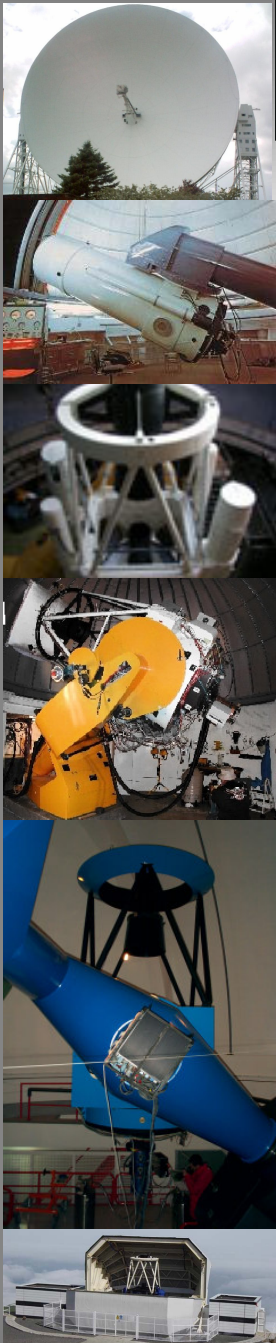
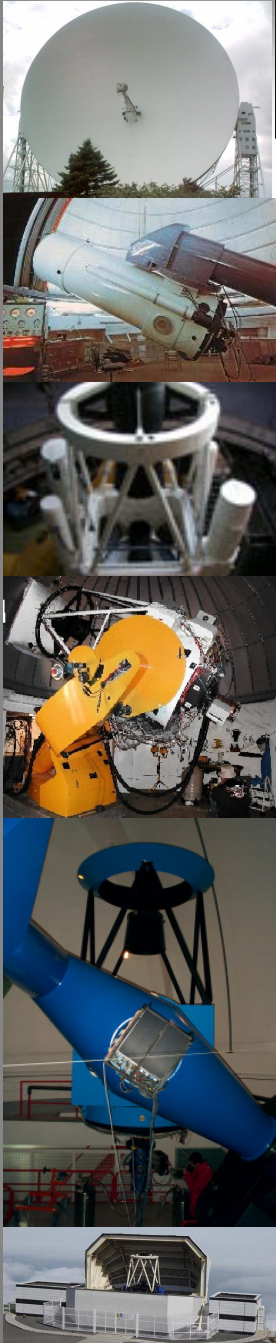


OBSERVING QUASARS LENSED BY A CLUSTER OF GALAXIES WITH GTC-OSIRIS

Tomás Verdugo
Guillermo Manjarrez
José A. de Diego
Darío Núñez
Vladimir Ávila
Jesús González

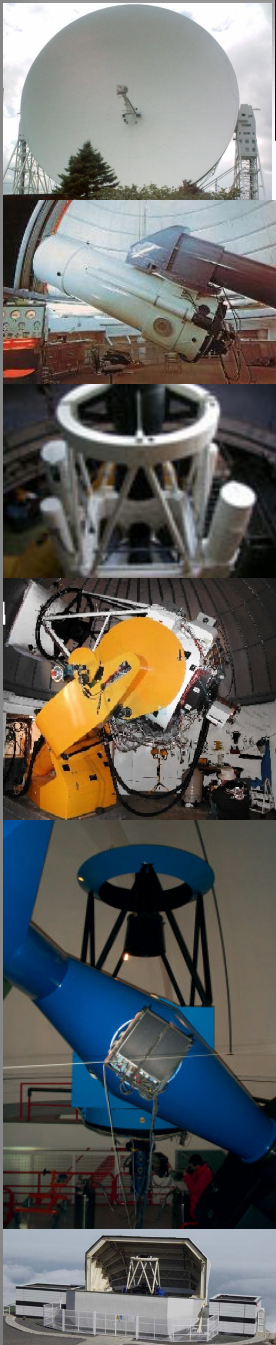




- Emission line objects at high redshift
- GTC-OSIRIS
- Detection of LAEs behind a cluster of galaxies with GTC-OSIRIS
- Example case
- Statistics
- Conclusions

Emission line objects at high redshift

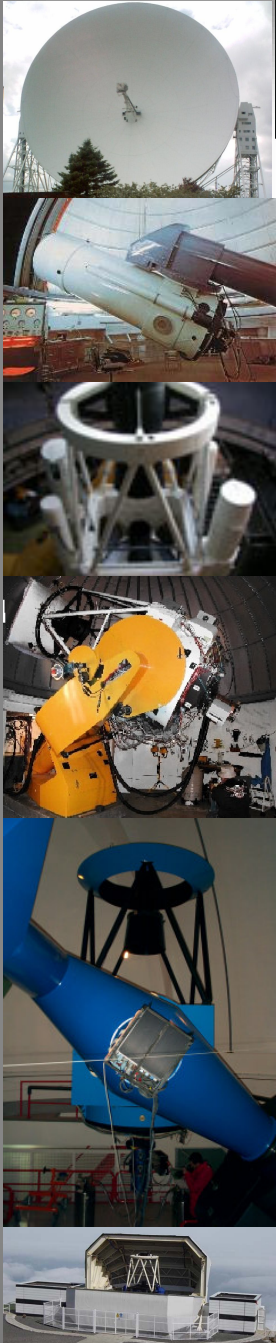
- AGN
- Stellar formation regions
- LAEs
Very strong Ly $_{\alpha}$ emission line (10^{43} erg /s)
FWHM : 20 – 30 Å ($3 < z < 5$)
Low-Luminosity LAEs at high redshift (Santos et al. 2004)



GTC-OSIRIS

OSIRIS (Optical System for Imaging and low Resolution Integrated Spectroscopy)

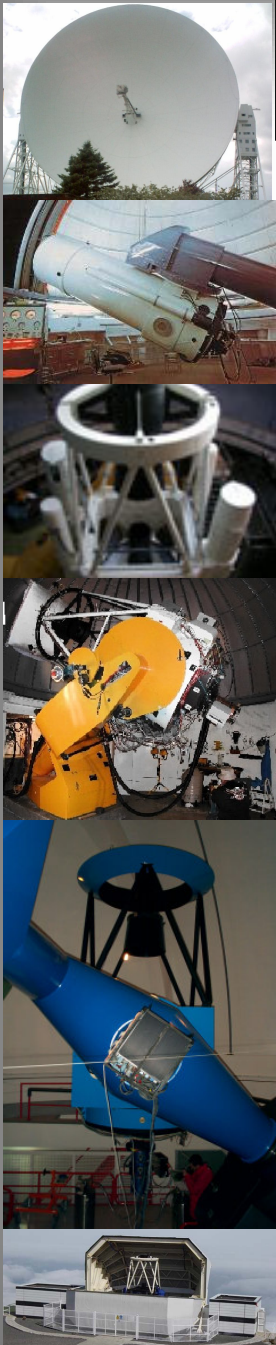
- Field of view
 - 8.53' x 8.53' (Imaging)
 - 8.00' x 5.20' (Spectrograph)
- P.S. 0.125 arcsec/pixel
- Range: 365-1000 nm
- Tunable filters
 - Resolutions 200-2000

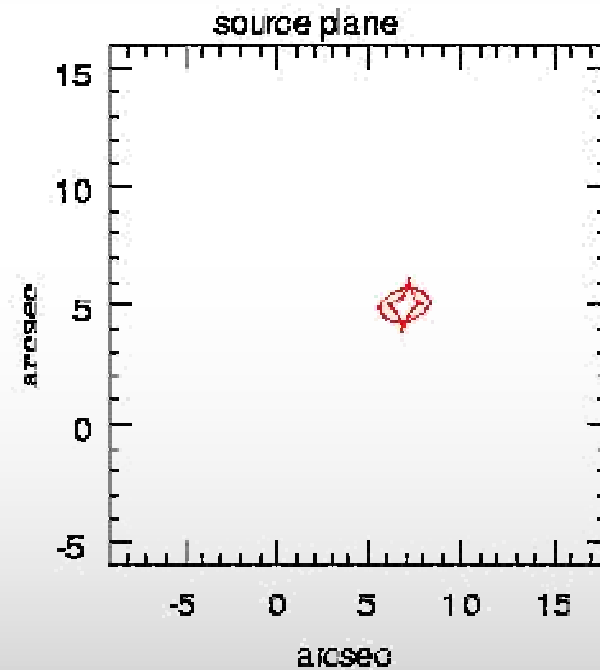
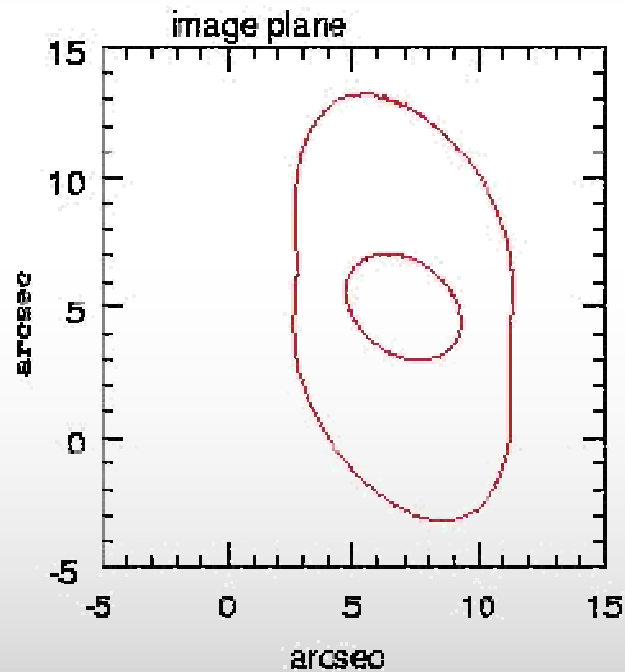
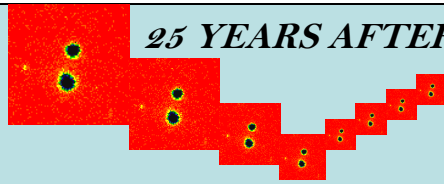
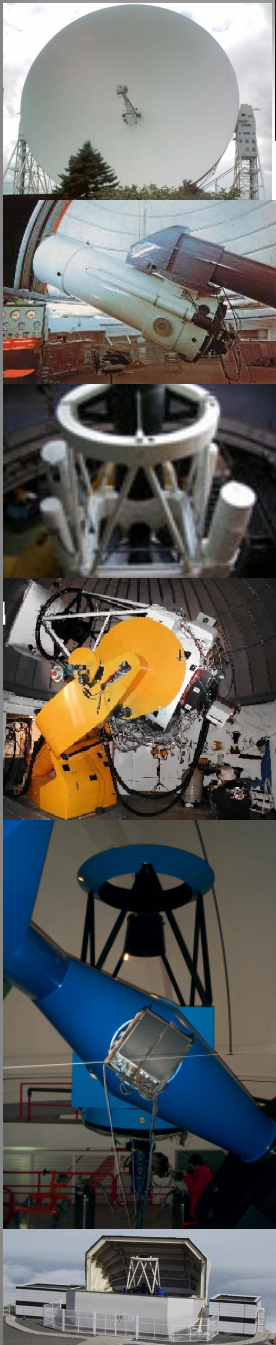


Detection of LAEs behind a cluster of galaxies with GTC-OSIRIS

- Low-Luminosity LAEs: $L \sim 10^{41}$ erg s⁻¹
- $F \sim 10^{-18}$ erg cm⁻² s⁻¹ for $3.0 < z < 5$

— m_{30-31}
v

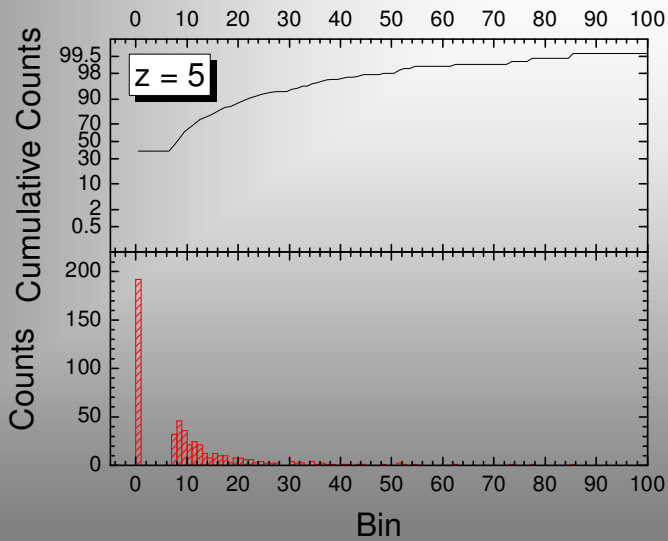
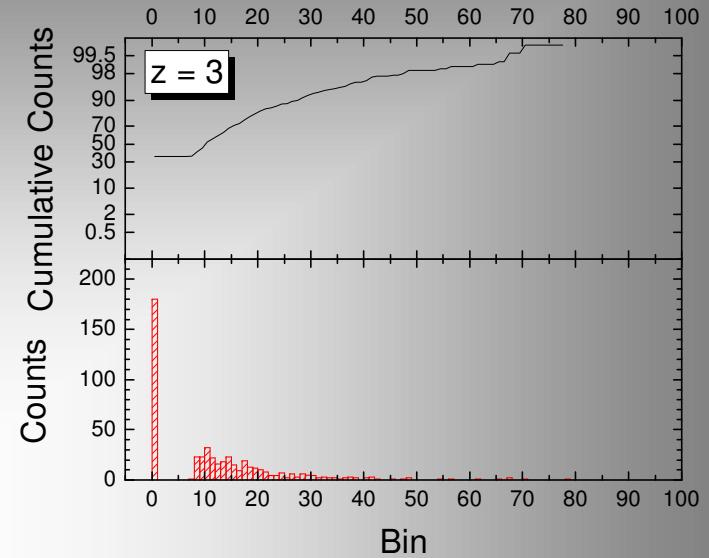
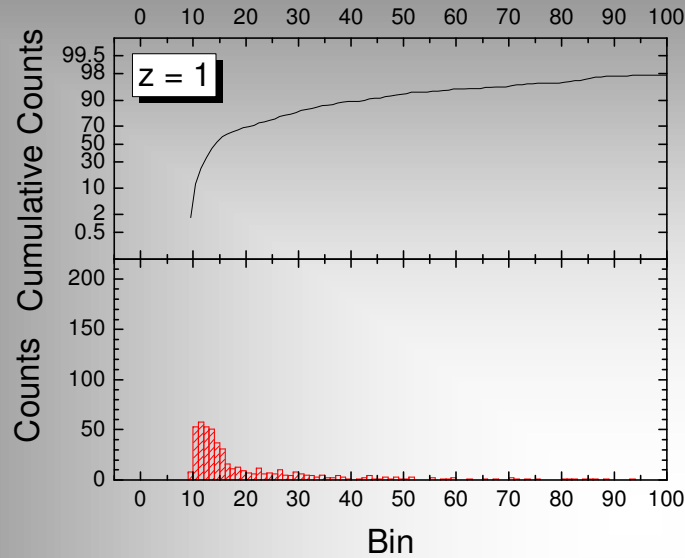
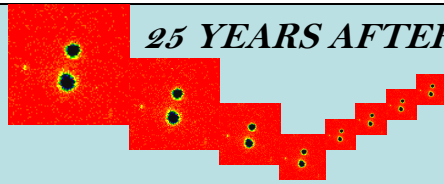
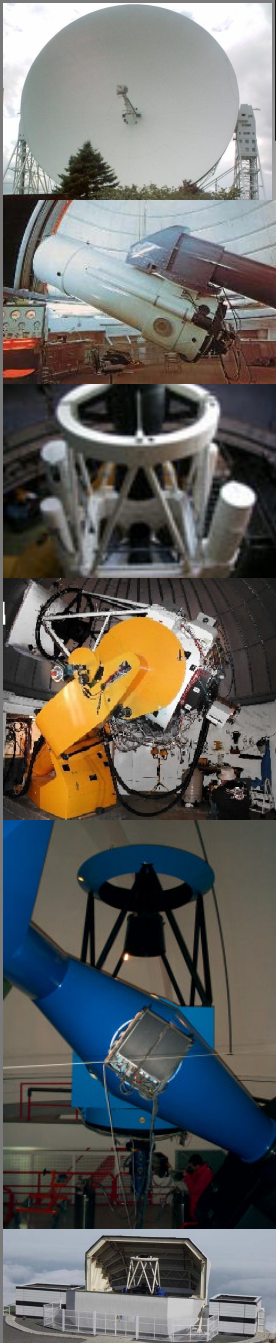




- For $z = 2$
 - Critical lines (left)
 - Caustics (right)
- SDSS J1004+4112 (Oguri et al. 2004)
 - $e = 0.498$
 - $\theta_e = 21.234$
 - $\gamma = 0.25$
 - $\theta_\gamma = -60.9$
 - $R_s = 50.0$

25 YEARS AFTER THE DISCOVERY: SOME CURRENT TOPICS ON LENSED QSOs

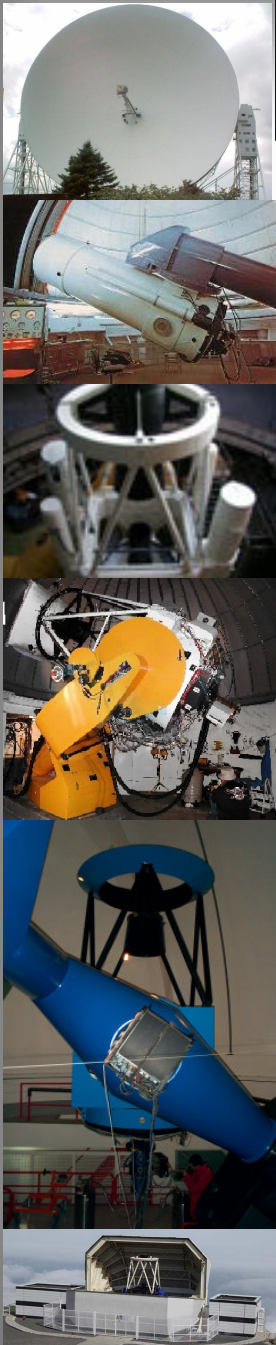
Santander (Spain), 15th-17th December 2004

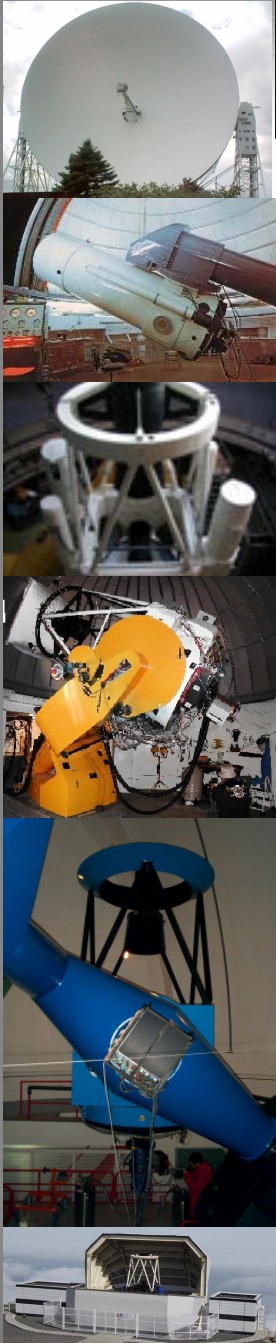


- Statistics

Statistics using Osiris

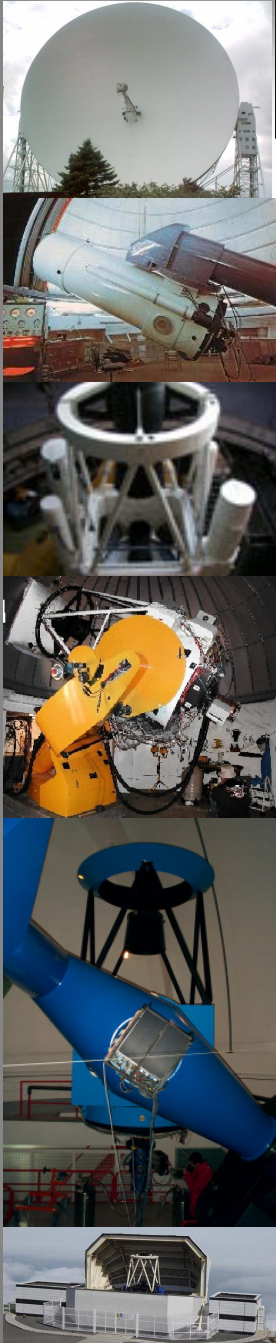
- Low luminosity LAEs
- Size $\sim 2''$ (~ 10 kpc)
- Amplification needed ~ 10 (SNR ~ 5)
- Integration times 1800 – 3600 s
- Probability of amplifications >10 for objects near caustics
 - 88% at $z=1$ (AGN-HII)
 - 68% at $z=2$ (AGN-HII)
 - 48% at $z=3$
 - 35% at $z=5$





Conclusions

- OSIRIS: a powerful tool to detect emission line objects.
- Magnifications >10 .
- Detection of objects $m_v \sim 30$.



Future work

- Applying luminosity functions for different kinds of objects.
- Modeling mass distributions for a sample of clusters of galaxies.
- Observing with OSIRIS-GTC.
- Comparing observations vs. theory.