Ionized gas and outflows in type 2 quasars at 0.3<z<0.6

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Abstract / conclusions

We present results from a programme to study the ionized gas associated with luminous type 2 quasars at 0.3<z<0.6, using optical imaging and long-slit spectroscopy from the Very Large Telescope. All but one of our sample is associated with spatially extended emission line gas. We find these extended emission line structures have a variety of origins and ionization mechanisms: star forming companions, tidal features, or extended ionized nebulae. AGN related processes dominate the excitation of the nuclear gas. Contrary to several other studies, we find little evidence of large-scale / galaxy-wide ionized outflows.

SDSS J141611.77-023117.1

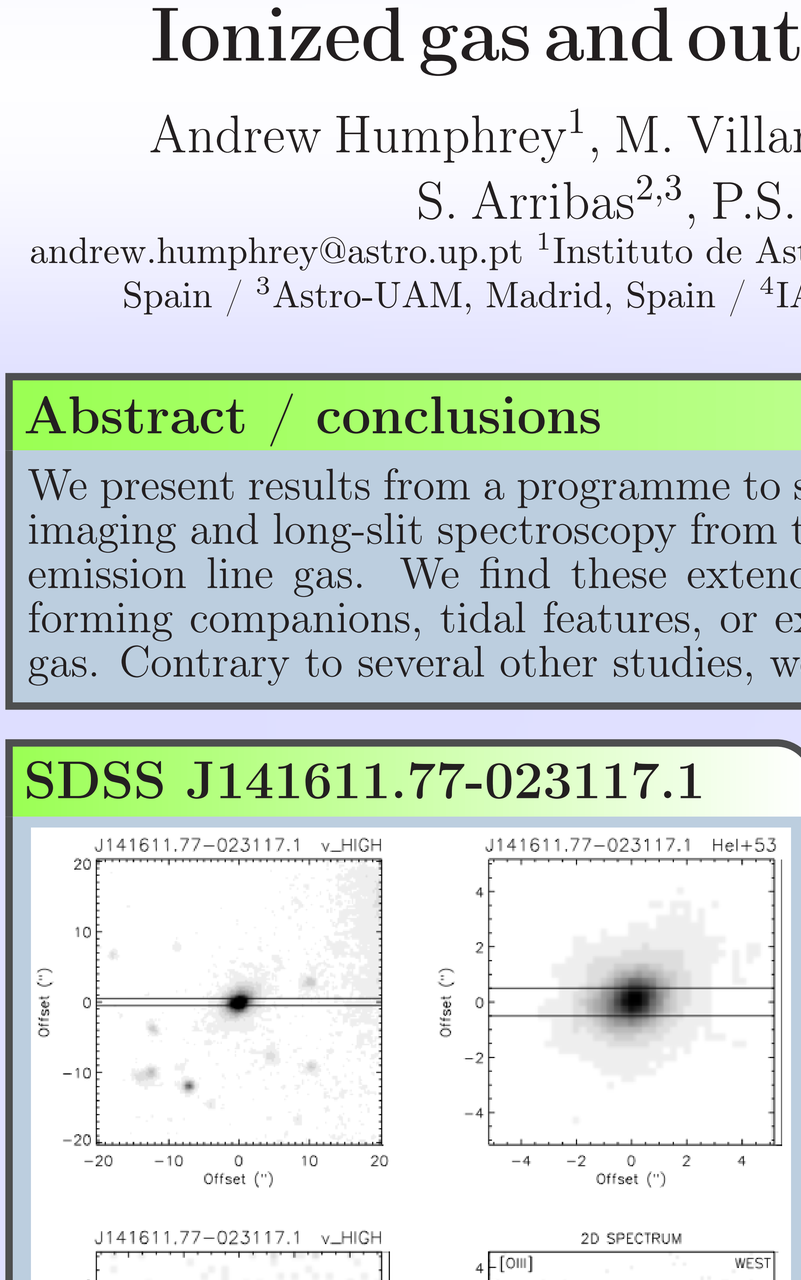

Figure 1. Images and spectrum of SDSS J141611.77-023117.1 (z=0.305). Extended and very narrow lines (∼27 kpc), but no concrete evidence for outflows.

Extended ionized gas

Faint extranuclear line emission is detected in 8/9 targets. They are of a diverse nature: EELR (6/9 objects) of typical radial sizes 12-22 kpc, as well as features related to mergers/interactions such as star forming compact knots and tidal tails (4/9). There is a mixture of excitation mechanisms (AGN or stellar photoionization) whose relative contribution varies spatially.

While the emission line spectrum of the ionized gas near the central engine is clearly excited by AGN related processes, stellar photoionization can also be present in the extranuclear ionized gaseous structures.

Based on [OII]/[OIII], the extranuclear ionized gas is often in a lower ionization state than the nuclear ionized gas. [OII] is often more extended than [OIII], suggesting low ionization lines might be relatively more efficient than e.g. [OIII] for detecting extranuclear and extended emission line structures in type 2 quasars.

SDSS J124749.79+015212.6

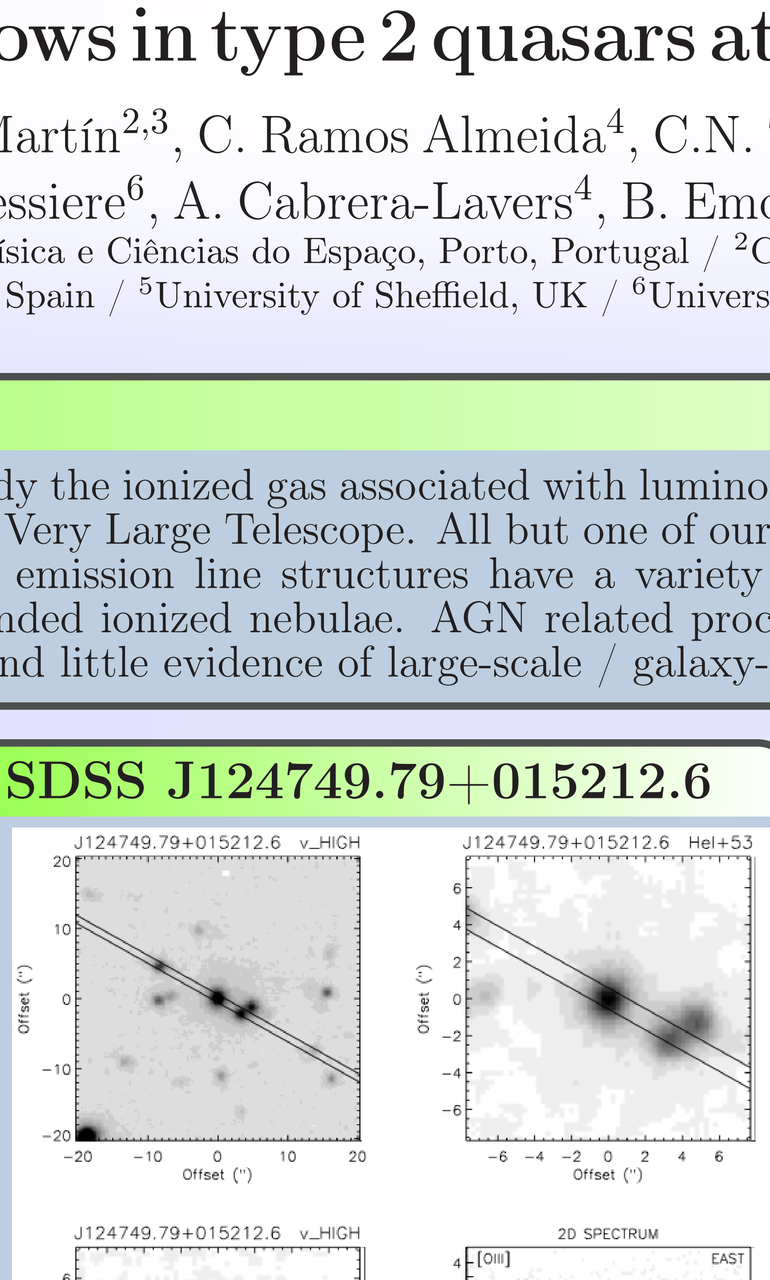

Figure 2. Images and spectrum of SDSS J124749.79+015212.6 (z=0.427). The quasar host galaxy appears to lie in a triple merger/interacting system, and shows extended line emission (∼17 kpc). Line profiles show evidence for an outflow, with radial size <1.4 kpc.

Merger/interaction signatures

7 out of 9 objects (78%) show clear morphological evidence for interactions or mergers in the form of disturbed morphologies and/or peculiar features such as tidal tails, amorphous halos, compact emission line knots, etc. This rate of interaction is consistent with other relevant studies of (more luminous) type 2 quasars at similar z, suggesting the merger rate is independent of the AGN luminosity at the high end of the AGN luminosity function.

References

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SDSS J090307.83+021152.2

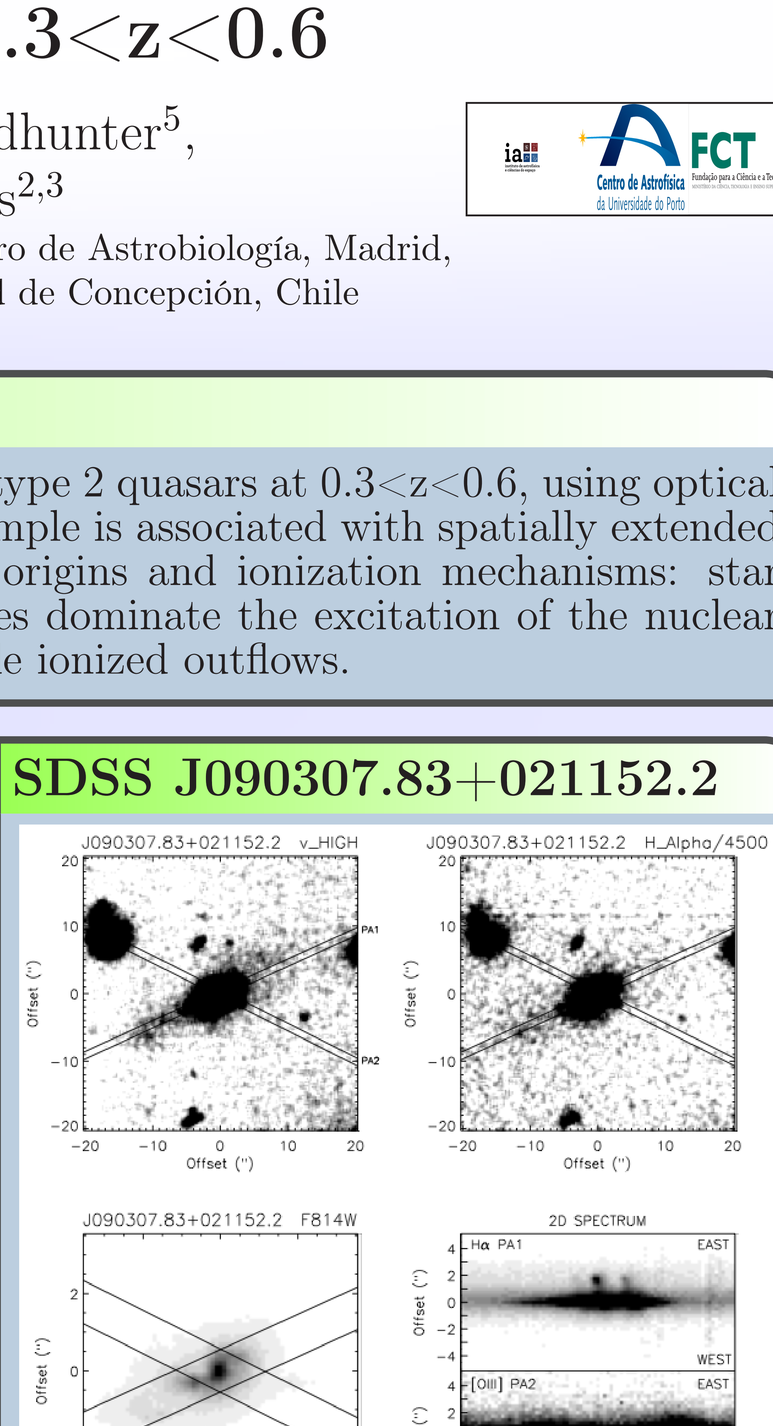

Figure 3. Images and spectrum of SDSS J090307.83+021152.2 (z=0.329). Extended line emission is detected along both slit position angles. Along PA 1, we detect a compact feature of line emitting gas 1.8" (8 kpc) SE of the quasar, which lies in the 'composite' region defined by Kewley et al. (2001). Prominent blueshifted components are seen in [OIII] and other lines, implying the presence of an ionized outflow. This is the only quasar in our sample to show strong evidence for a large-scale (∼10 kpc) outflow.

Paper II: Outflow sizes

We also investigate the presence of extended outflows in an expanded sample of 18 luminous type 2 quasars at 0.3<z<0.6. We infer typical lower limits of several 100 pc and upper limits of ∼2 kpc for the sizes of the outflows.

Energy injection rate, mass injection rate, and outflow mass are $\sim 10^2$-10^4 times lower than claimed in several other studies.

In agreement with Karouzos, Woo & Bae, (2016), we do not find evidence in support of the ubiquity of large-scale AGN-powered outflows in luminous type 2 quasars claimed by others (e.g., Liu et al. 2013; Harrison et al. 2014; McElroy et al. 2015).