PHYSICAL CONDITIONS IN OUTFLOW QUASARS

F. Jiménez-Luján,1,2,3, C. R. Benn1 & J. I. González-Serrano1

1Instituto de Física de Cantabria (CSIC-Universidad de Cantabria), Avda. de los Castros s/n, E-39005 Santander, Spain
2Dpto. Física Teórica y de la Información, Universidad de Cantabria, Avda. de los Castros s/n, E-39005 Santander, Spain
3Instituto de Física de Cantabria (CSIC-Universidad de Cantabria), E-39005 Santa Cruz de La Palma, Spain

ABSTRACT

We present a detailed analysis of several high-redshift (2.5 ≤ z ≤ 4.2) quasars presenting resolved absorption doublets (such as CIV, SiIV and NV) in their spectra, based on high-resolution WHT+ISIS observations: 0217-0854, 0844+0503, 1236+4533 and 1624+3758. Each have known radio counterparts observed by the VLA FIRST survey, and 0008+0658 and 1210+5256. Covering factors and column densities of several atomic species in the absorbing gas have been measured by comparison of the residual intensities in the two components of the doublets. From these, the ionisation parameters have been estimated providing constraints on the distance of the gas from the (for plausible assumed values of electron densities), and therefore the kinetic luminosity of the outflow. We infer that the outflows studied here are not energetic enough to significantly contribute to AGN feedback processes since the maximum percentage of the kinetic luminosity with respect to the bolometric luminosity of the quasar is ≤ 0.003%.

1. INTRODUCTION

Outflows from Active Galactic Nuclei (AGNs) are an important diagnostic of the physical conditions in the inner regions of AGN. Their kinetic luminosity \( L_K \) can be used to describe the role that outflows may play in various AGN feedback mechanisms (e.g. evolution of their host galaxies and enrichment of the intergalactic medium) (Diven 2006). To derive \( L_K \) it is necessary to estimate the distance of the outflow from the quasar nucleus. Broad Absorption Line (BAL) quasars (10 - 20% of all quasars) are characterised by extended absorption troughs in the blue wings of some UV resonance emission lines. The absorption is thought to be from clouds of gas near the AGN. Since these absorptions span hundreds or thousands of km/s, BALs are likely to be intrinsic to the quasar. However, their distance from the central source because in CIV, SiIV and NV) in their spectra, based on high-resolution WHT+ISIS observations: 0217-0854, 0844+0503, 1236+4533 and 1624+3758. Each have known radio counterparts observed by the VLA FIRST survey, and 0008+0658 and 1210+5256. Covering factors and column densities of several atomic species in the absorbing gas have been measured by comparison of the residual intensities in the two components of the doublets. From these, the ionisation parameters have been estimated providing constraints on the distance of the gas from the (for plausible assumed values of electron densities), and therefore the kinetic luminosity of the outflow. We infer that the outflows studied here are not energetic enough to significantly contribute to AGN feedback processes since the maximum percentage of the kinetic luminosity with respect to the bolometric luminosity of the quasar is ≤ 0.003%.

2. SAMPLE SELECTION

To estimate the ionisation parameter \( U \) at a given cloud in the outflow, we require measurements of the column densities of at least two ions e.g. CIV and SiIV. To measure the column density of a given ion, we require observation of at least two unsaturated, unblended absorption lines due to that ion e.g. the CIV 1549–4 doublet. We therefore selected from the SDSS DR4 catalogue (Data Release 4, Adelman-McCarthy, J. K. et al. 2005) all quasars satisfying the following criteria: (i) \( z ≥ 1.5 \) (to allow spectra with good signal-to-noise in the redshift range 2.5 ≤ \( z \) ≤ 4.2), so that the doublet fall within the range of SDSS (4000 – 9000 Å); and (ii) likely, on the basis of visual inspection of the low-resolution SDSS spectra to show velocity-resolved (i.e. probably intrinsic), ionised, unblended doublets, the absorption is well resolved and we find velocity structure. If those column densities, the ionisation parameters have been evaluated and, the ionising number densities, distances and kinetic luminosities have been estimated.

3. OBSERVATIONS AND DATA REDUCTION

Medium-resolution (R = 7000) spectra of the quasars were obtained with the Intermediate dispersion Spectrograph and Imaging System (ISIS) dual-arm spectrograph on the 4.2m William Herschel Telescope (WHT). The data were reduced in the usual way, using standard packages for IRAF for the bias subtraction, flat fielding, cosmic-ray removal and wavelength calibration.

4. PHYSICAL PARAMETERS OF THE ABSORBERS

4.1. 0217-0854

The BAL quasar 0217-0854, at redshift \( z = 2.572 \), has a known radio counterpart observed by the VLA FIRST survey. Its bolometric luminosity is \( 8.22 \times 10^{46} \) erg/s, and the total radio flux density is 5.6 mJy. We present the WHT spectra in Fig. 1. The absorber (e) \( \sim 0.2 \) (Hoeflich & Bolzonella 2001). Since these absorptions span hundreds or thousands of km/s BALs are likely to be intrinsic to the quasar. However, their distance from the central source because in CIV, SiIV and NV) in their spectra, based on high-resolution WHT+ISIS observations: 0217-0854, 0844+0503, 1236+4533 and 1624+3758. Each have known radio counterparts observed by the VLA FIRST survey, and 0008+0658 and 1210+5256. Covering factors and column densities of several atomic species in the absorbing gas have been measured by comparison of the residual intensities in the two components of the doublets. From these, the ionisation parameters have been estimated providing constraints on the distance of the gas from the (for plausible assumed values of electron densities), and therefore the kinetic luminosity of the outflow. We infer that the outflows studied here are not energetic enough to significantly contribute to AGN feedback processes since the maximum percentage of the kinetic luminosity with respect to the bolometric luminosity of the quasar is ≤ 0.003%.

5. CONCLUSIONS AND FUTURE WORK

We have found that 0217-0854 has absorbers that are extended from 0.5 - 9 pc if we consider that they lie in a Broad Line Region and from 2.7 – 27 kpc if we assume the typical values found recently for BALs. For these results, we infer that the outflows studied in this quasar are not energetic enough to significantly impact on its evolution or on the intergalactic medium. Extending this analysis for the totality of the observed sample is our first aim in the near future, improving the global overview of this kind of objects. We are also looking for excited/ground level transitions in other i.e. CIV, SiIV and NV) in their spectra, based on high-resolution WHT+ISIS observations: 0217-0854, 0844+0503, 1236+4533 and 1624+3758. Each have known radio counterparts observed by the VLA FIRST survey, and 0008+0658 and 1210+5256. Covering factors and column densities of several atomic species in the absorbing gas have been measured by comparison of the residual intensities in the two components of the doublets. From these, the ionisation parameters have been estimated providing constraints on the distance of the gas from the (for plausible assumed values of electron densities), and therefore the kinetic luminosity of the outflow. We infer that the outflows studied here are not energetic enough to significantly contribute to AGN feedback processes since the maximum percentage of the kinetic luminosity with respect to the bolometric luminosity of the quasar is ≤ 0.003%.

References


Figure 1: 0217-0854 WHT spectra. The velocities correspond to the blue component of the following absorbers: (a) \( z = 2.572 \) \( v = 256 \) km/s, (b) \( z = 2.546 \) \( v = 224 \) km/s, (c) \( z = 2.503 \) \( v = 204 \) km/s.