Hα EMISSION LINES IN HIGH REDSHIFT QUASARS

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ABSTRACT. We present new data on the redshifts and Hα profiles of 18 medium to high redshift QSOs observed by us using the FIGS spectrometer at the Anglo-Australian Telescope facility and compare the data to that of the strong UV lines obtained in spectra taken at nearly the same time. We find that the Hα line is redshifted by an average of 1100 km s^{-1}with respect to CIVλ1549. Low ionization lines, such as OIλ1305 and MgIIλ2798 are shifted by similar amounts. These results are difficult to reconcile with any simple models currently available, including those where dust obscuration is solely responsible for the observed velocity shifts. The similarity between the velocities of Hα and MgII, OI provides some support for models where the Balmer lines are produced predominantly in a warm HI region, perhaps by X-ray heating, while the Lyman lines arise mainly in a population of optically thin clouds. A velocity separation between the two cloud populations, along with some obscuration, could explain the main features. However, detailed differences between lines of similar ionization suggest that the true situation is more complex.

A search for correlations between the velocity shift and other quantities revealed only one, namely with the ratio of the CIII]λ1909 and CIVλ1549 line fluxes. The meaning of this

D. E. Osterbrock and J. S. Miller (eds.), Active Galactic Nuclei, 355–356.

is obscure, but may relate to density or projection effects. A number of other correlations proposed by previous workers as tests for their models were sought but not found.

DISCUSSION

GASKELL The two things the redshift difference implies are *radial motion* and *obscuration* or scattering. The model I used to favor for the high-low ionization profile difference was outflow coupled with an occulting object (e.g., accretion disk). I originally thought that it was the high-ionization lines that were blueshifted, but I would like to draw attention to Junkkarinen's paper where he claims that it is the *low* ionization lines that are redshifted. This offers a way of reconciling the redshift differences with the variability observations favoring infall of the BLR gas.

ESPEY There are a number of complications to interpretation of the data collected so far on emission line redshifts. Including Seyferts with QSOs in the analysis may not be a correct assumption due to the possible influence of luminosity effects on the redshift differences. Also important is the mesurement technique where asymmetric lines are involved and, as Wilkes has pointed out, results are still ambiguous between different people's samples: Vesa's results presented in preprint form here (i.e., a redshift difference between C IV and the forbidden lines of +40 km s^{-1}) is at odds with his work on $z_{abs} > z_{em}$ systems where the difference is a *blueshift* of C IV by up to $\sim$ 1000 km s^{-1}. His present sample also only showed forbidden lines in 13 out of 35 objects.

Regarding the obscuration, we have pointed out here the similarity of the O I redshift (where observed) with the Hα and low-ionization line value. This, together with the similarity of the Ly α and C IV profiles, sets limits on the amount of scattering allowed.

Kundt, in a paper to appear in *Astrophysics and Space Science* has interpreted your time delay results differently – he proposes *infall* in NGC 4151 coupled with a time delay due to diffusion. He argues that this can explain the delay of the red wing of the C IV and Mg II lines. I cannot comment on the relative merit of your two arguments, but wish to point out that the whole question about the systemic velocity and cloud motion is still open!

WILKES Following Gaskell's comment, I'd like to point out that the question of which emission lines are at the systemic velocity is not yet settled. In my work I found that Mg II was unshifted relative to the forbidden lines, whereas Junkkarinen has found a shift in this case. This is not necessarily a problem in the models because if the high-ionization lines are blue shifted, inflow coupled with obscuration due to dust or high optical depths in the back, neutral regions of the clouds can explain this.

ESPEY Yes, I agree. Also, the situation is by no means clear-cut as yet due to problems with sample size, e.g., previous work by Junkkarinen last year seemed to show agreement of the forbidden lines with the low-ionization emission peak, and also there remain problems with spectral resolution and differences in measurement techniques between different workers.