High-redshift BAL quasars and jet-outflow connection

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Introduction

Intrinsic absorption lines are a common feature in quasar (QSO) spectra, and they are likely produced by outflowing winds along the line of sight that are launched from the accretion disk around the central supermassive black hole (Murray et al. 1995; Proga, Stone & Kallman 2000). Broad absorption lines (BALs) in ultraviolet and visible spectra of quasars are the most spectacular manifestation of such outflows, with absorption velocity width larger than 2000 km/s (Weymann et al. 1991). Powerful outflows can enrich the quasar host galaxy interstel- lar medium, contributing to a variety of feedback effects such as regulating host galaxy star formation rates (Hopkins & Elvis 2010), and limiting quasar lifetimes by removing fuel from the nuclear regions (Silk & Rees 1998). Understanding the physics behind BAL outflows may be fundamental to disclose the connection between the evolution of quasars and their host galaxies. Several studies found systematic observational differences between BAL QSOs and the remaining population of quasars, including redder optical and infrared broadband colors. However, despite these results and the important implications that BAL QSOS may have, the nature of these objects is still not fully understood. In particular the two main theoretical scenario that have been proposed to explain their nature - i.e the *evolutionary* and the *orientation* scenario- have been proved to not to be able to solve this issue.

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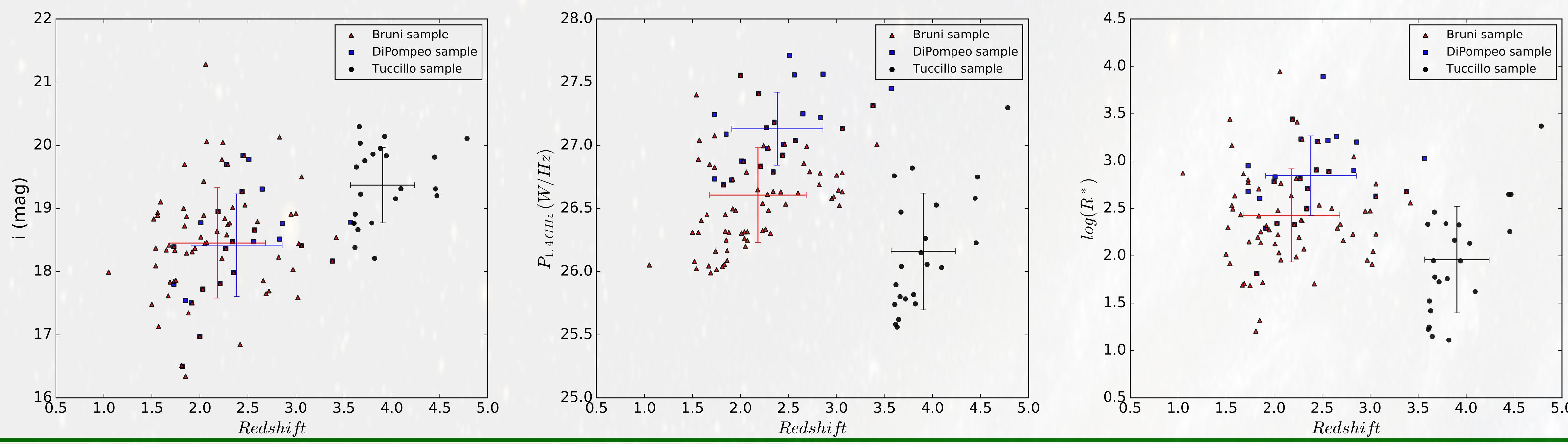
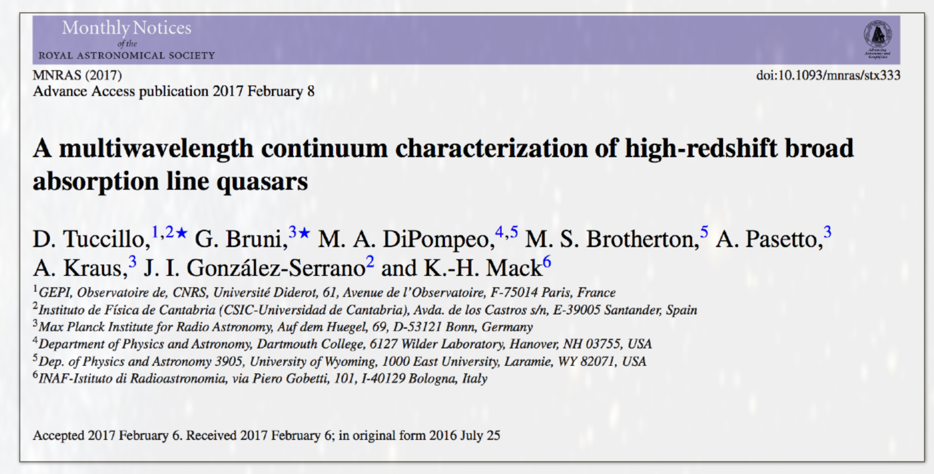
High-z BAL quasar sample

We published the results of a multi-wavelength study of a sample of high-redshift Radio Loud (RL) Broad Absorption Line (BAL) quasars in the highest redshift range (3.6 < z <4.8) they have been observed. This way we extend to higher redshift previous studies on the radio properties, and broadband optical colors of these objects. Our sample of 22 BAL QSOs extend the space parameter of previous studies on BAL QSOs, not only in redshift but also in radio and optical wavelength. .



As a whole, our sample of 22 RL BAL quasars extend the samples used in DiPompeo et al. (2011) and Bruni et al. (2012), for the redshift range covered (out to z = 4.8) and extend to lower optical and radio flux densities.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A multiwavelength continuum characterization of high-redshift broad absorption line quasars

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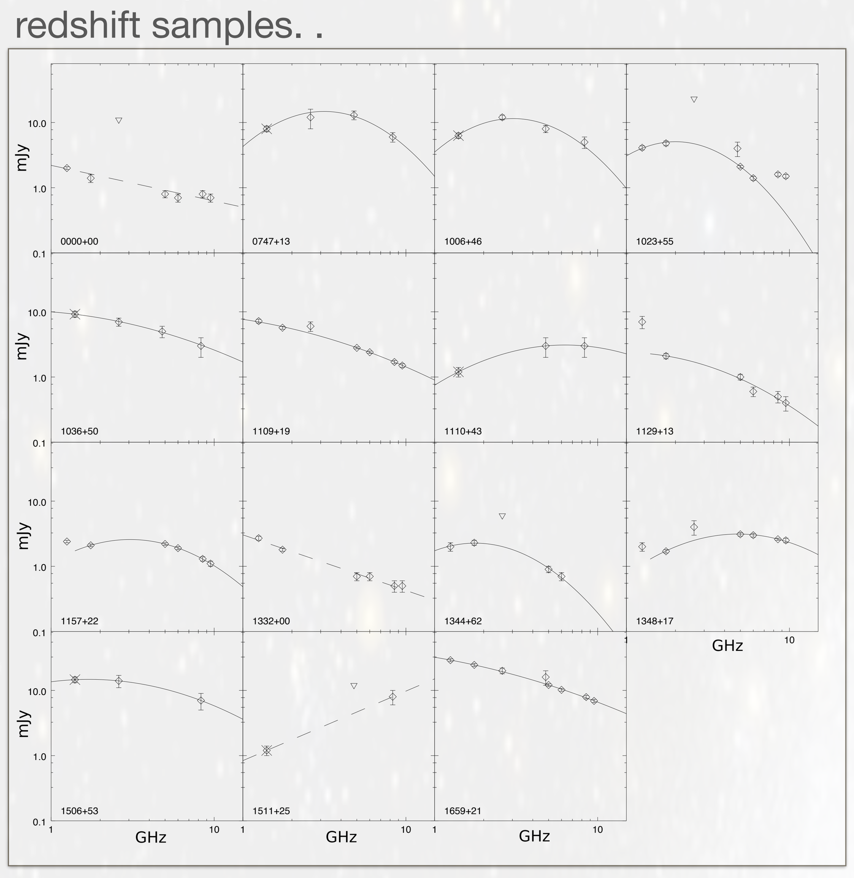
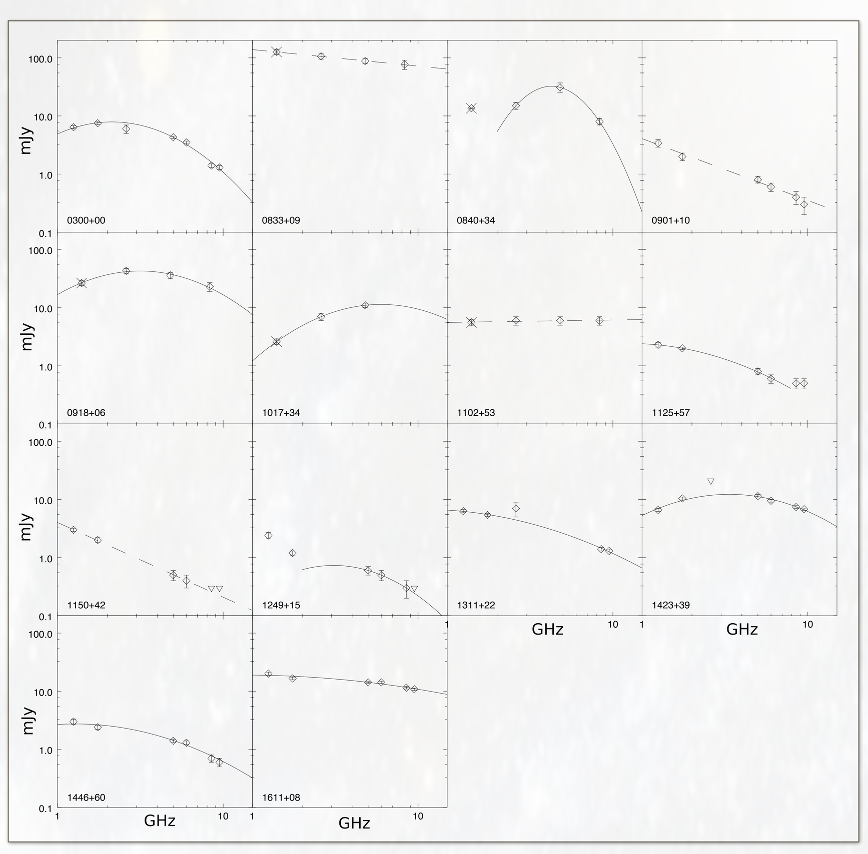
Results in Radio

We determine the synchrotron peak frequency, constraining their age. A large number of GigaHertz Peaked Spectrum (GPS) and High Frequency Peakers (HFP) sources has been found **in both samples** (80% for BAL and 71% for non-BAL QSOs), not suggesting a younger age for BAL quasars. The spectral index distribution provides information about the orientation of these sources, and we find statistically similar distributions for the BAL and non-BAL quasars **in contrast** to work done on lower redshift samples. .



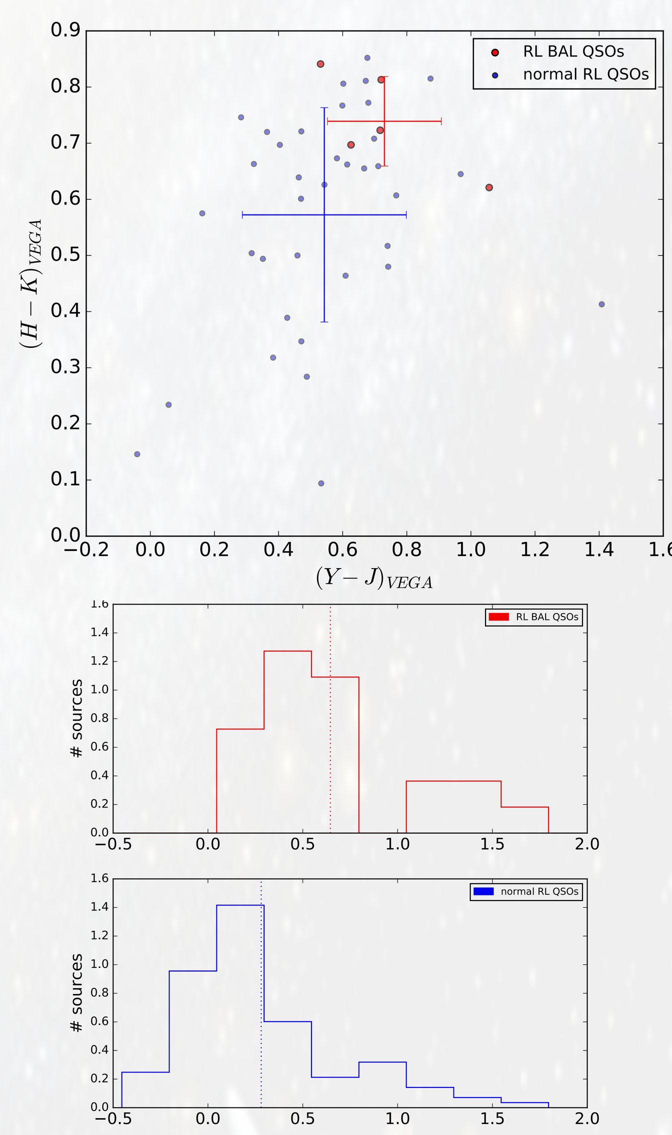


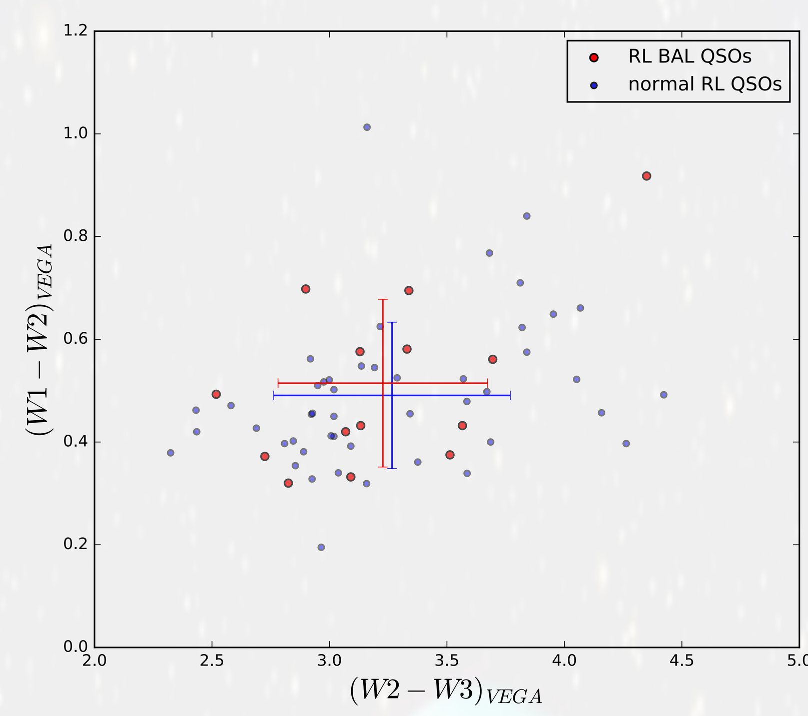
High percentage of **young radio-sources**

Our results are **in contrast** with works at lower redshift DiPompeo et al. (2011) and Bruni et al. (2012), finding a mildly preferred over-abundance of edge-on orientation for BAL QSOs.

Optical and IR broadband colors

Analyzing the properties of broadband colors in both optical (SDSS) and near- and mid-infrared (UKIDSS and WISE) bands, we find that also at high redshift BAL quasars tend to be optically redder than non-BAL quasars. However, these differences are no more evident at longer wavelength, when comparing colors of the two samples by mean of the WISE survey, again in contrast with previous studies at lower redshift.





BAL quasars are redder than normal QSOs in the optical and NIR.

But **in contrast** with studies at lower redshift (DiPompeo et al. (2012)), these differences are not evident at WISE wavelengths.

Questions:

Are the differences that we found respect to previous studies, connected with the higher population of young radio sources that we have in our sample?

Hypothesis:

If the outflows responsible for the BAL absorption could be later re-oriented to form the jet (Elvis 2000), young radio sources could present an outflows more likely oriented towards the polar direction, and our results are in agreement with a link between the jet-collimation mechanism and the accretion-disk outflows reorientation, favoring the hypothesis that accretion disk rotation can be at the origin of magnetic jet launching.

Ongoing Research:

Radio-loud variable BAL QSOs, presenting real-time changes in the outflow velocity/orientation, are the ideal test-bed to verify this possible connection through the study of the radio emission. Thus, we observed 29 RL BAL QSOs from Welling et al. 2014, with a redshift between 0.2 and 3.4, and spanning a range of variability going from the minimum to the maximum found by these authors, in order to verify any possible trend linking the radio phase and the outflow evolving properties.

We will study: 1) jet orientation, tested via the obtained spectral indices. In order to establish if the orientation plays a role in the detection of BAL variability.

2) polarimetry study in multiple bands, to allow estimate the rotation measure in these sources, probing the physical conditions in their environment, such as magnetic fields strength and electron density.

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