Low redshift QSO environments

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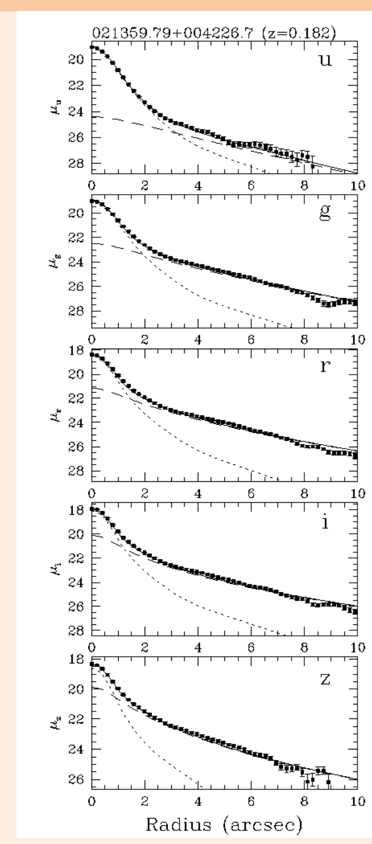
QSO phenomenon assumes that the nuclear activity occurs due to the major merger of two gas-rich galaxies that feed the central engine and enable the growth of a spheroidal stellar component. However, important details on what triggers the gas fueling and how nuclear activity affects the subsequent evolution of the host galaxies remain poorly understood. The study of correlations between black hole masses, properties of the host galaxies and their environments could provide relevant clues to investigate the fundamental issues on quasar activity and its role on the evolution of galaxies.
To pursue this goal it is crucial to analyze an adequate large sample of active QSOs and a suitable comparison sample of inactive galaxies. We investigate a sample of ~400 low z (<0.5) quasars that were imaged in the SDSS Stripe82. These images are ~2 mag deeper than standard Sloan images. For these quasars we undertake a study of the host galaxies and of their environments in *u,g,r,i* and z bands. For a subsample of low z sources the imaging study is complemented by spectroscopy of QSO hosts and close companion galaxies.
This study suggests that the fuelling and triggering of the nuclear activity is only weakly dependent on the local environment of quasars. Contrary to past suggestions, for low z QSO there is a very modest connection between recent star formation and the nuclear activity.

HOST GALAXIES

QSO hosts are dominated by luminous galaxies of absolute magnitude M*-3 < M(R) < M*. QSO are hosted in a variety of galaxies from pure ellipticals to complex/composite morphologies that combine spheroids, disk, lens and halo (Figure 1). The black hole mass of the quasar, estimated from the spectral properties of the nuclei, are poorly correlated with the total luminosity of the host galaxy. However, taking into account only the bulge component we found a significant correlation between the BH mass and the bulge luminosity of the host (Figure 1)

Falomo et al. 2014 (MNRAS 440, 476)



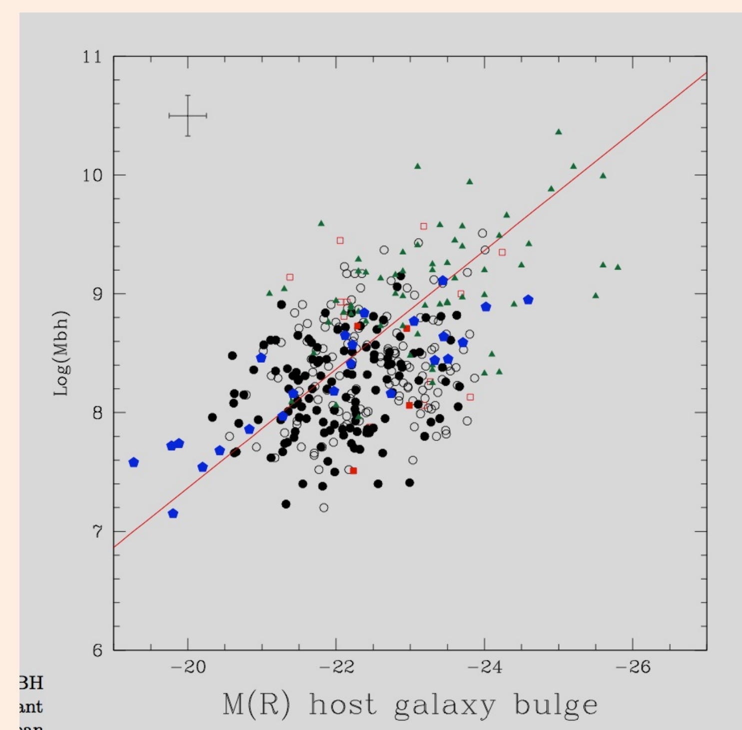


Figure 1 LEFT: *Average radial brightness profiles (filled squares) of a QSO in all 6 bands and the best fit model (PSF + Sersic galaxy.* ***RIGHT:*** *Absolute magnitude of QSO host galaxies (spheroidal component) versus BH mass of quasars compared to the relation for local (inactive) galaxies (red line). See details in Falomo+2014*

GALAXY ENVIRONMENTS

The galaxy number density of the quasar environments is comparable to that of the inactive galaxies with similar luminosities, both classes of objects showing significant excess compared to the background galaxy density for distances <400 kpc (Figure 2). There is no significant dependence of the galaxy number density on redshift, quasar or host galaxy luminosity, black hole mass or radio loudness.

Karhunen et al. 2014 (MNRAS 441, 1802).

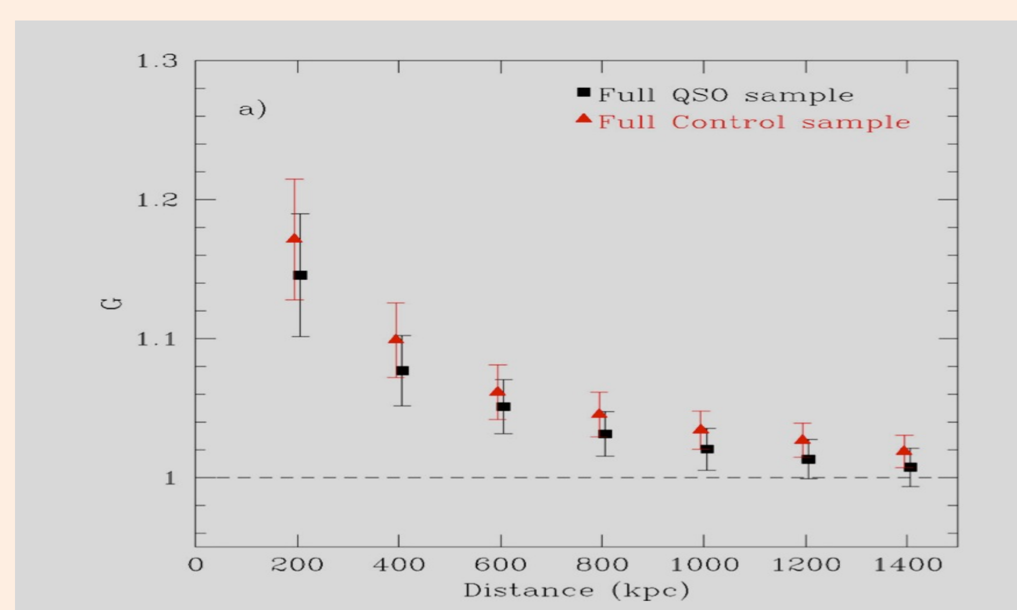


Figure 2 Mean cumulative galaxy overdensity of the environments as a function of distance for ~400 QSO and inactive galaxies

COLORS & CLOSE COMPANIONS

For the subsample of objects that are resolved also in *u* band we found that the *u-g* color of QSO hosts are similar (1.40±0.30) to that of inactive galaxies (1.54±0.62). We find no significant difference between the two samples for the number and the color of close (projected distance < 50 kpc) companion galaxies (Figure 3). Many of these associated companions exhibit [OII] λ3727 Å emission lines (Figure 4) suggestive of episodes of modest (0.1-1.5 $M_{\odot}$/yr) star formation possibly induced by past interactions.

Bettoni et al 2015 (MNRAS 454, 4103), Bettoni et al 2016 (MNRAS, submitted)

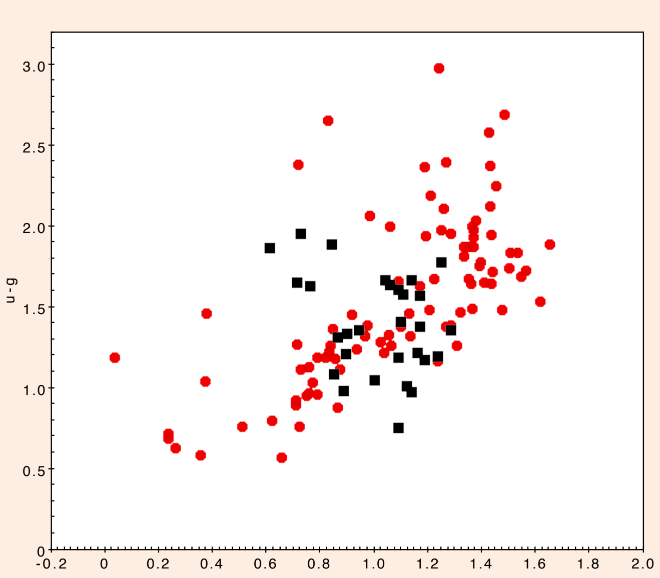
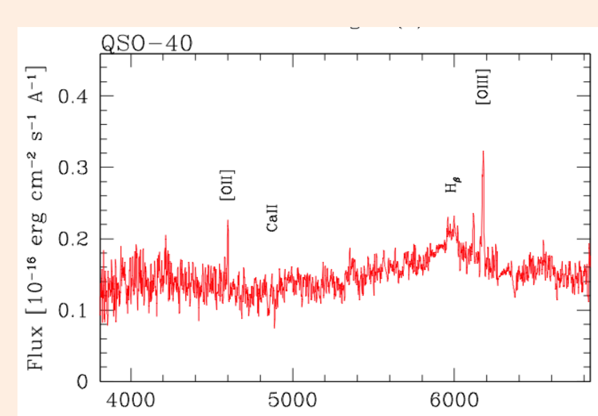
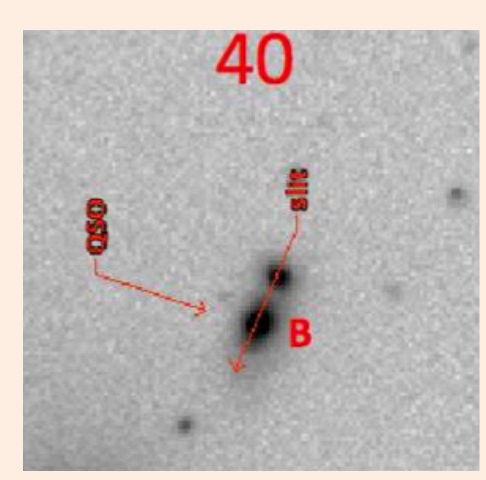


Figure 3 *Two color diagram (u-g ,g-i) of QSO host galaxies (black squares) compared with that of a sample of inactive galaxies (red circles).*





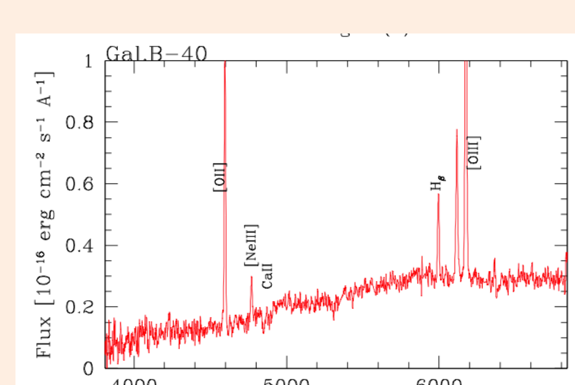


Figure 4 *Example of QSO spectrum (#40) and that of an associated companion galaxy showing [OII] 3727 emission lines.*

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