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Q0059-2735: A Hybrid Starburst / Broad Absorption Line QSO? Clues from Spectropolarimetry

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Abstract. Spectropolarimetric data support the hybrid BALQSO / starburst model proposed for the iron Lo-BAL QSO Q0059-2735.

1. Q0059-2735 and the Hybrid BALQSO / Starburst Model

Q0059-2735 (z =1.59) is one of the extreme and very rare low-ionization broad absorption line (Lo-BAL) QSOs which exhibit narrow absorption lines (NALs) from metastable levels of Fe II. Q0059-2735 is often considered as the prototype of the "iron Lo-BAL" QSO class.
A hybrid BAL QSO / Starburst model has been proposed for Q0059-2735 by Cowie et al. (1994) and Egami et al. (1996). These authors suggest a model in which the central (BAL) QSO is surrounded by a dusty shell of young stars contributing to the excess of UV continuum, and at the origin of the Fe II NALs. The mixture of starburst and reddened quasar properties appears in varying degree as a function of wavelength, and could be the signature of a younger stage in the quasar evolutionary sequence. A couple of BAL QSOs with characteristics supporting this interpretation were recently found by Becker et al. (1997).
Since Q0059-2735 is polarized like many other low-ionization BAL QSOs, we have investigated its UV rest-frame polarized spectrum.

2. Clues from Spectropolarimetry

Spectropolarimetric data have been obtained for Q0059-2735 with the ESO 3.6m telescope at La Silla, and are presented in Lamy & Hutsemékers (2000).
In agreement with the standard interpretation of BAL QSO spectropolarimetry (Cohen et al. 1995, Schmidt & Hines 1999), the rise of polarization in the BAL troughs (cf. Fig. 1 and Table 2 in Lamy & Hutsemékers 2000) suggests that the scattered continuum is less absorbed in the BAL region (BALR) than the direct unpolarized continuum. The fact that some BALs (e.g. C IV) are also seen in the polarized flux indicates that the scattered flux crosses the BALR in regions of

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lower opacity. However, the absence of Al III in the polarized flux of Q0059-2735 suggests that the scattered flux misses the region of the BALR where Al III is formed. This behavior is not unique among BAL QSOs: in the polarized flux of Q1246-0542 there is apparently no trace of any BAL, including C IV. In the case of Q0059-2735, this suggests that the low-ionization Al III BALR is less extended than the high-ionization one, and does not cover the scattering region. On the other hand, the Fe II absorption blends are detected in the polarized flux, while they are not significantly more polarized than the continuum. Thus, the iron absorbing gas must intercept both the polarized and unpolarized continua with roughly the same opacity, suggesting a different location and/or geometry of the Fe II absorbing region. Compared to the other low-ionization BALs, the behavior of the Mg II BAL is quite striking since it appears more polarized than the continuum (although not as much as Al III), while it is seen in the polarized flux, like Fe II. These intermediate properties may indicate a hybrid origin of the Mg II BAL.

These results are consistent with the interpretation that the spectrum of Q0059-2735 is a superposition of a BAL QSO spectrum and a starburst one, the starburst being at the origin of the Fe II NALs (Cowie et al. 1994; Egami et al. 1996). In this model, Q0059-2735 is seen along a line of sight close to the dusty equatorial plane. In the framework of the disk-wind model of the BALR, such an orientation could explain the presence of low ionization troughs, the very deep and steep C IV absorption trough, and the high degree of polarization in the continuum (cf. Murray et al. 1995, Hutsemékers et al. 1998). Free electrons and/or dust scatter the continuum photons along lines of sight that cross the BALR where the opacity is still large for C IV, and much smaller for Al III and Mg II, the latter ions being located much closer to the disk as suggested by Murray et al. (1995). Within this model, the Fe II NALs are produced beyond the BALR, in material swept up by the strong winds of supernovae in the starburst (Hazard et al. 1987, Norman et al. 1994), such that the scattered and direct continua are similarly absorbed. The Mg II BAL could be hybrid, partly formed in the QSO disk-wind and partly in the starburst. The fact that the polarization in the Mg II BAL is not the highest at exactly the wavelength at which the BAL profile is the deepest could support this hypothesis, although data with higher spectral resolution are needed.

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