Unusual radio BAL quasar 1624+3758

Chris Benn[1], Ruth Carballo[2], Joanna Holt[3], Mario Vigotti[4], Ignacio González-Serrano[2], Karl-Heinz Mack[4], Rick Perley[5]

(1) Isaac Newton Group, La Palma, Spain; (2) Universidad de Cantabria, Spain; (3) University of Sheffield, UK;
(4) Istituto di Radioastronomia, Bologna, Italy; (5) NRAO, Socorro, USA

Unusual features

1624+3758, at z = 3.377, is the most radio-luminous BAL quasar known. It has several unusual properties:

(1) The radio rotation measure, 18350 radm^{-2}, is the second highest known for any quasar.

(2) The FeII UV191 1787-A emission line is prominent.

(3) The BAL trough (BALnicity 2990 kms^{-1}) is detached by 21000 kms^{-1}.

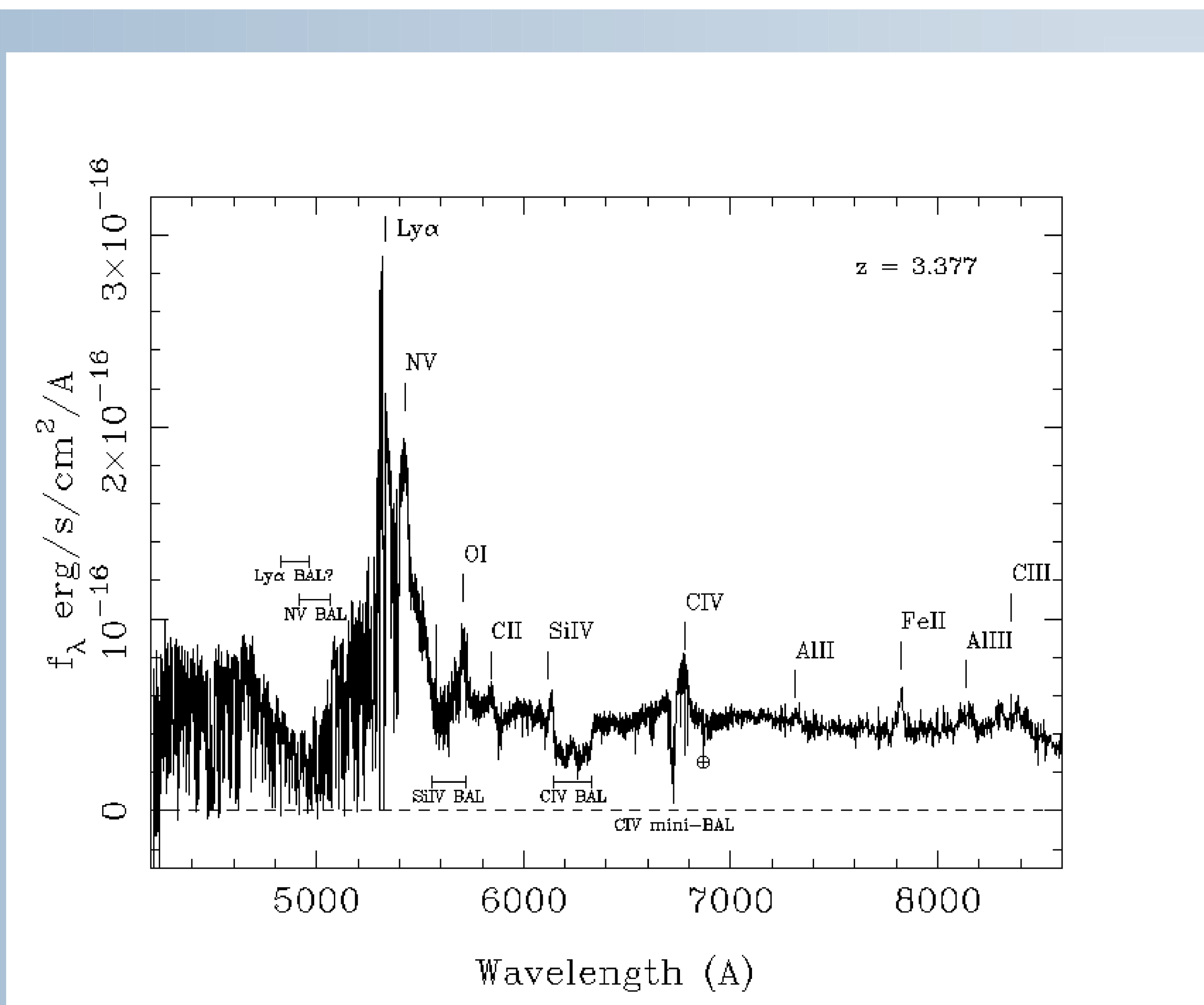

Fig. 1 - WHT spectrum of 1624+3758 (supplemented with lower-resolution SDSS data redward of 7000 A).

(1) The Faraday rotation (measured from VLA and Effelsberg observations) must arise in gas lying between us and the radio-emitting region (size > 1 kpc). The high rotation measure implies a high value of at least one of the magnetic field, electron density or path-length through the region responsible. It is unlikely to depend strongly on the orientation at which we view the quasar.

(2) The strong 1787-A FeII emission may imply an unusually strong FeII 'small blue bump', which could be a signature of the thickening of the accretion disk at accretion rates close to the Eddington limit (Boroson 2002, ApJ, 565, 78).

(3) The detachment of the BAL by 21000 km/s suggests an angle of view well away from the plane of the accretion disk, so that the line of sight to the quasar nucleus exits the curving streamlines far above the disk.

In summary, the observed properties of the quasar are more consistent with it being intrinsically unusual than with it being viewed at an unusual orientation. Being highly radio luminous, it may be a good example of an object which is accreting both at a very high rate, and near the Eddington limit (bottom left corner of Fig. 2).

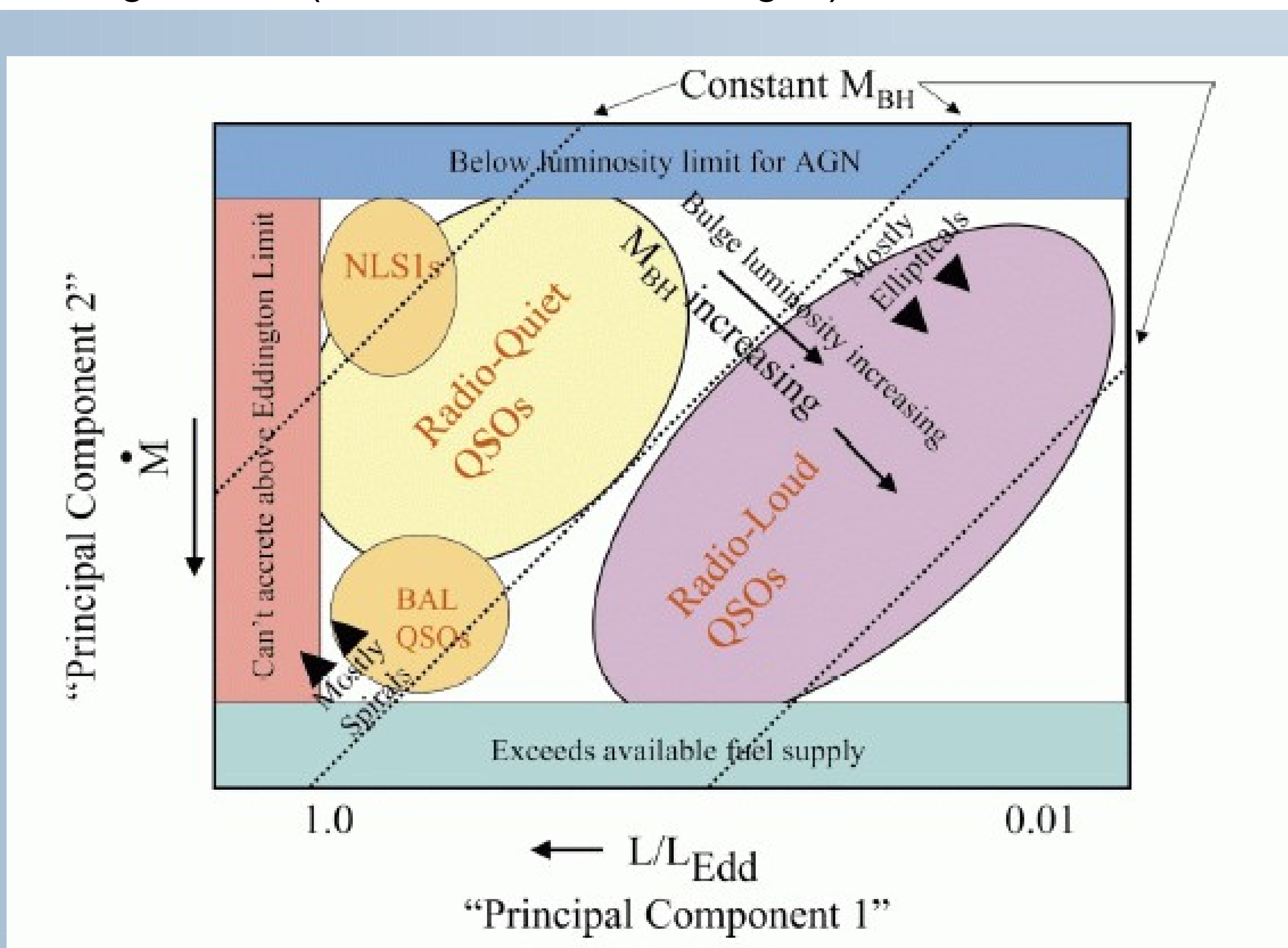

Fig. 2 - Boroson's (2002) two-component scheme for the classification of AGN. In this scheme, the rare radio-loud BAL quasars may be objects with extremely high accretion rates.

Covering factor of CIV mini-BAL

The spectrum includes a complex CIV mini-BAL (Fig. 3). The velocity range is similar to the wavelength separation of the CIV doublet, which makes this system ideal for separating out the effects of covering factor C and optical depth τ (see e.g. Arav et al 1999, ApJ, 525, 566).

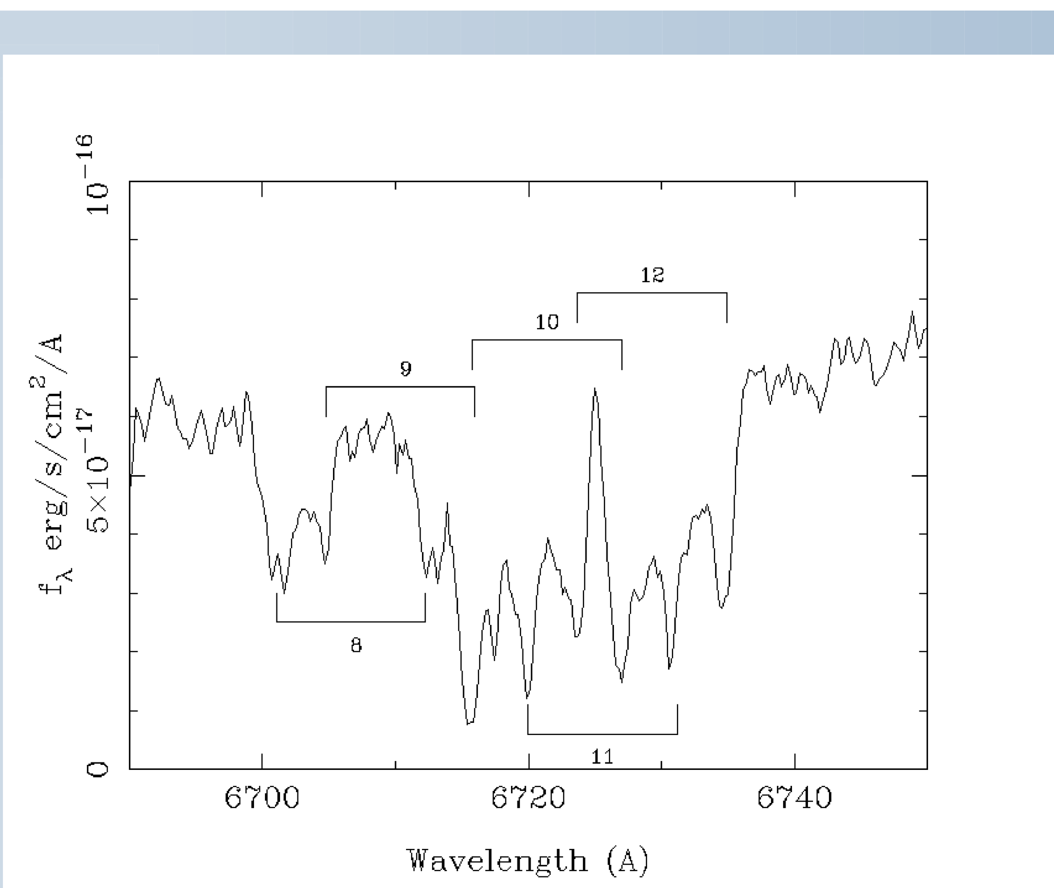

Fig. 3 - WHT ISIS spectrum of the CIV mini-BAL (doublets indicated).

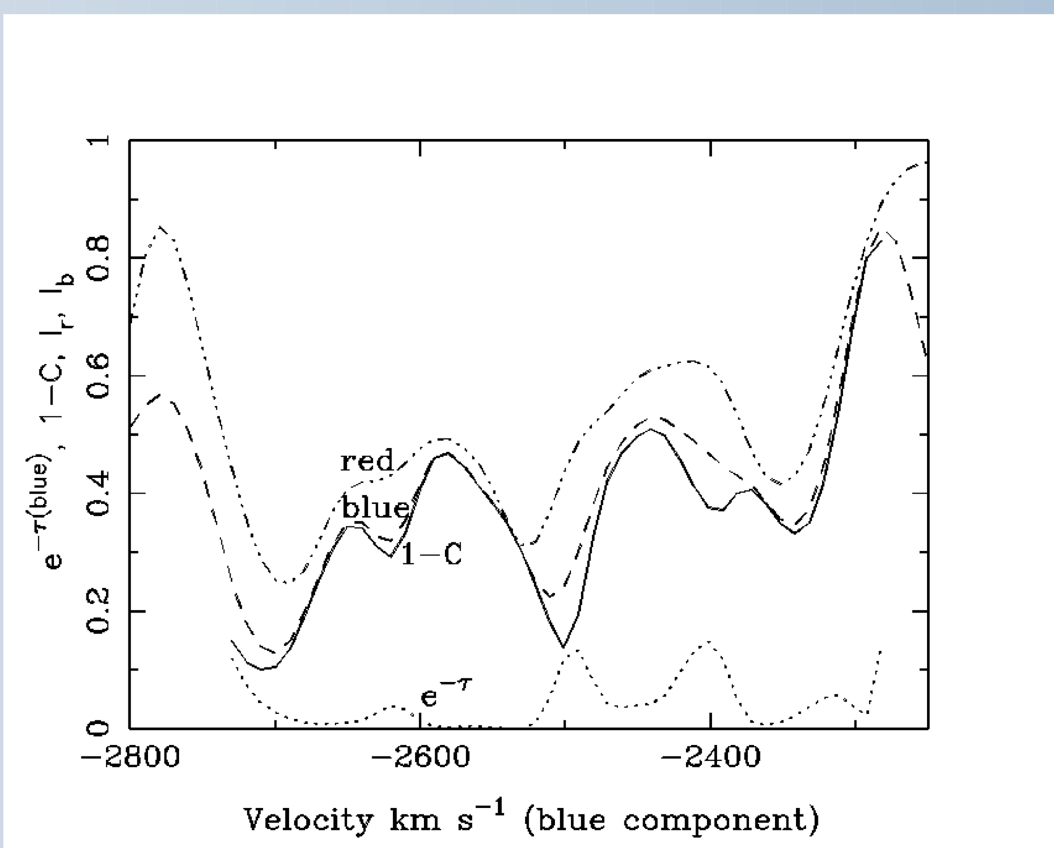

Fig. 4 - Covering factor C (the solid curve shows 1-C) and optical depth τ (dotted), derived (Fig. 5) as a function of velocity from part of the spectrum in Fig. 3 (the dashed and dot-dashed lines show the original spectrum - red and blue components of the doublet). The form of the mini-BAL is dominated by variations in C. Column densities in CIV (and other ions) can be estimated over part of the velocity range, providing constraints on the ionisation parameter U. We are now observing at similar resolution a sample of NALs/miniBALs in SDSS BAL quasars, using ISIS on the 4.2-m WHT and DOLORES on the 3.5-m TNG.

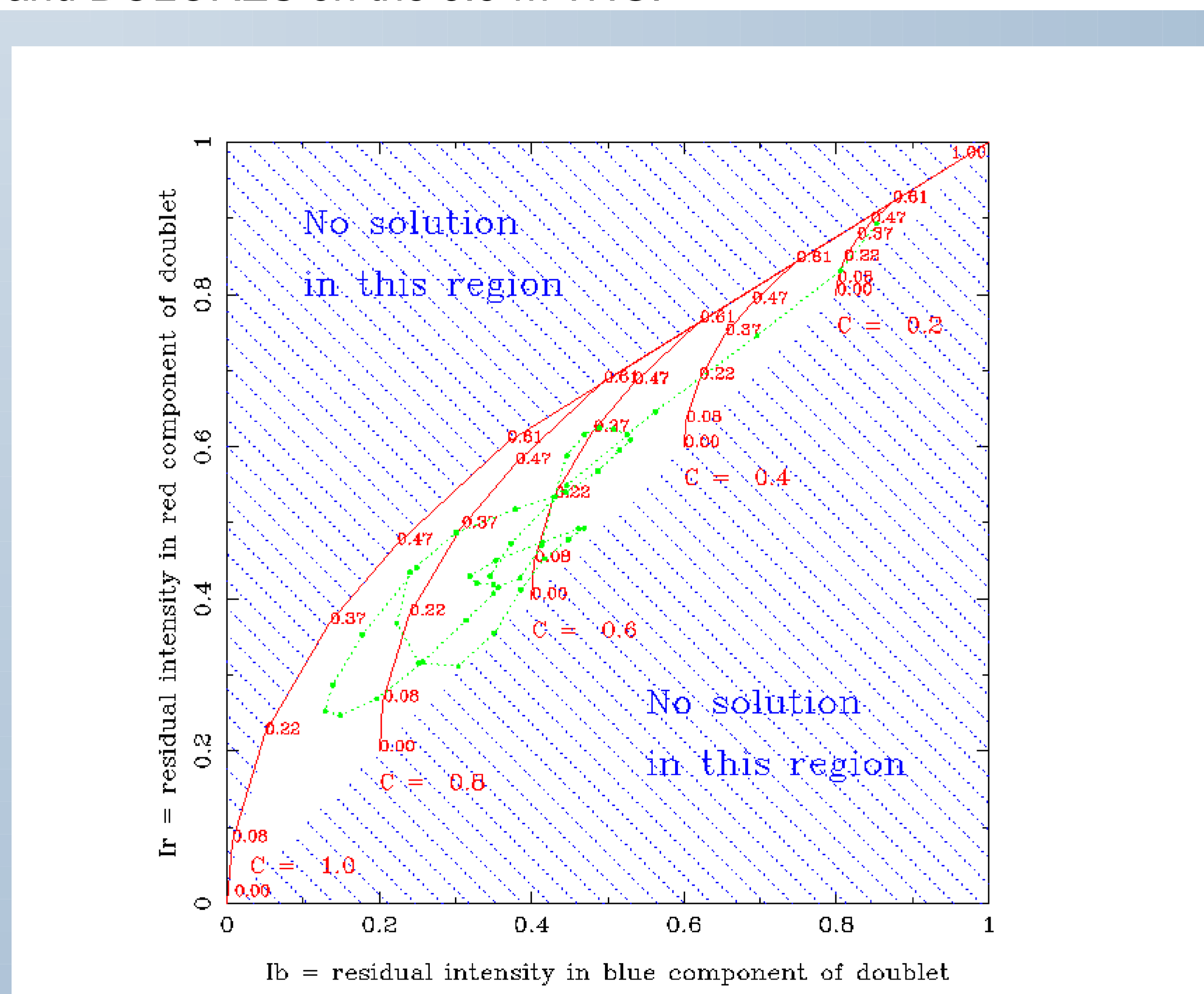

Fig. 5 - Derivation of covering factor C (red numbers in large font) and optical depth τ (small font) from the residual intensities Ir and Ib in each component of a doublet line. The green curve shows the locus of C and τ derived in Fig. 4.

See Benn et al (2005, MNRAS, 360, 1455) for further details.