

Napoli, 26-29 September 2016

Active Galactic Nuclei 12 *a Multi-Messenger perspective*

The Quasar Pairs Environment at $z \sim 0.5$

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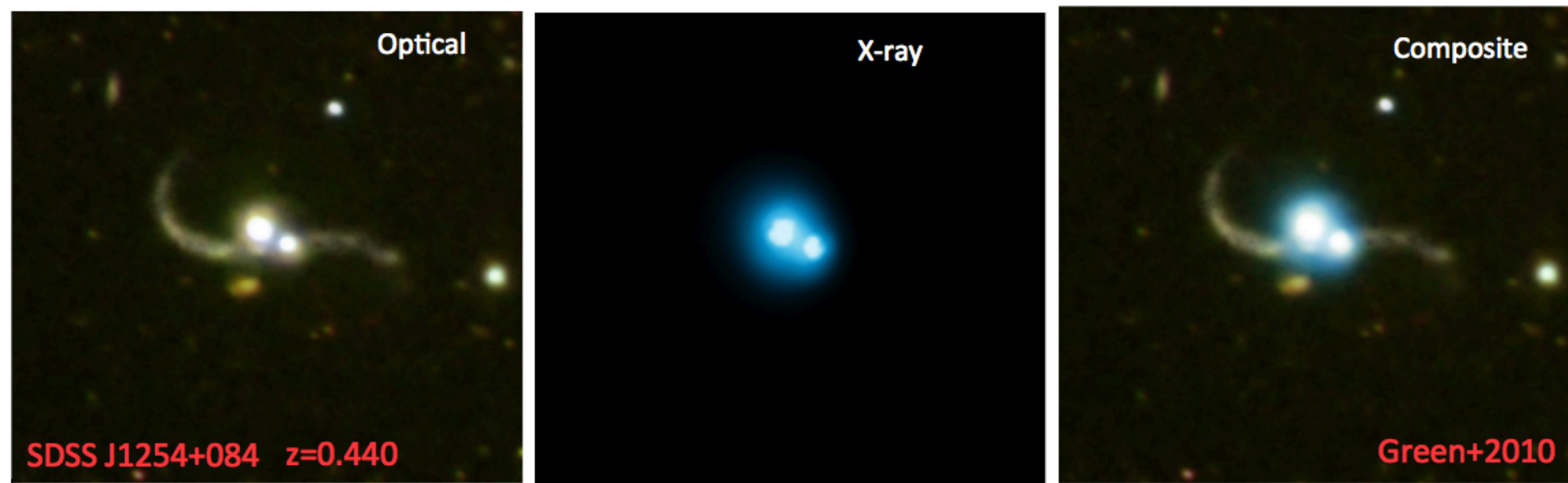
R. Falomo, *INAF - OA Padova*

A. Treves, *Università dell'Insubria, Como*

R. Scarpa, *IAC Tenerife*

M. Uslenghi, *IASF Milano*

BH activation into a QSOs phase:
mergers between gas-rich galaxies.
(e.g. Toomre 1972, Green 2010, Kauffmann 2000, Hopkins 2008)

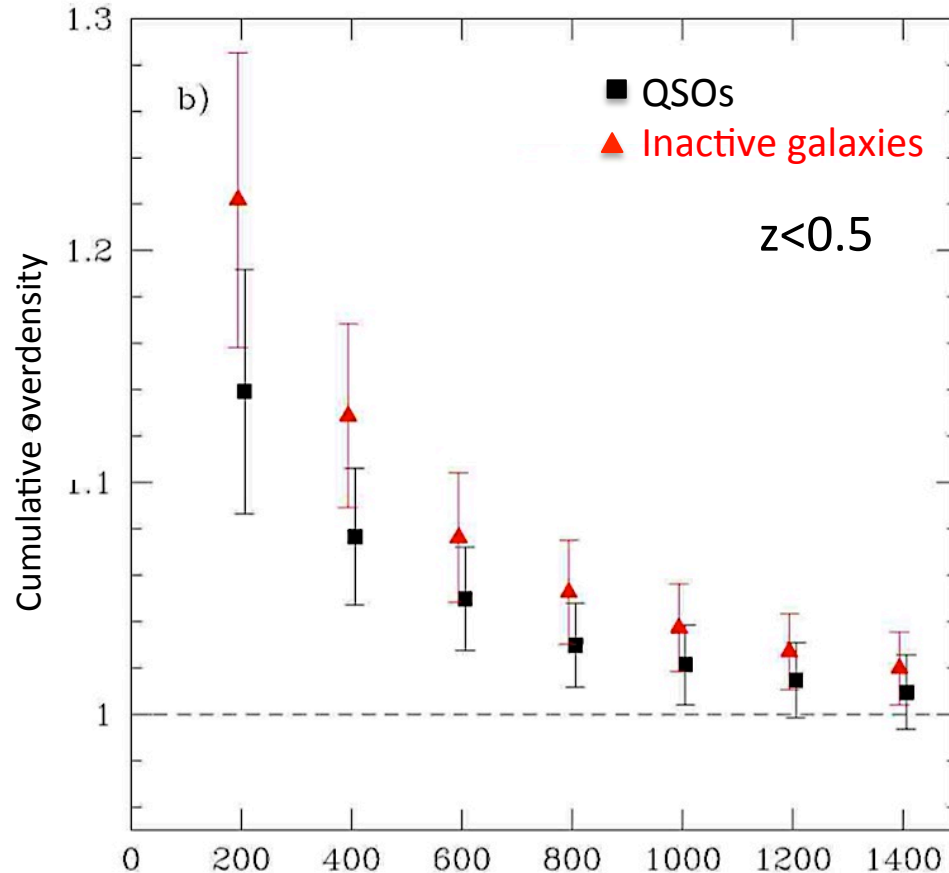


but also other alternative

(e.g. Ciotti & Ostriker 2007).

Galaxy environment around isolated QSOs

a tool to explore the QSO phenomenon



Large samples of
QSOs and
inactive galaxies
at in SDSS Stripe82

Karhunen+2014

Environment of QSO pairs similar to that of inactive galaxies

Why QSO pairs ?

QSO pairs: physically associated QSOs

Expected in richer environments

special rare cases

to investigate how and to what extent
the environment deals with the nuclear activity

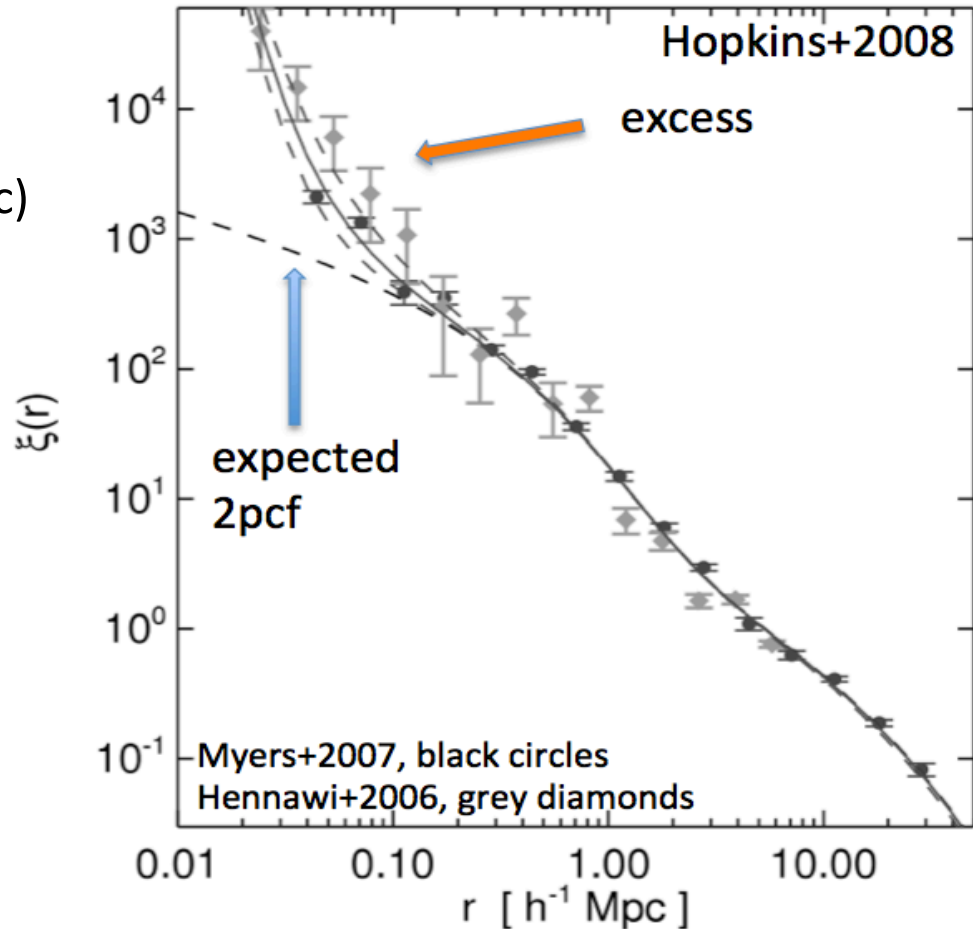
rich galaxy environments ?

(e.g. Djorgoski 2003, Zhdanov & Surdej 2001)

QSO pairs: rare, but not too much

excess of QSO Pairs in sub-Mpc scale

- from mutual galaxy interaction (tens kpc)
(e.g. Djorgovski 1991, Myers 2008)
- statistical predictable result of overdense group-scale environments (>100 kpc)
(e.g. Hopkins 2008)



Galaxy environment around QSOPs

The role of the environment on QSO pairs activity

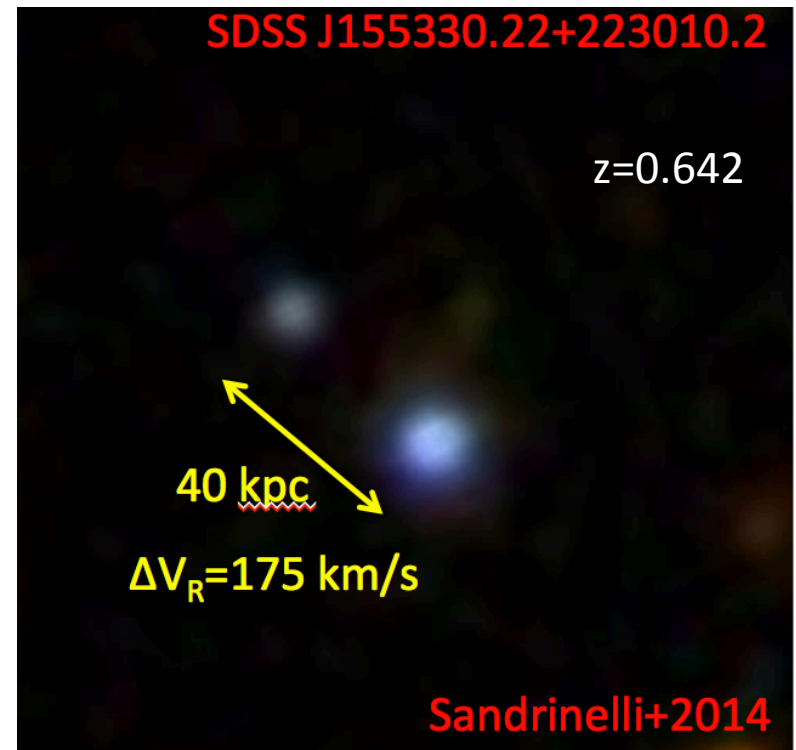
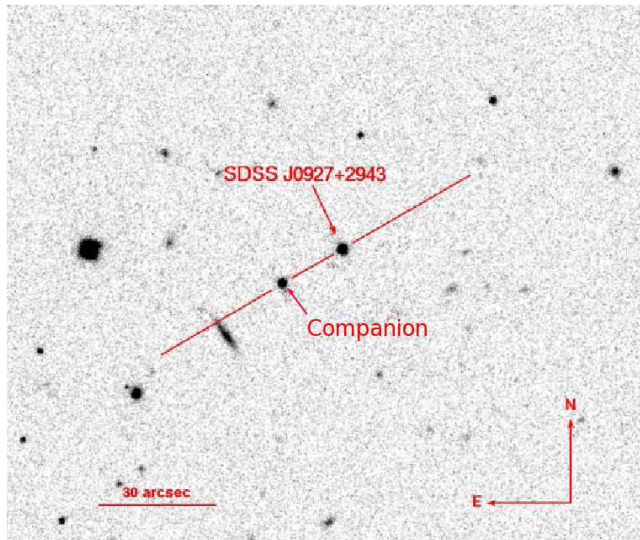
previous works:

Boris+2007	4 QSOPs, $z \sim 1$, inconclusive
Green+2010	1 close (~ 20 kpc) QSOP in act of merging, role of the environment not clear
Green+2011	7 close QSOP (< 30 kpc), $z \sim 1$, no evidence of rich environments
Farina+2011	6 QSOPs ($z < 0.6$) one case of pair in a moderately rich group
Sandrinelli+2014	14 QSOPs, $z < 0.85$, on average galaxy over density similar to that of isolated QSOs, But hint of galaxy over density for close QSOPs

Search for QSO physical pairs

- Position-redshift correlation from QSO catalogues
- Estimation of **systemic radial velocity V_R** from **[OIII]5007**

→ low redshift QSO pairs



Search for physical QSO pairs

SDSS images/catalogue

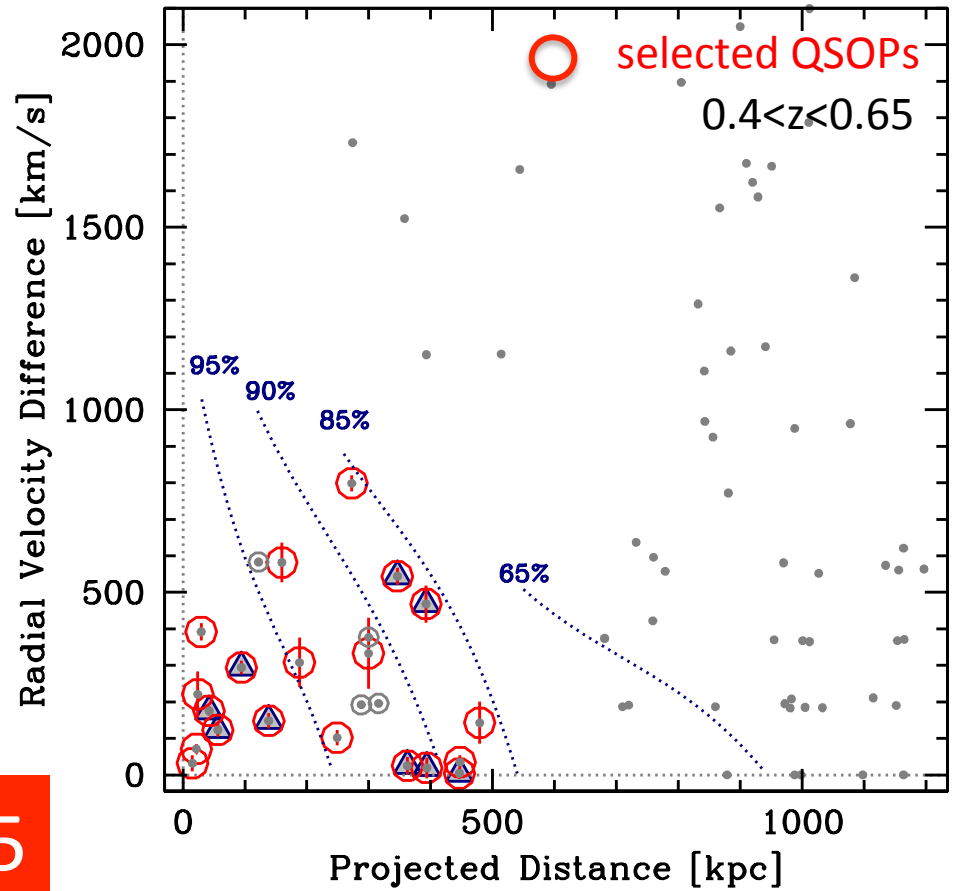
$\Delta PD < 500$ kpc
 $\Delta V_R < 800$ km/s

Chance superposition or
bound systems?

redshift permutation method
(Zhdanov & Surdej 2001)

Low z to detect faint galaxies

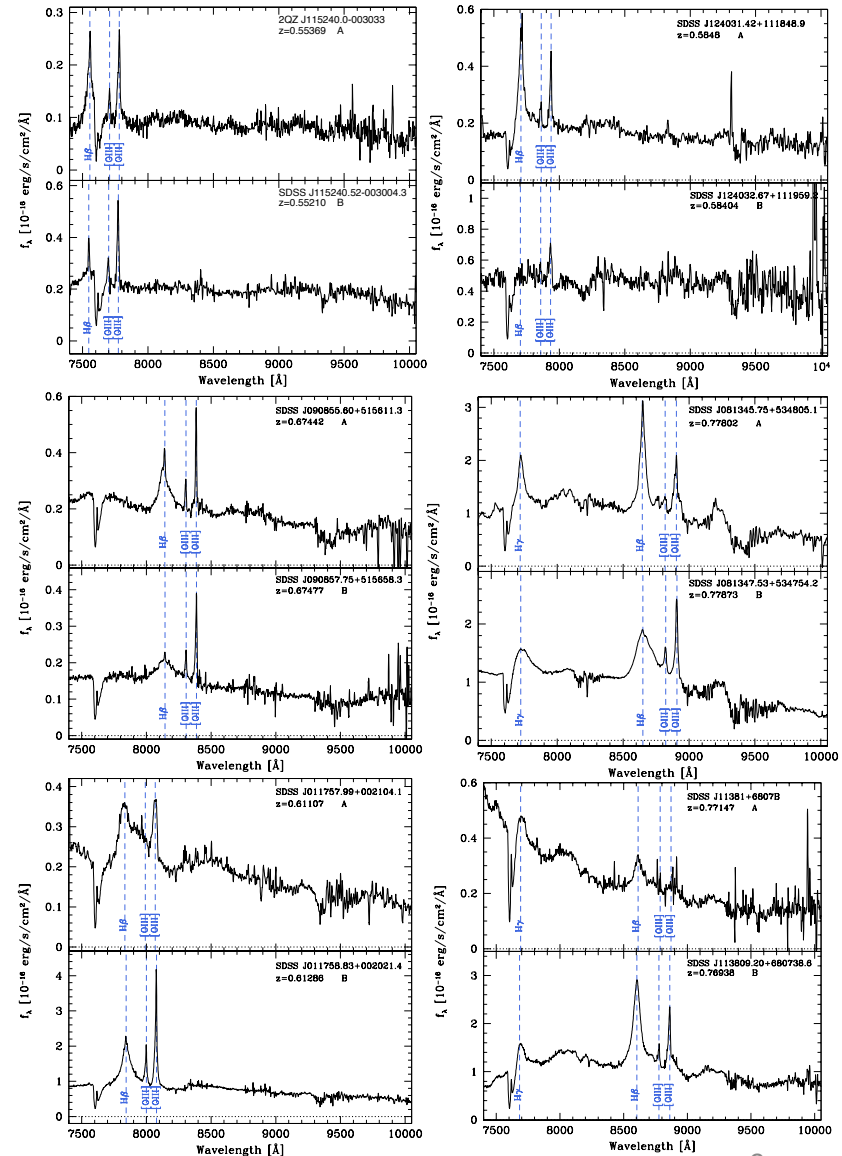
20 QSOPs at $0.4 < z < 0.65$



Sandrinelli+2016

Spectroscopic probe of QSO pairs

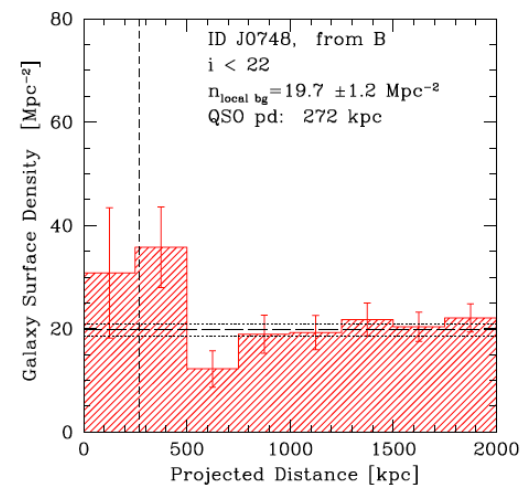
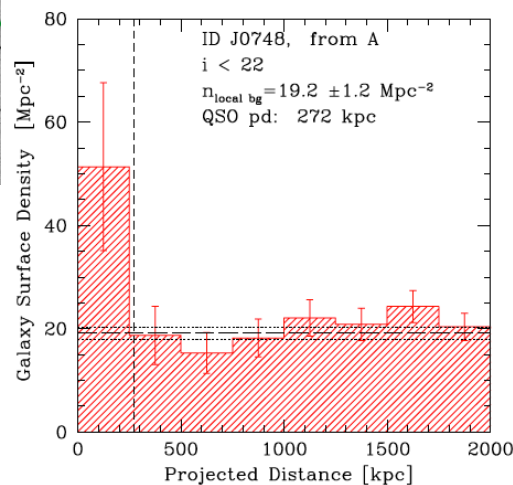
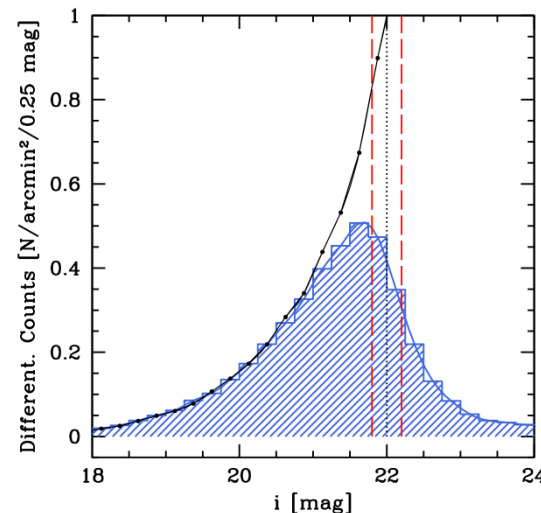
- Optical spectroscopy to properly evaluate difference of systemic velocity (< 50 km/s).



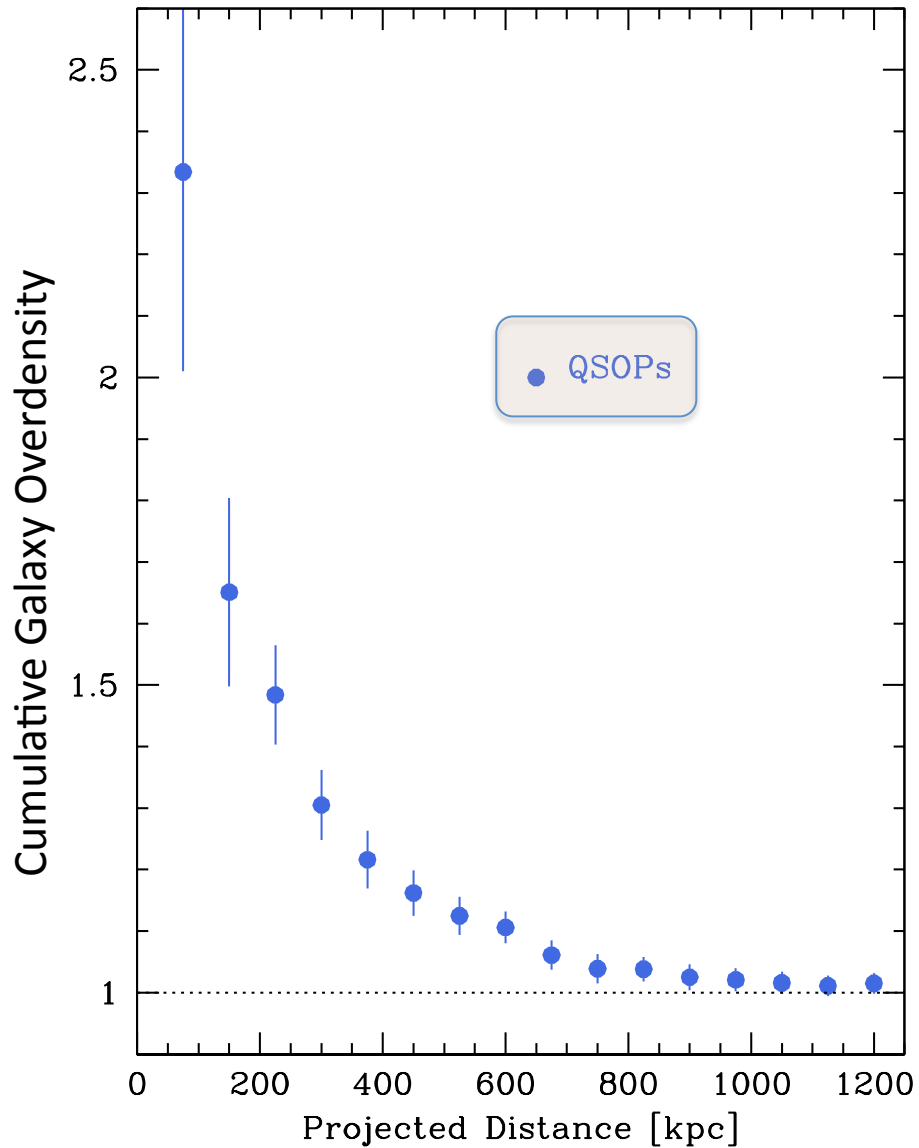
Galaxy environment of QSO pairs

SDSS images : *i* filter
objects classified as galaxies in
SDSS DR12 catalogue

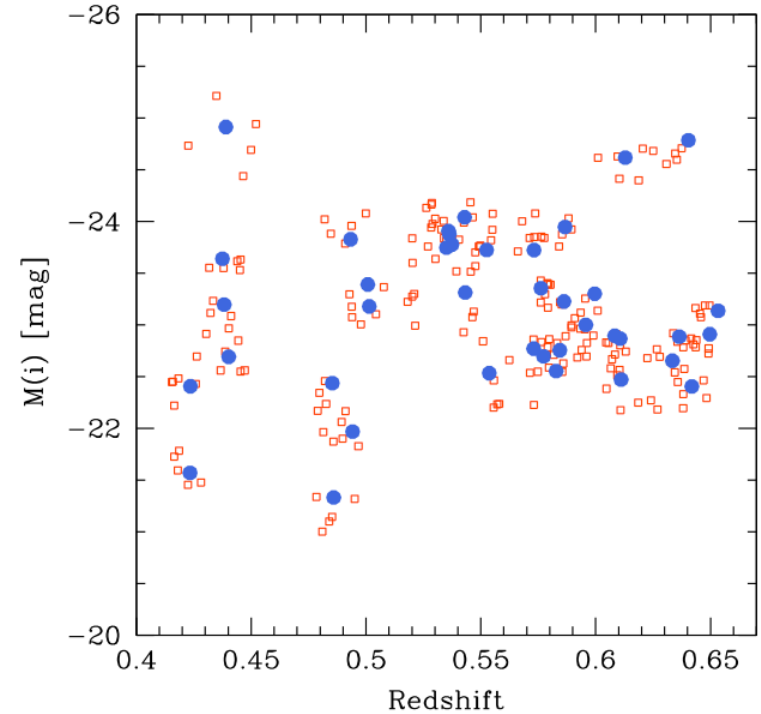
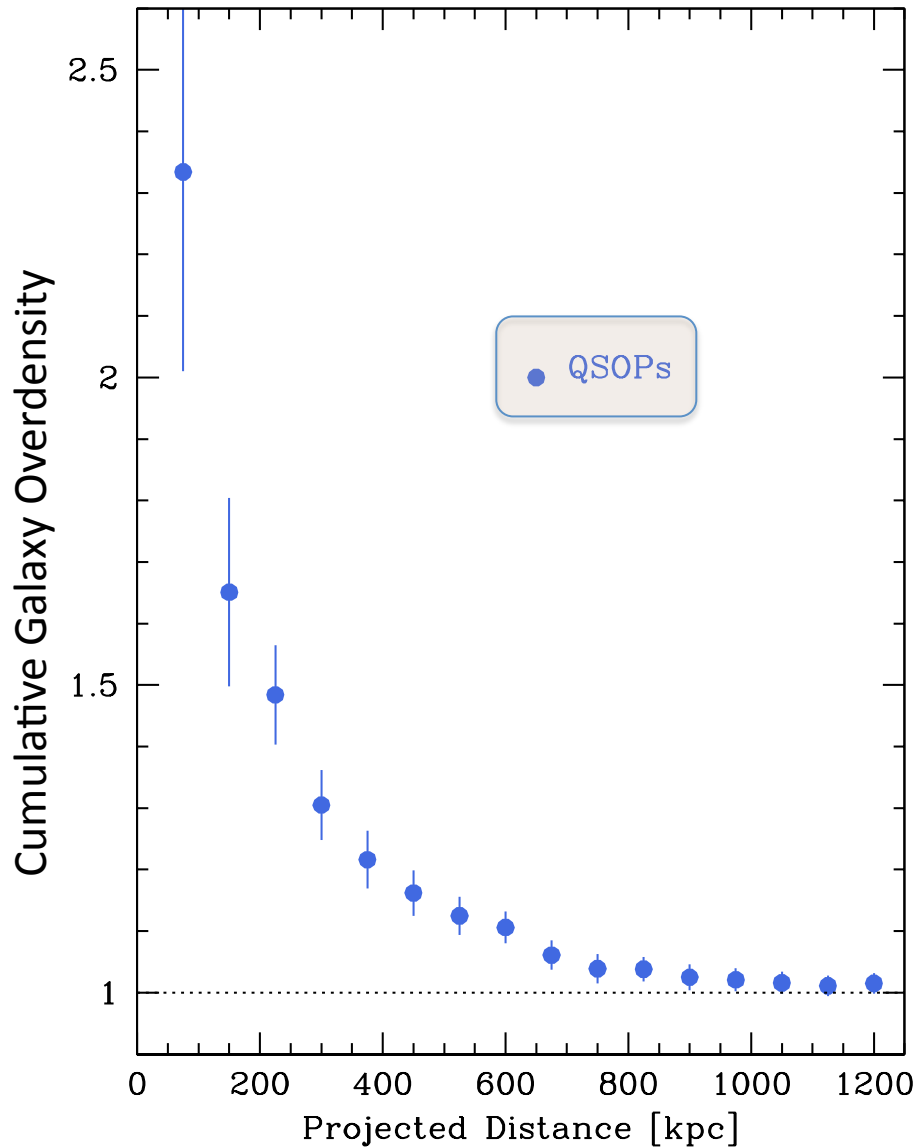
$i < 22$ mag = 50% completeness
(Capak+2007)
 $M^* < M < M^* + 2$ galaxies



Galaxy overdensity of QSO pairs

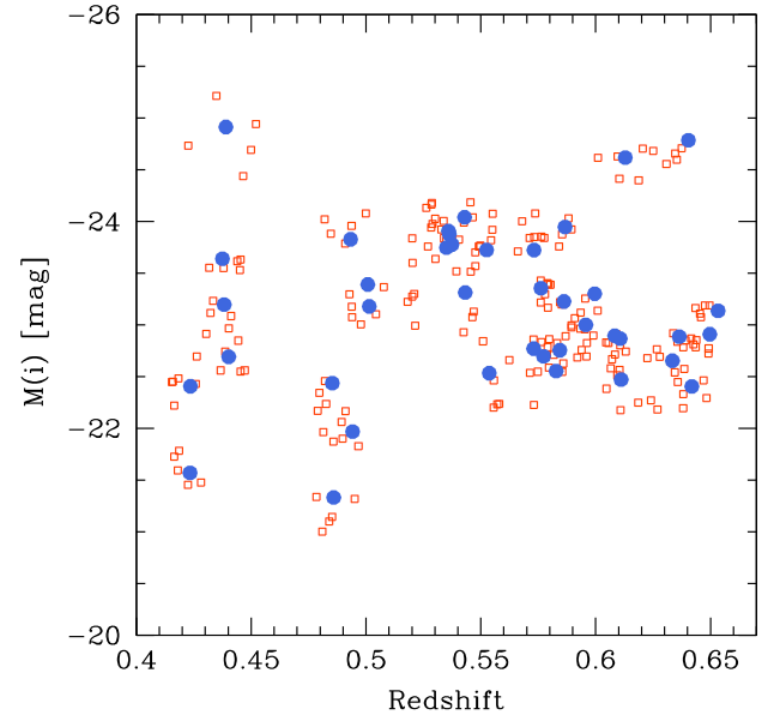
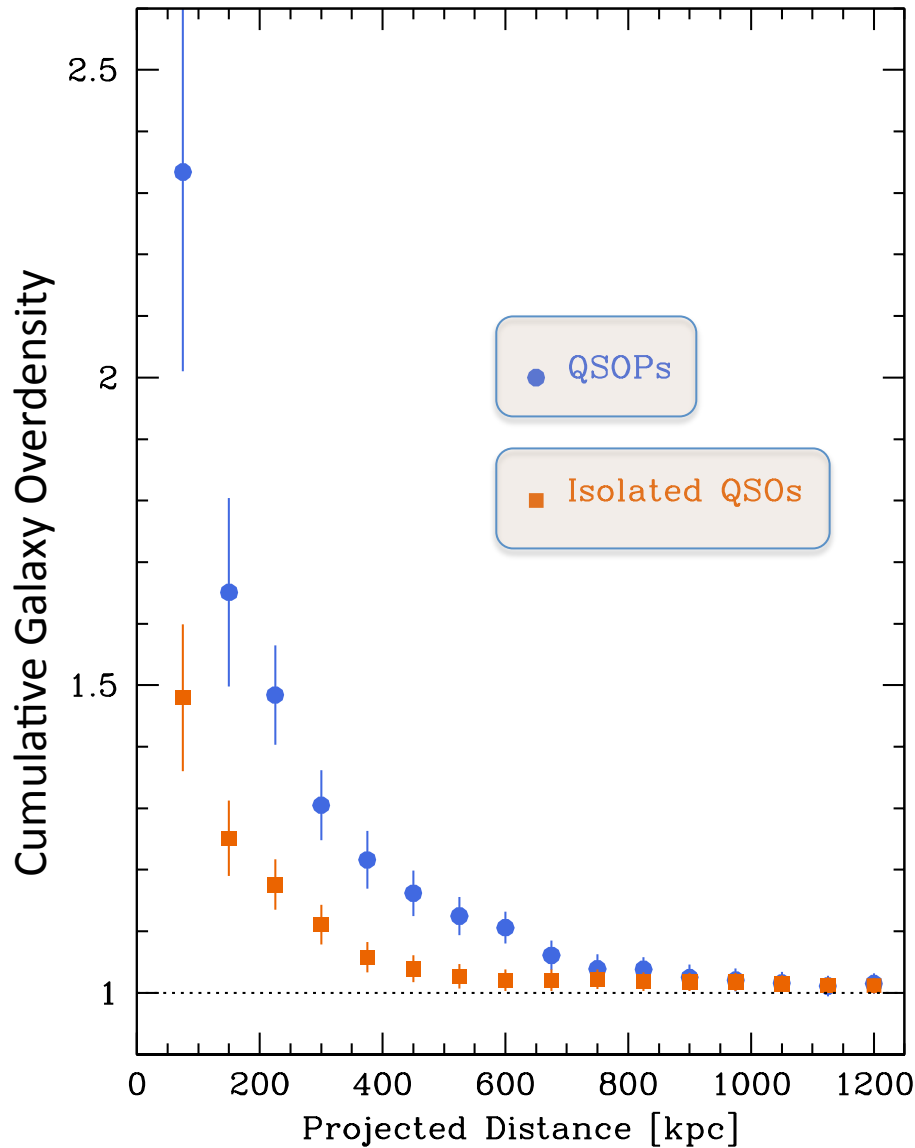


Galaxy overdensity of QSOPs



Comparison sample of isolated QSOs from SDSS DR12 QSO cat (Paris+2015) **matching in redshift and luminosity** with the QSO in pairs

Galaxy overdensity of QSOPs



On average QSO pairs environment is **richer** than that around isolated QSO of similar redshift and luminosity.

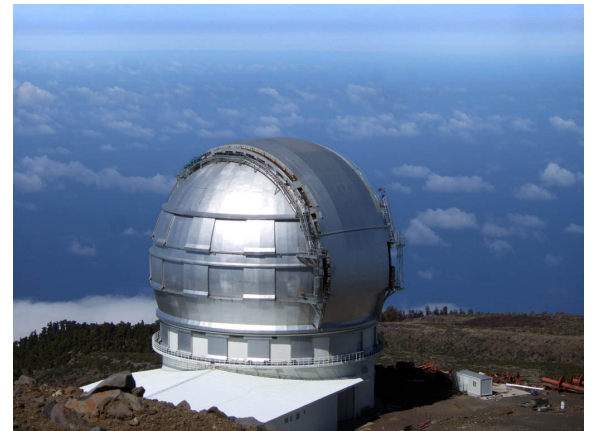
Preliminary Conclusions *(on going project)*

- Enhanced galaxy environment around QSO pairs with respect to that isolated QSOs

Evidence for galaxy merging effect? Maybe.

Further planned study:

- Larger sample of QSO pairs
- Extension to higher redshift
- Spectroscopy of the galaxies
 - ✓ prove physical association
 - ✓ dynamical mass of the system
 - ✓ signature of star formation



Running program at GTC for near-IR MOS spectroscopy