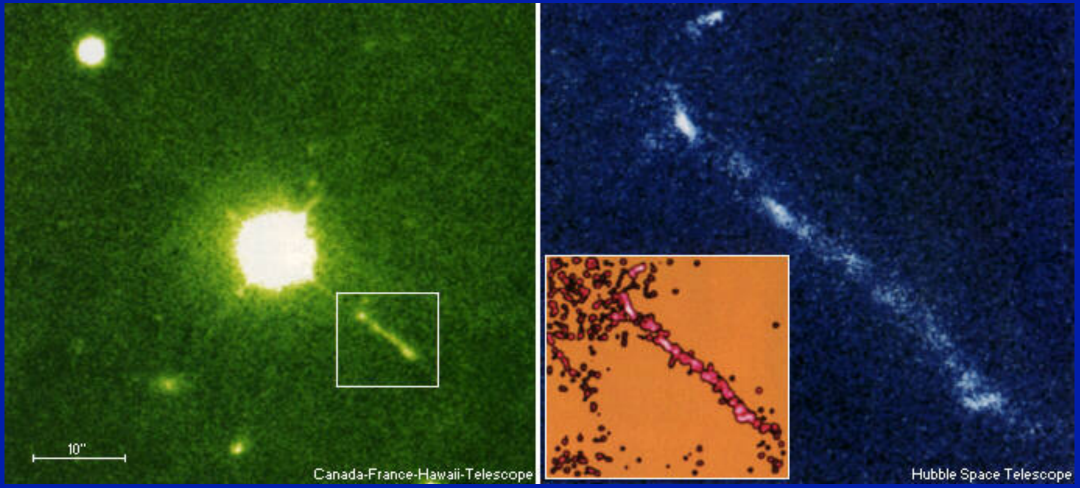
Imaging the QSO Host Galaxies

QSO-host observations: faint extended nebulosity that is superposed over a bright point-like source.

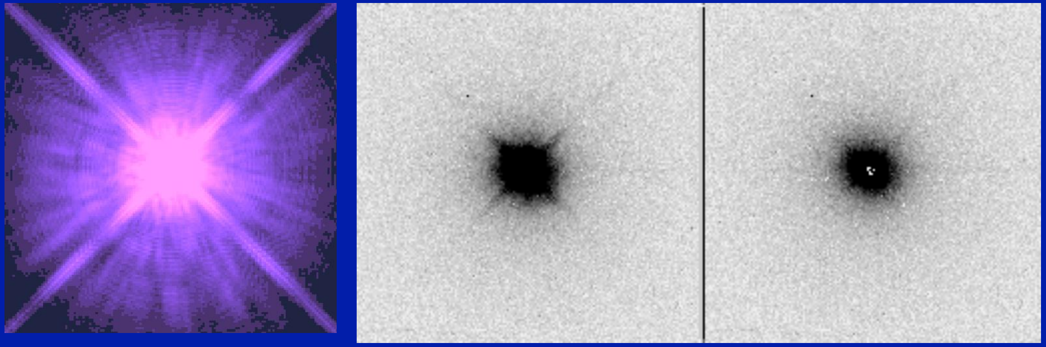


Host galaxies study needs good PSF and high efficiency to measure the faint surface brightness over the background.

3C 273



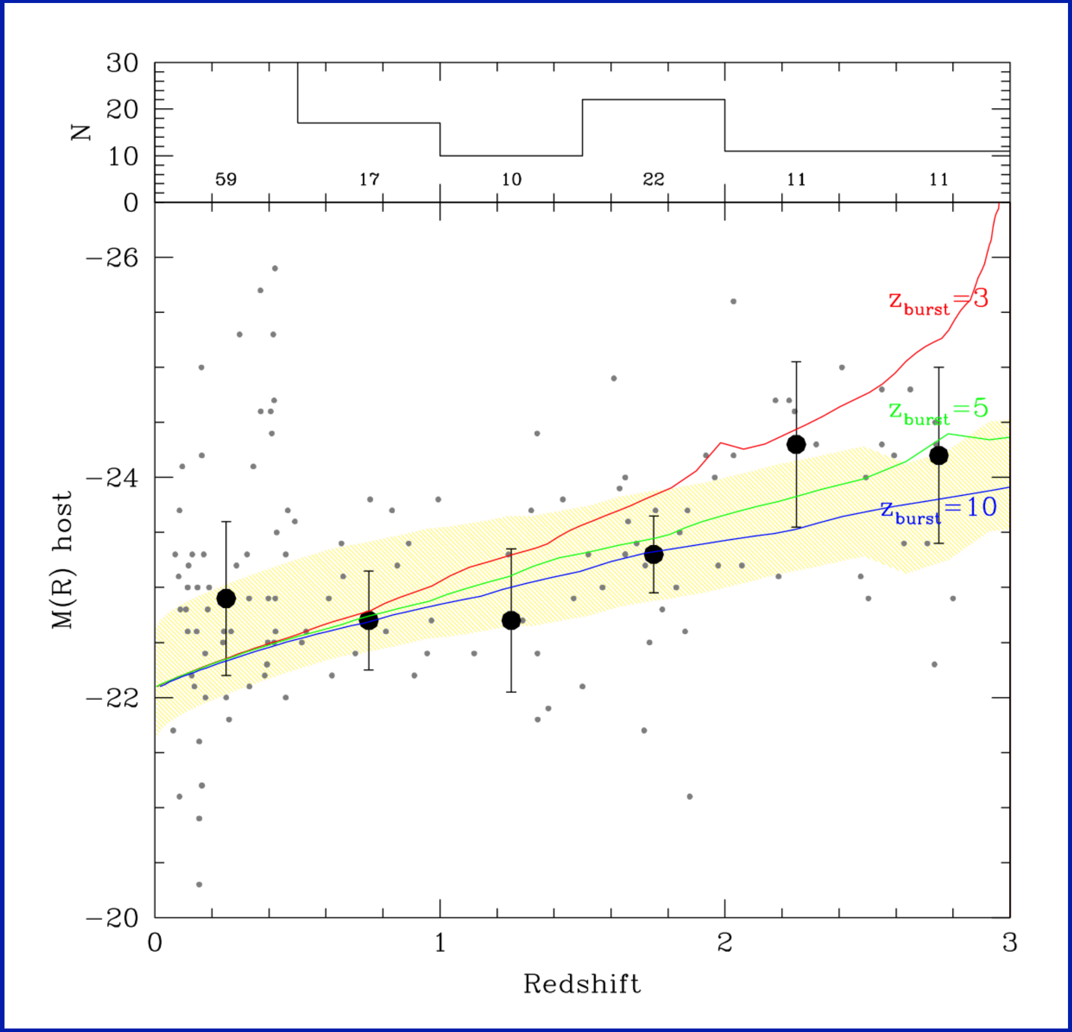
PKS 0828+49 (z = 0.548)



HST-PSF OBJ OBJ-PSF

Quasar hosts and SMBH evolution

Quasar hosts appear to follow the luminosity evolution of massive spheroidal dominated galaxies up to z ~3



Kotilainen+2009

Quasar hosts and SMBH evolution

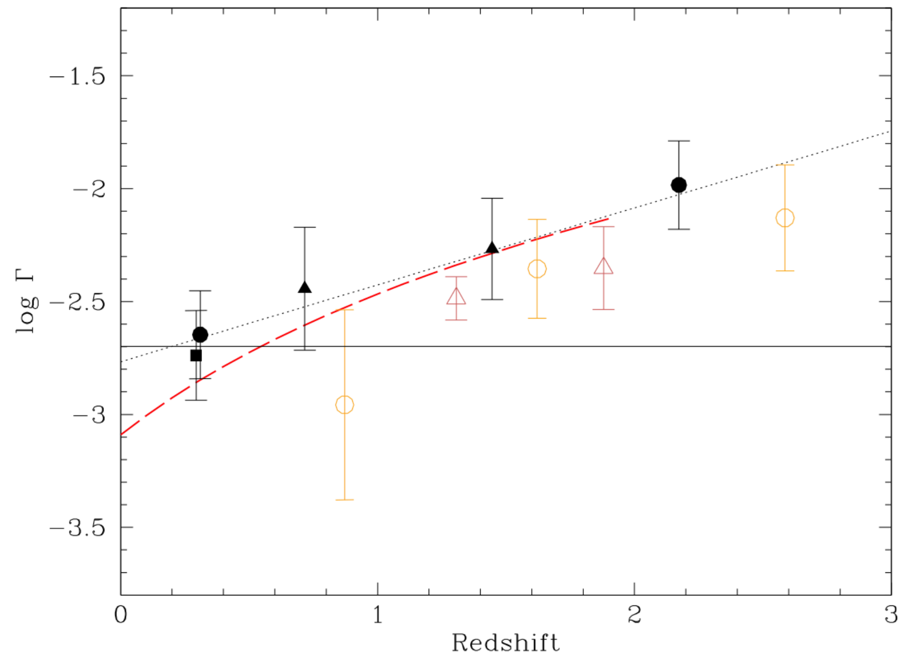
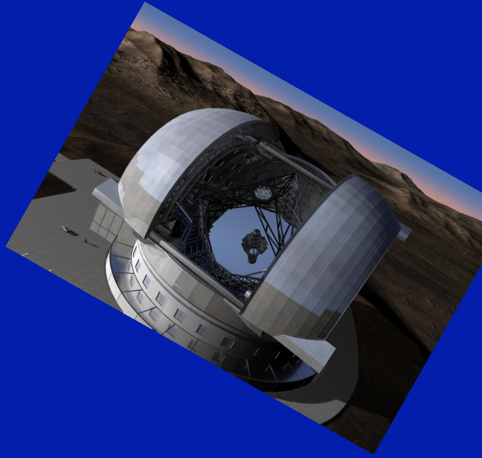


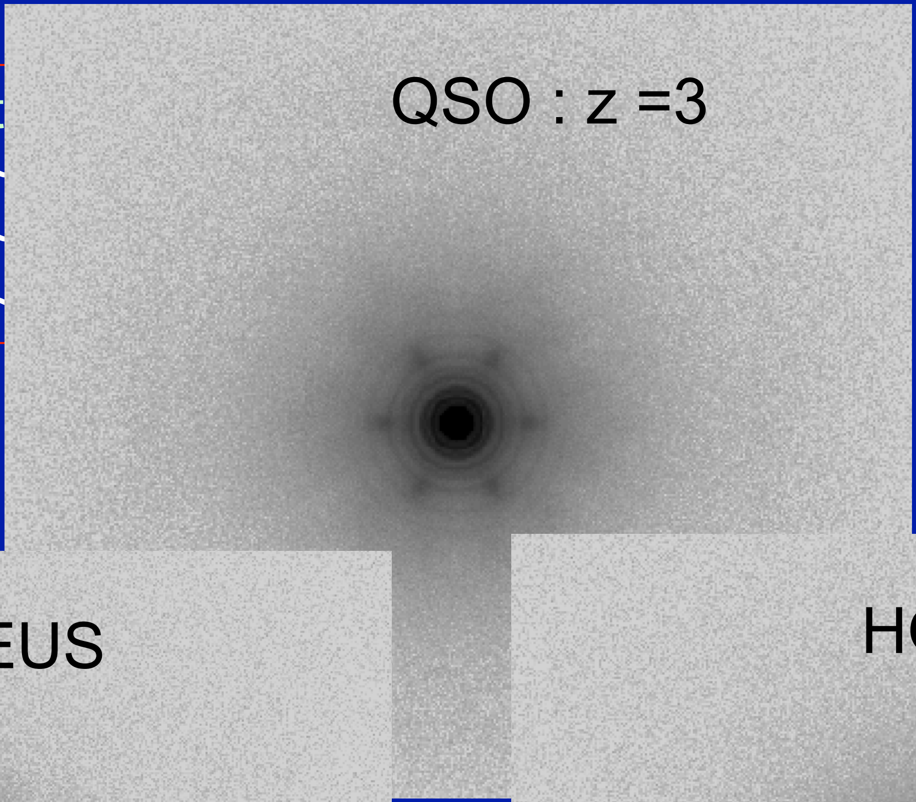
Figure 8. The average values of Γ for the quasars in our sample (filled symbols), together with the linear best fit (dotted line). Error bars are the 2-σ uncertainties in the average values for each data bin. For a comparison, the trend found in the study of radio loud AGN by McLure et al. (2006) is plotted as a dashed line. We also plot the average Γ values of the 51 lensed and non-lensed quasars from Peng et al. (2006a,b) (empty circles) and of the 89 AGN from Merloni et al. (2009) (empty triangles). The horizontal solid line represents the constant $\Gamma = 0.002$ case. All together the data depict an increase of Γ with z.

Decarli+2010

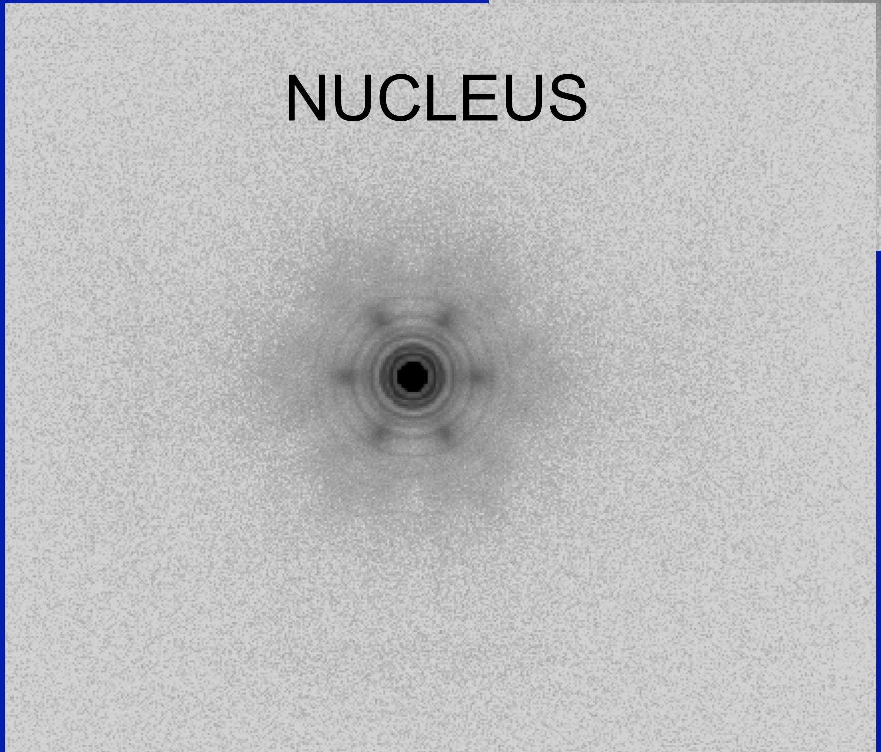
High z quasar hosts with ELTs

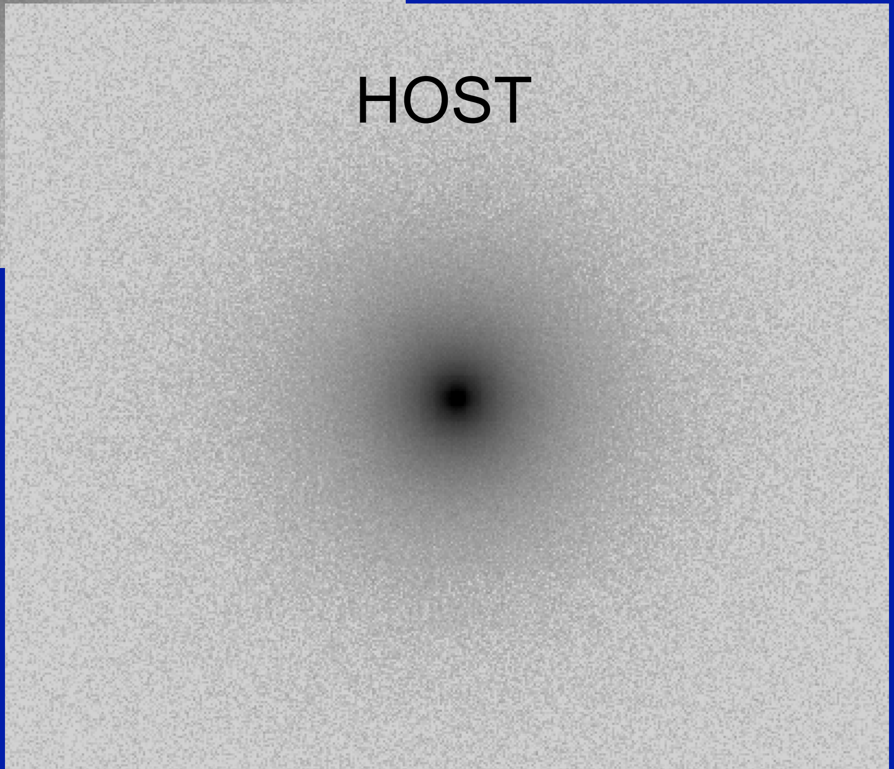
K band observat
V @ z ~
B @ z ~
U @ z ~





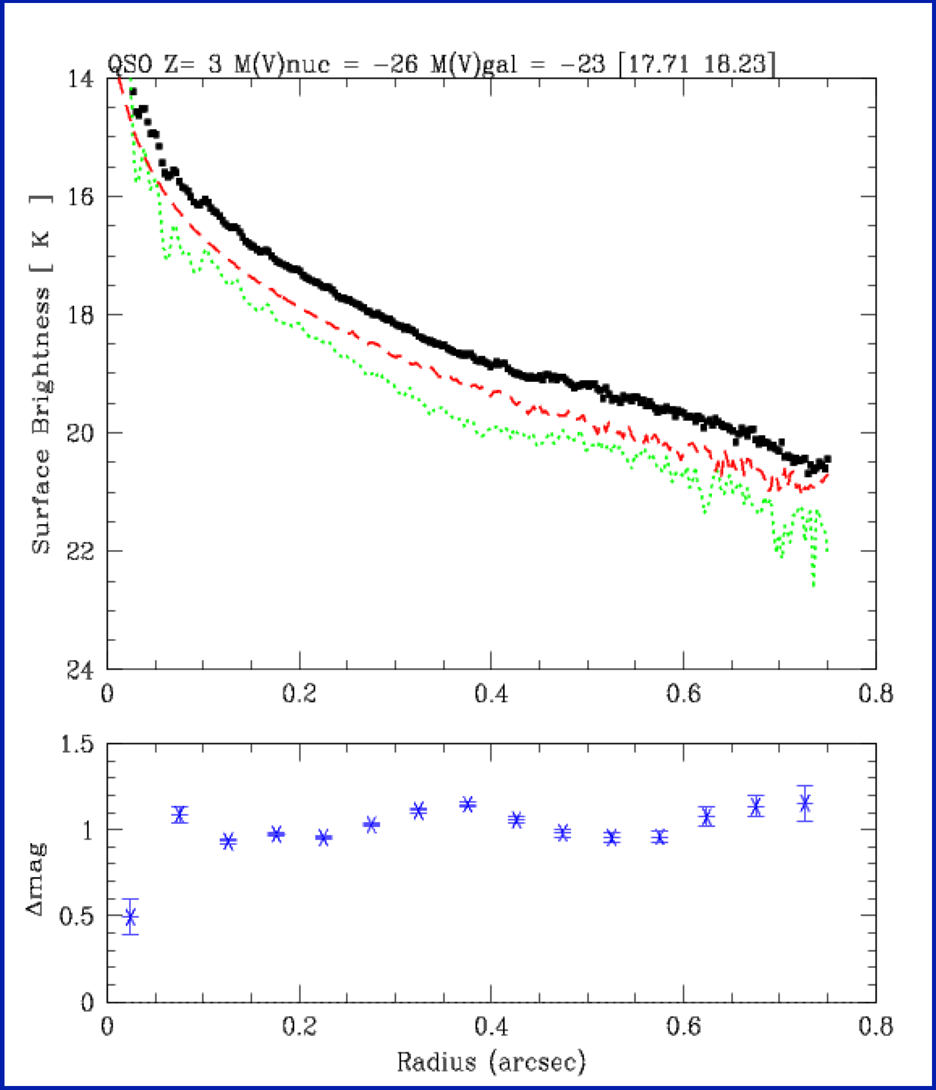
SIMULATION

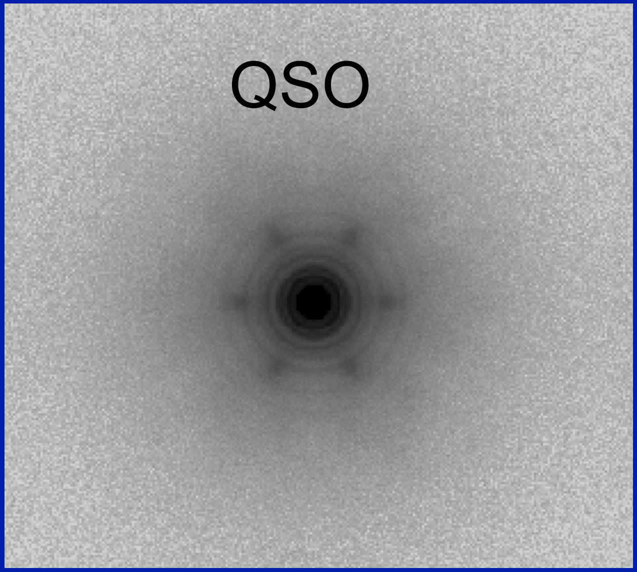




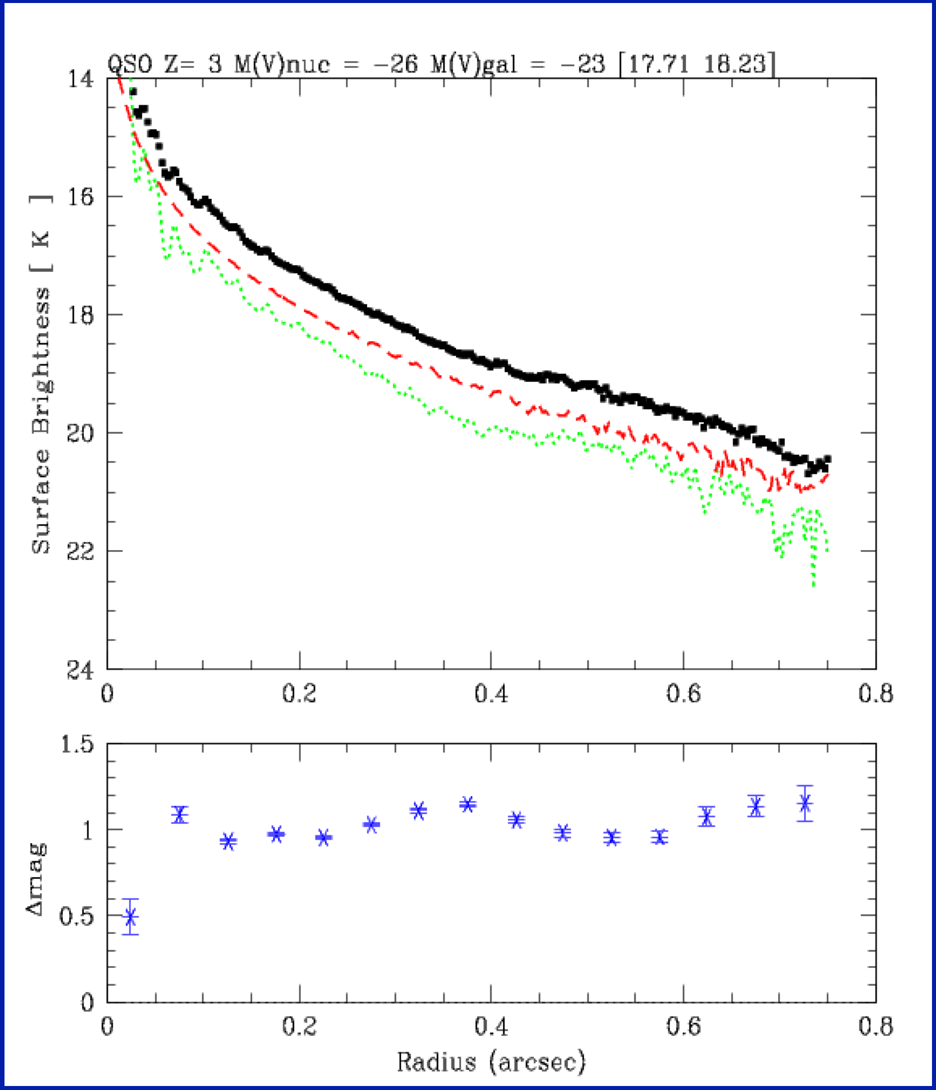
High z quasar hosts with ELTs

SIMULATION

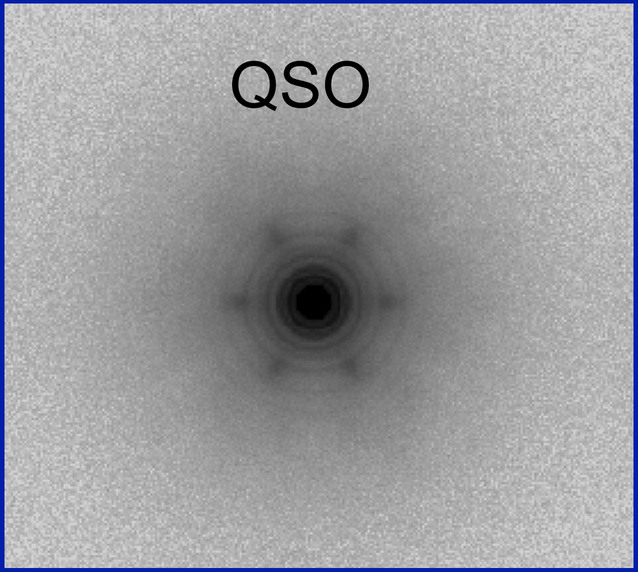




High z quasar hosts with ELTs

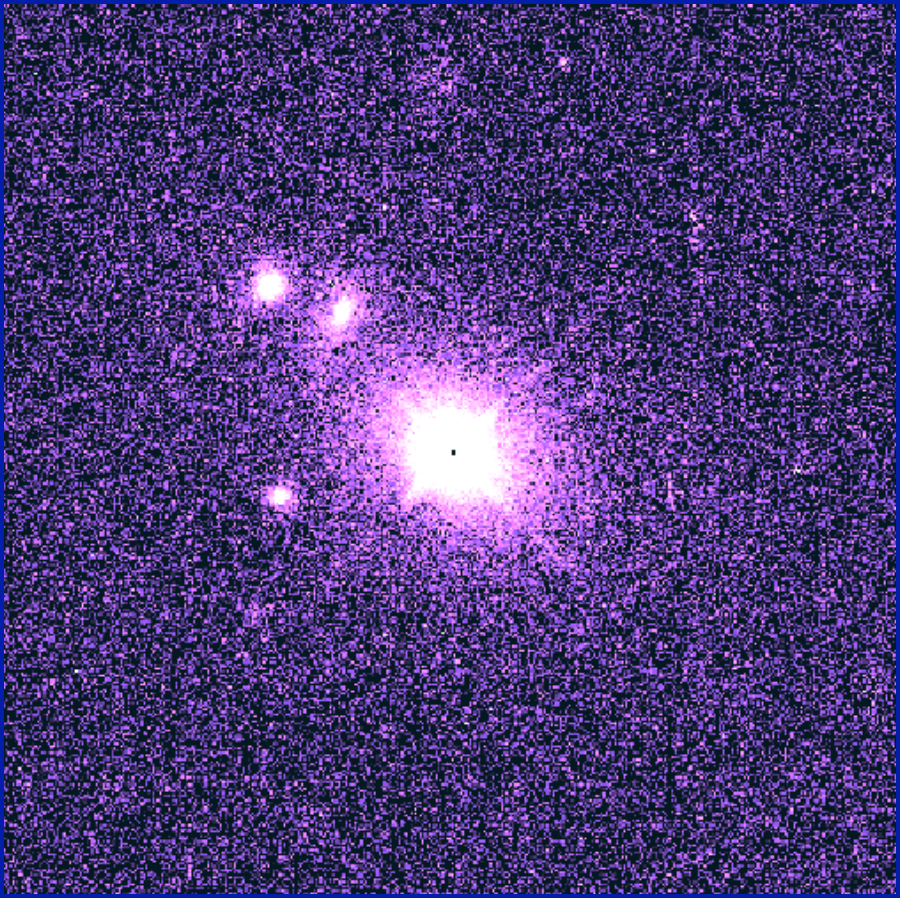


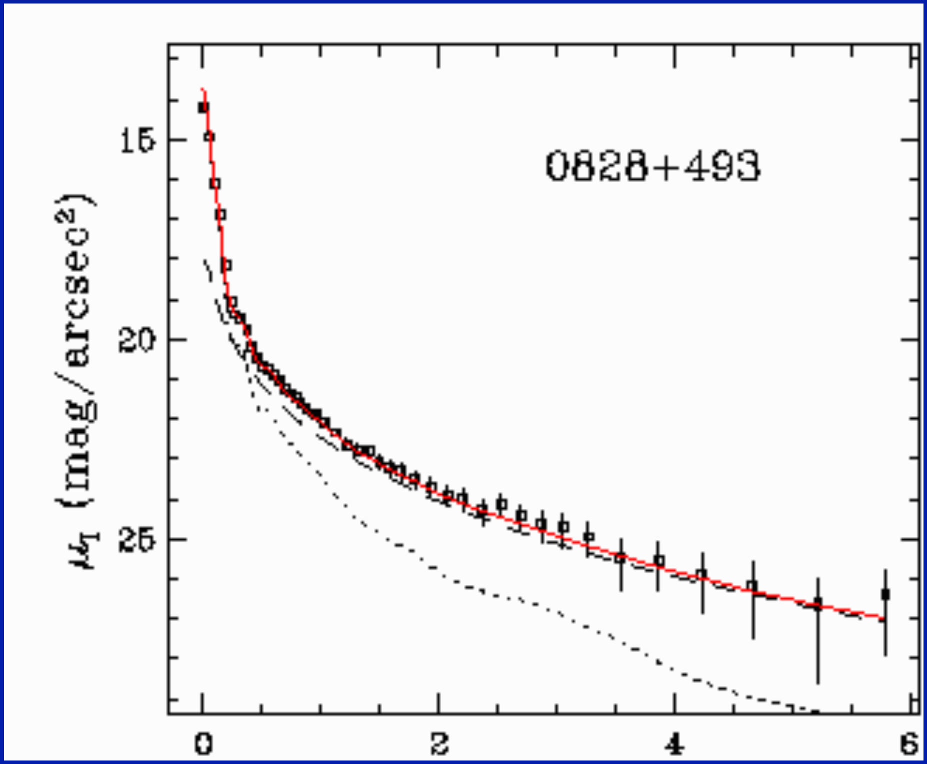
SIMULATION



Redshift of BL Lacs

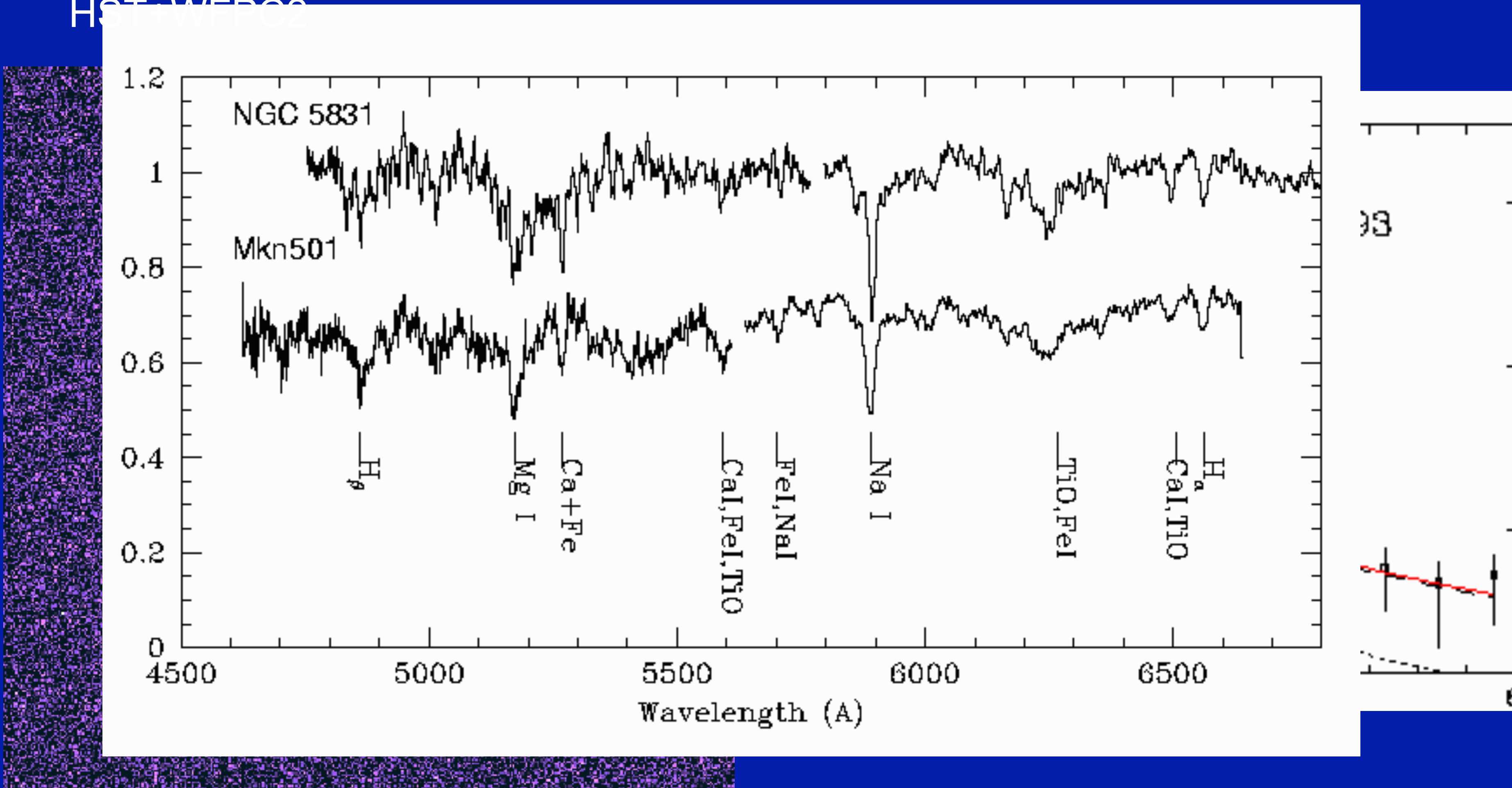
HST+WFPC2



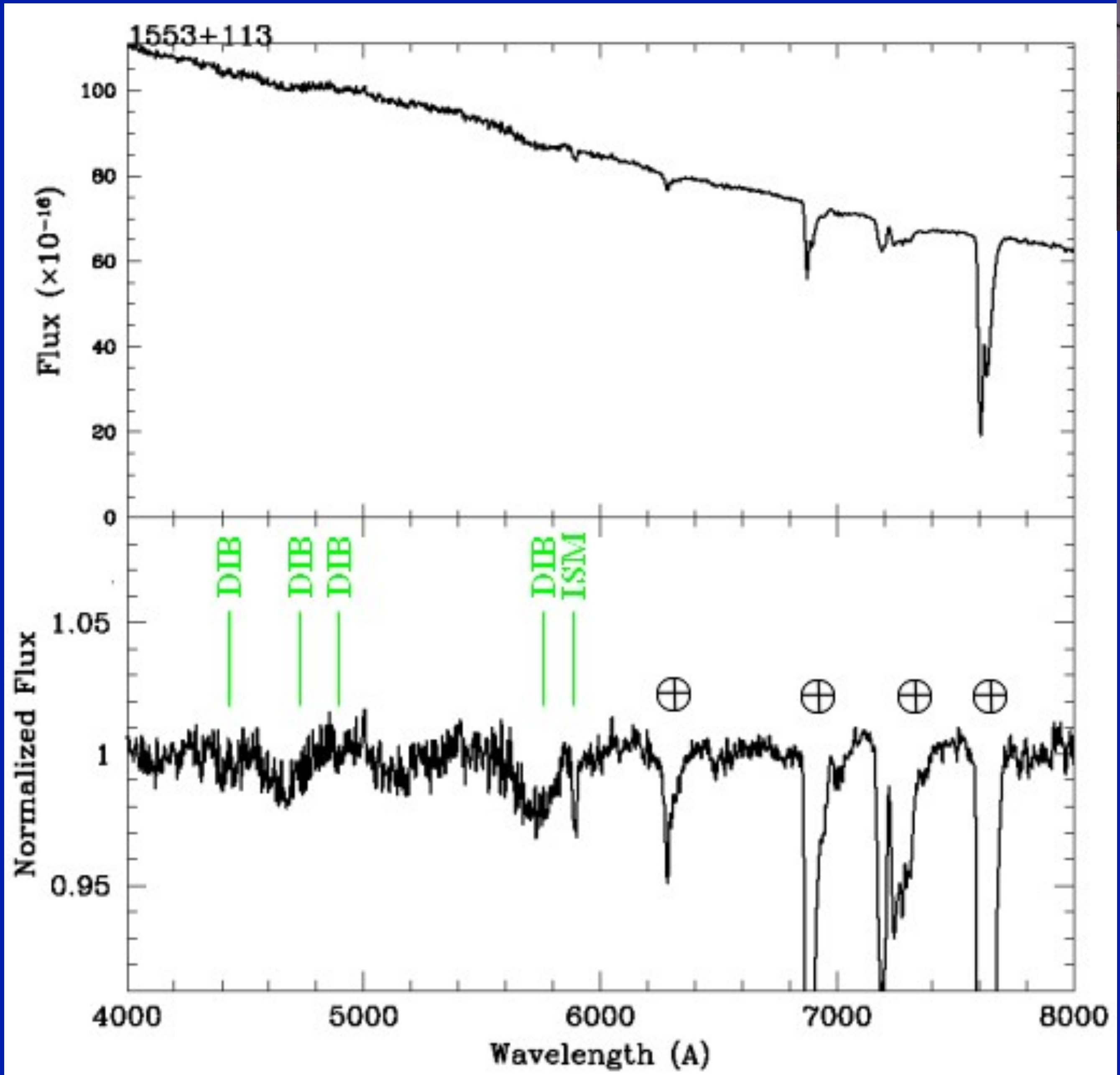


Redshift of BL Lacs

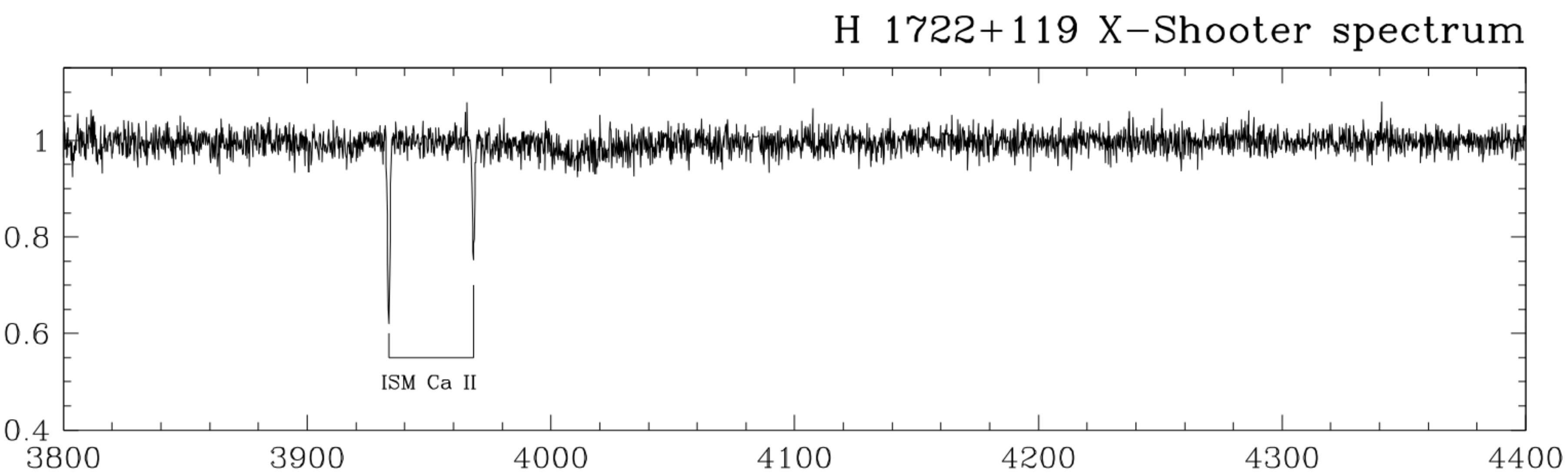
HST+WFPC2



Redshift of BL Lacs

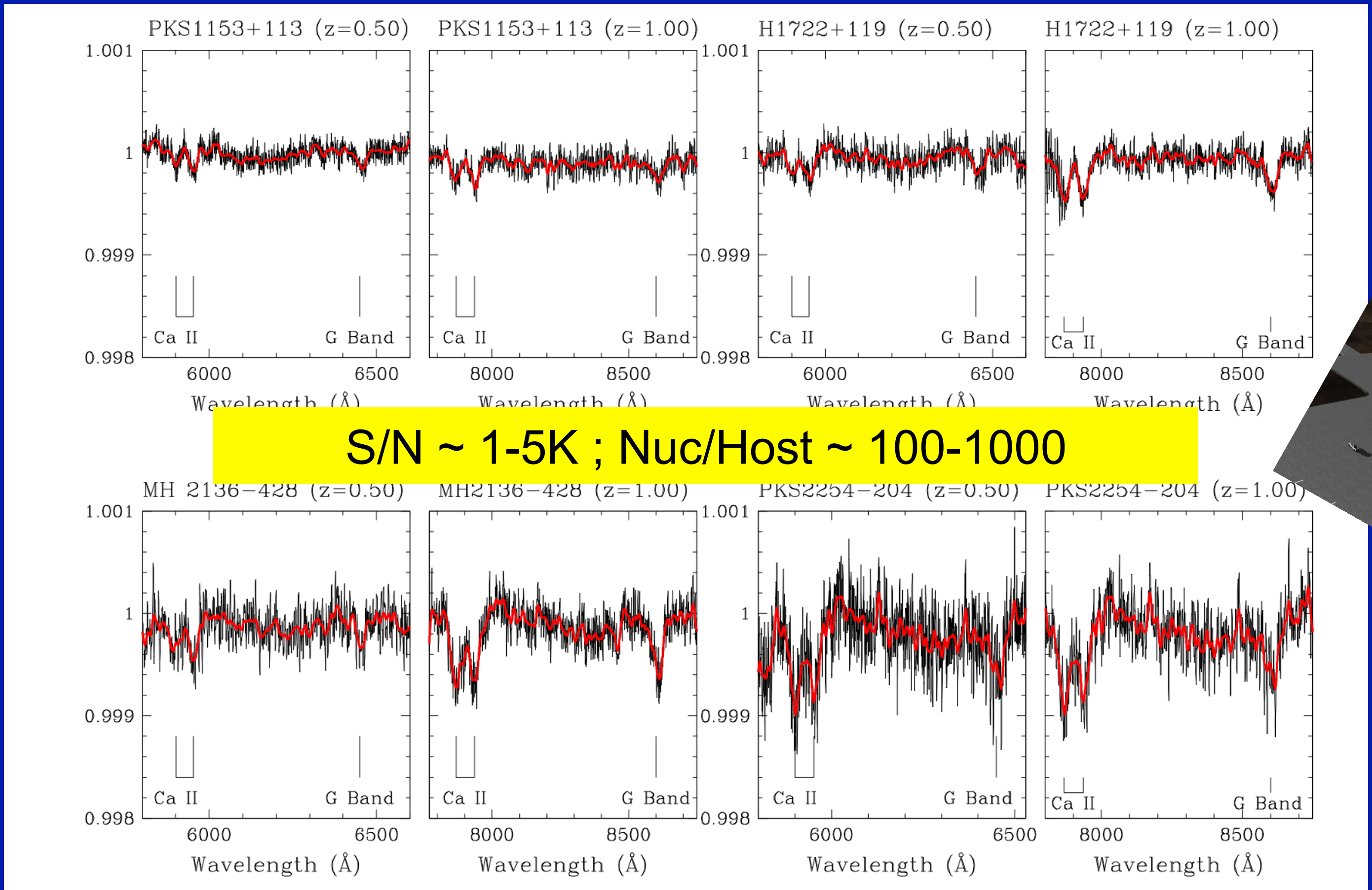


Redshift of BL Lacs



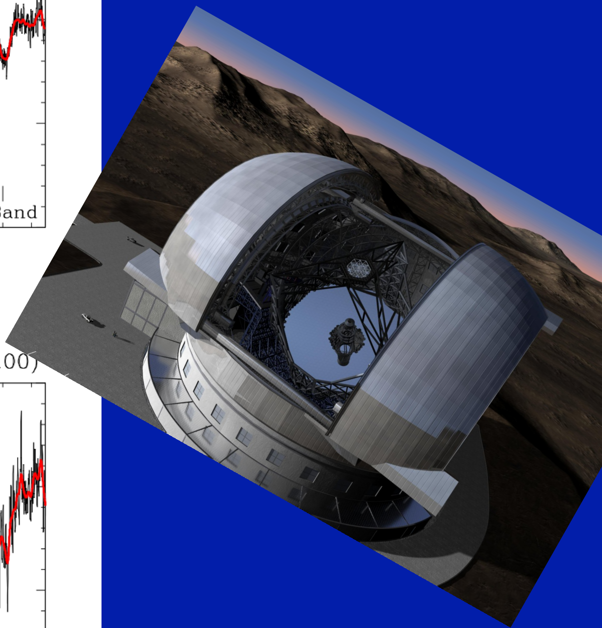
pure featureless spectrum

Redshift of BL Lacs (by ELTs)



S/N ~ 1-5K ; Nuc/Host ~ 100-1000

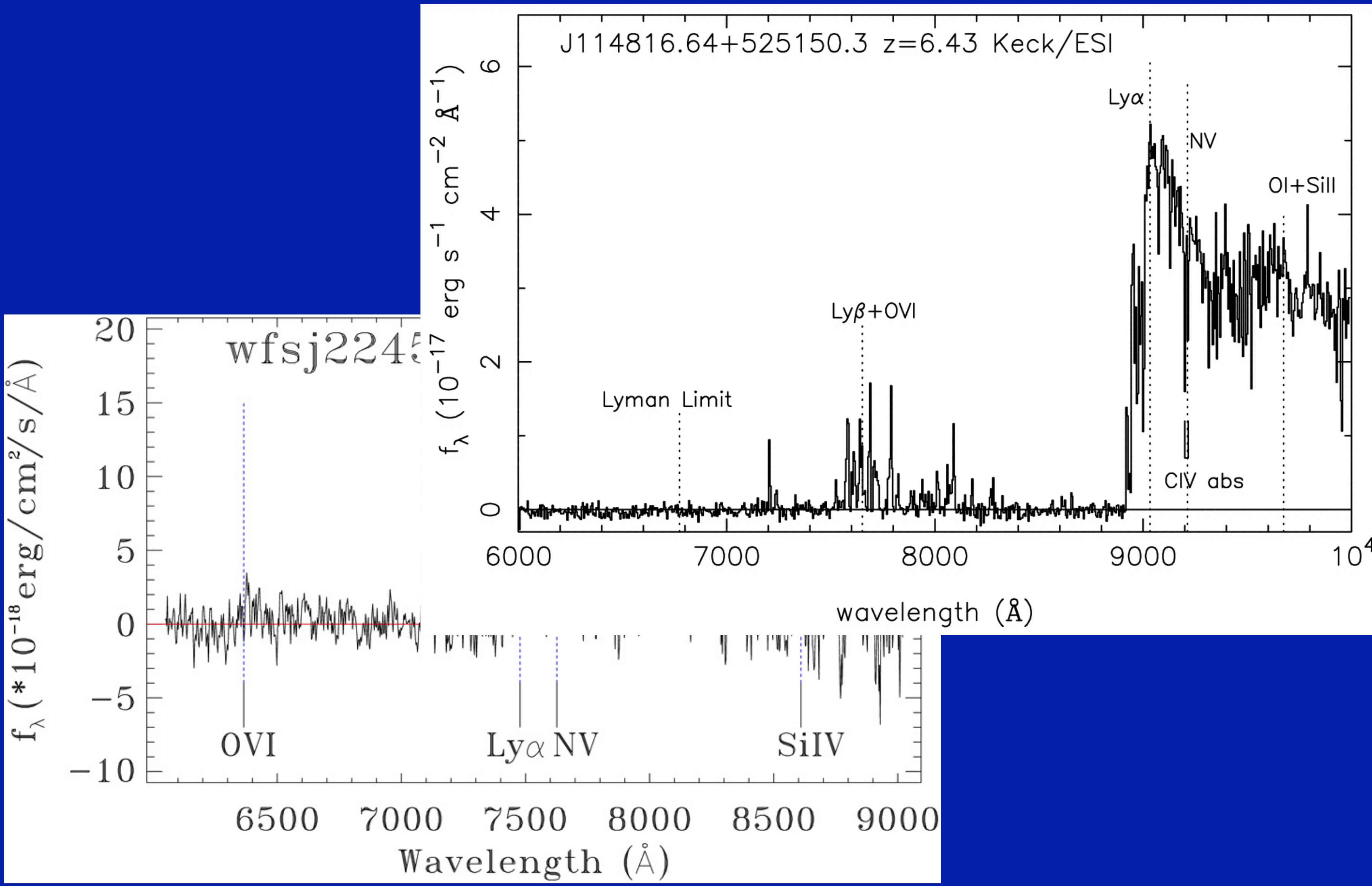
Fig. 5. Simulated spectra of four BL Lacs using E-ELT equipped with an X-SHOOTER like instrument (t_{exp} = 3600s, $R \sim 3000$). For each object we report two cases at z = 0.50 on the left panel and z = 1.00 on the right panel. The red solid line is the smoothed spectrum obtained by the adoption of a boxcar filter (9 pixels). The spectra represent the maximum N-H flux ratio for which it is possible to detect Ca II and G Band absorption lines of the host galaxy (see details in Table 2).



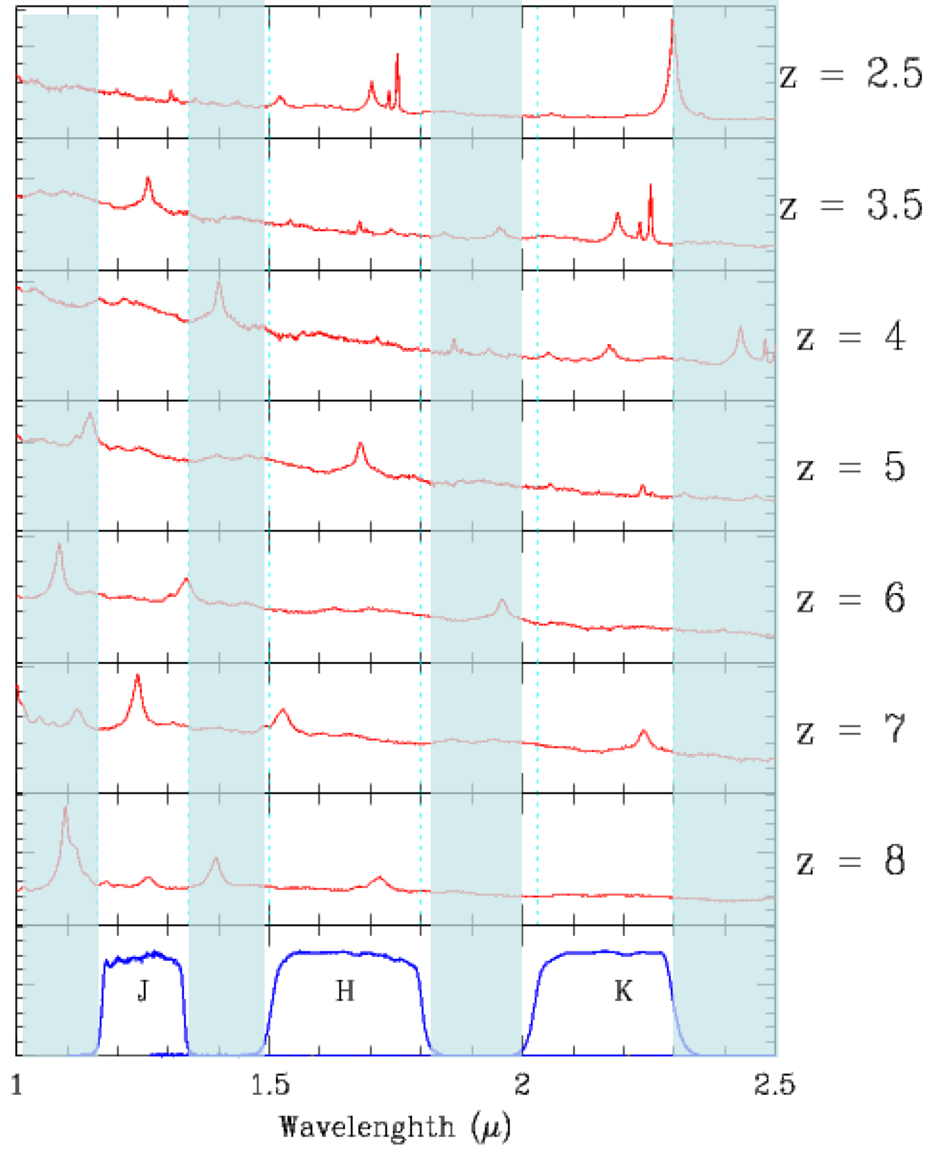
ALL redshifts of BL Lacs known in the ELT era

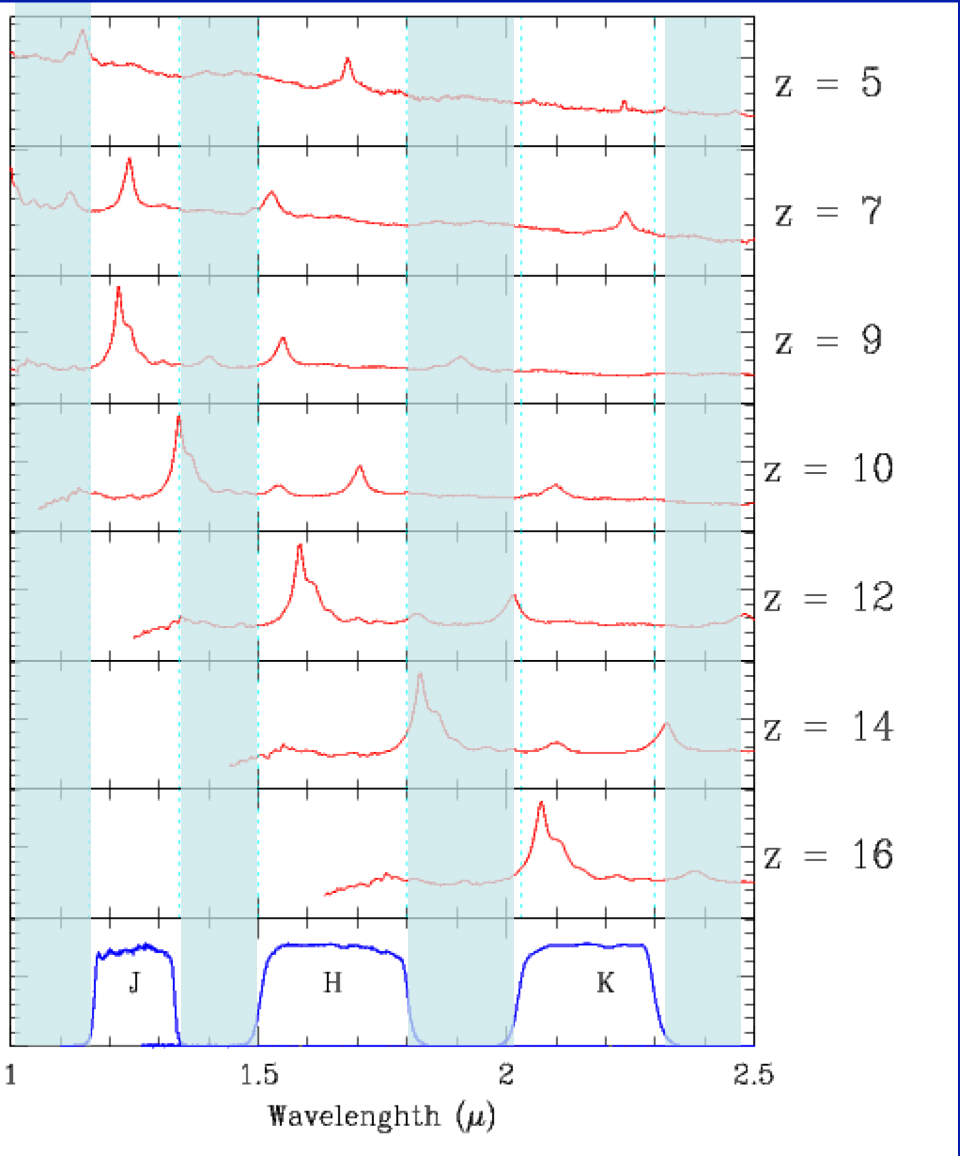
Landoni et al 2014,,

QSO spectroscopy in the ELT era

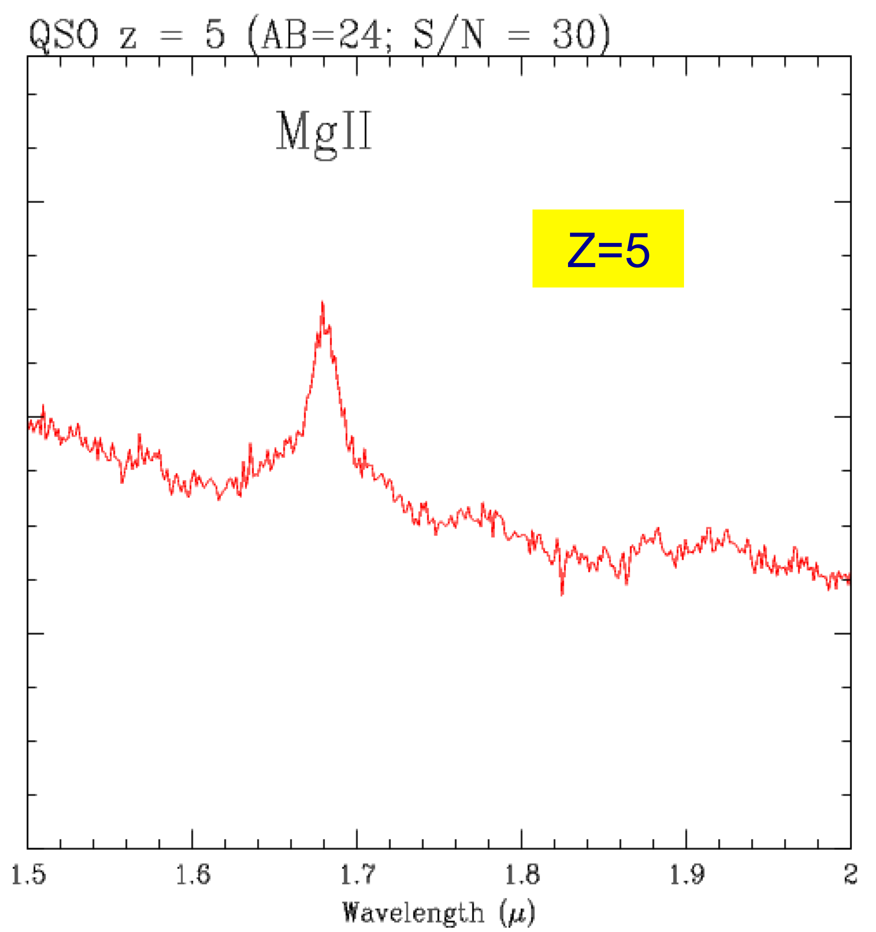


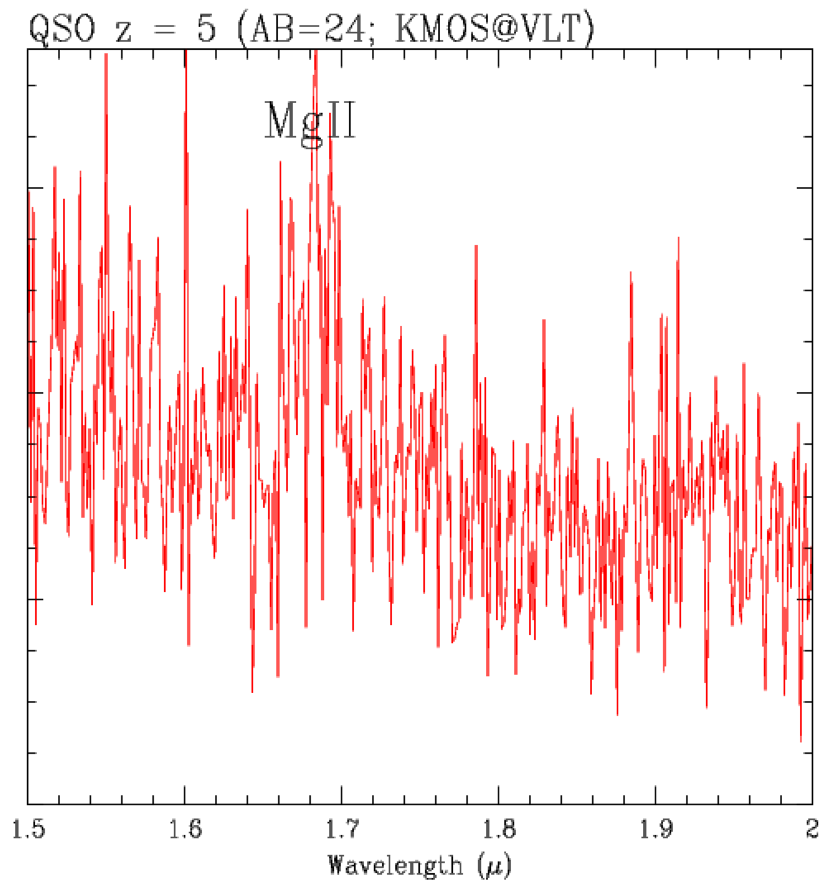
QSO spectroscopy in the ELT era



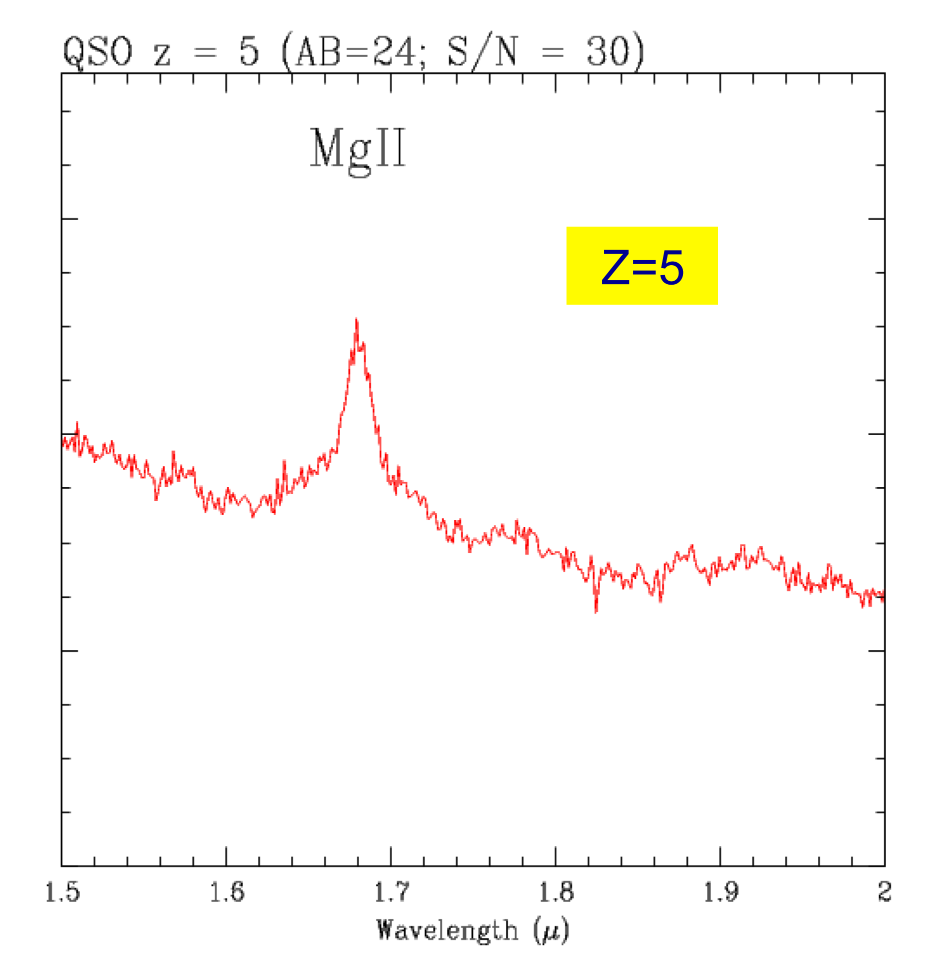


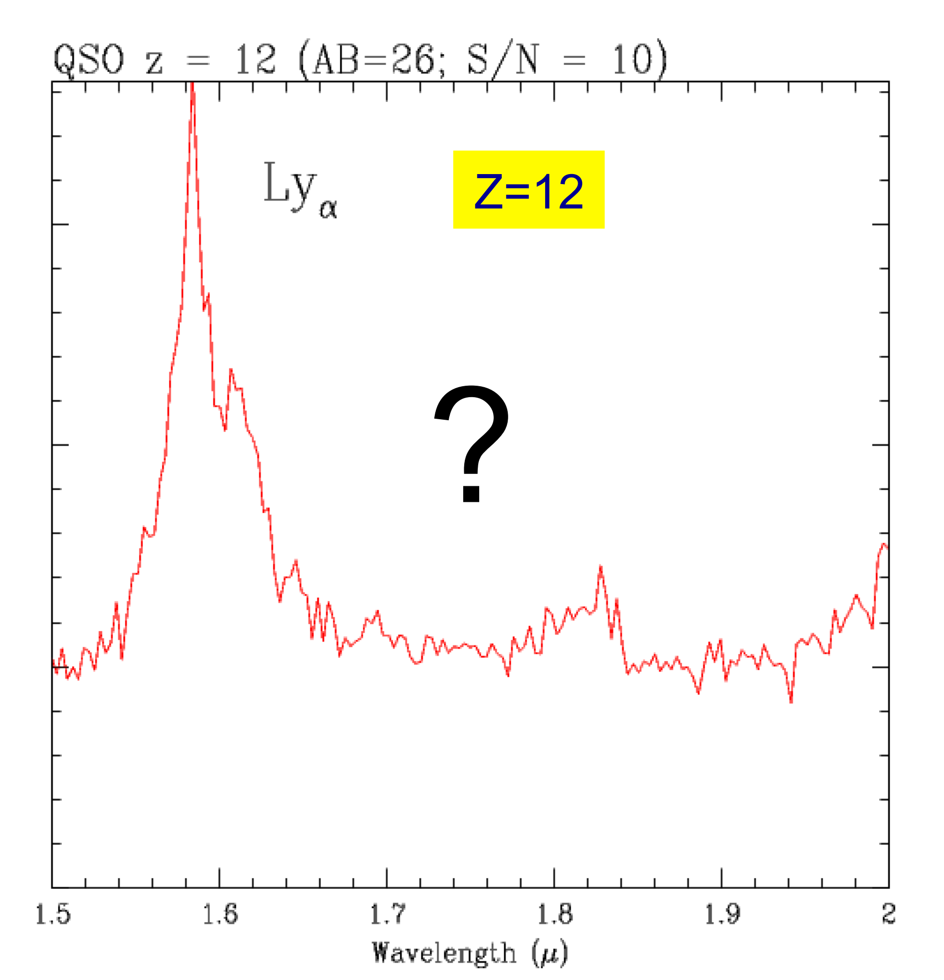
QSO spectroscopy in the ELT era





QSO spectroscopy in the ELT era






AGN 17 Sept 2026
Thank you