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POSTERS

The evolution of star formation in QSOs according to WISE

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Abstract. Using WISE data, we calibrated the W2-W3 colors in terms of star formation rates (SFRs) and applied this calibration to a sample of 1285 QSOs with the highest flux quality, covering a range in redshift from $z\sim0.3$ to $z\sim3.8$. According to our calibration, the SFR increases continuously, reaching a value at $z\sim3.8$ about 3 times higher on average than at lower redshift. This increase in SFR is accompanied by an increase of the BH mass by a factor 100 and a gradual increase of the mean Eddington ratio from 0.1 to 0.3 up to $z\sim1.5-2.0$, above which the ratio stays constant, despite a significant increase in BH mass. Therefore, QSOs at high redshifts have both more active BHs and higher levels of star formation activity.

Keywords. (galaxies:) quasars: general; infrared: galaxies; galaxies: evolution

1. Introduction

In Coziol *et al.* (2014), a new mid-infrared (MIR) diagram (MIRDD) based on WISE (Wright *et al.* 2010 was devised that allows to separate type II AGNs from star forming galaxies (SFGs) in a way similar to the BPT-VO diagram in the optical (Baldwin *et al.* 1981; Veilleux & Osterbrock 1987). The key of the MIRDD was shown to be the sensitivity of the W2-W3 color to the intensity of star formation: as the star formation (SF) intensity increases in the host galaxies, W2-W3 becomes significantly redder (Donoso *et al.* 2012; Jarrett *et al.* 2013). In Coziol *et al.* (2015) the authors observed the same phenomenon in type I AGNs, suggesting an increase of SF with the redshift (Leipski *et al.* 2014; Delvecchio *et al.* 2014). Using the data in Coziol *et al.* (2015), we calibrated the W2-W3 color in terms of star formation rate (SFR) and applied this calibration to a sample of 1285 QSOs from the SDSS DR12Q sample of Paris *et al.* (2017), with high quality MIR fluxes (A in all the four fluxes), redshifts between $z\sim0.3$ and $z\sim3.8$, and continuum luminosity and BH mass previously determined by Kozlowski (2017). Depending on the emission line used to determine the BH mass (MgIIλ2798 at low redshift and CIVλ1549 at higher redshifts), our sample was separated in two (identified simply as MgII and CIV).

2. Results

In Fig. 1 we compare in the two samples the SFR, the BH mass (M_{BH}), and Eddington ratio, $n_{\rm Edd} = {\rm Log}(L_{\rm bol}/L_{\rm Edd})$, in different redshift bins. In the MgII sample (upper panels), SFR and M_{BH} increase with the redshift (up to $z\sim2.5$) by a factor 3 and 100 respectively, while the Eddington ratio increases from 0.1 to 0.3. In the CIV sample the SFR and M_{BH} increase by a factor 10 from $z\sim1.0$ to $z\sim3.8$, while the mean Eddington ratio stays almost constant at its highest value (∼0.3).

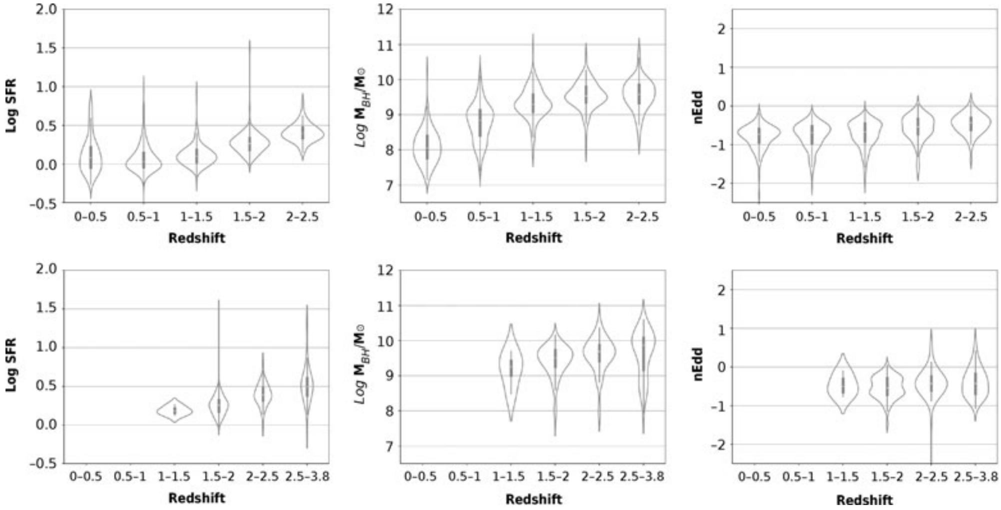

Figure 1. In the upper panel, the MgII sample was divided in 5 redshift bins, to highlight the evolution in SFR (left), BH mass (middle) and Eddington ratio (right). In the lower panel the same comparison is done for the CIV sample divided in 4 redshift bins. The core of the violin shows the mean (white dot), first and third quartiles (central vertical bar), while the body of the violin traces the (rotated kernel) density distribution.

3. Conclusions

The observation that the BH mass decreases at low redshift more rapidly than the SFR suggests that the timescales of the mass accretion by the BHs and the growth in mass of the galaxies through SF are not directly correlated. What is remarkable, in particular, is the high values of n_{Edd} at high redshifts. Since $n_{Edd} \propto L_{AGN}/M_{BH}$, the fact that this ratio stays high despite the increase in M_{BH} suggests the mass accretion onto the BH and the SF activity in the host galaxies are high at the same time. Taken at face value, this might imply a lack of influence of the BHs on their host galaxies (no BH feedback). Note however that our sample is biased towards QSOs with high quality fluxes in MIR, which is a small fraction of QSOs. Note also that there seem to be QSOs with unusually high SFRs at low redshift (the neck of the violin with lowest redshift bin in Fig. 1 left upper panel), and QSOs with unusually low BH masses and high SFRs at high redshifts (the end pin of the violin with highest redshift bin in Fig. 1 central lower panel). These cases could be consistent with narrow line QSOs, and the fact they have extreme SFRs and n_{Edd} might suggest they are examples of QSOs in an early phase of formation.

References

Baldwin, J. A., Phillips, M. M., & Terlevich, R. 1995, *PASP*, 93, 5
Coziol, R, Torres-Papaqui, J. P., Plauchu-Frayn, I. *et al.* 2014, *RMxAA*, 50, 255
Coziol, R., Torres-Papaqui, J. P., & Andernach, H. 2015, *AJ*, 142, 192
Delvecchio, I., Gruppioni, C., Pozzi, F., *et al.* 2014, *MNRAS*, 439, 2736
Donoso, E., Yan, L., Tsai, C., *et al.* 2012, *ApJ*, 145, 6
Jarrett, T. H., Masci, F., Tsai, C. W., *et al.* 2013, *AJ*, 145, 6
Kozłowski, S. 2017, *ApJS*, 228, 9
Leipski, C., Meisenheimer, K., Walter, F., *et al.* 2014, *ApJ*, 785, 154
Pâris, I., Petitjean, P., Ross, N. P., *et al.* 2017, *ApJ*, 597, A79
Veilleux, S. & Osterbrock, D. E. 1987, *ApJS*, 63, 295
Wright, E. L., Eisenhardt, P. R. M., Mainzer, A. K., *et al.* 2010, *AJ*, 140, 1868

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