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Geometric-kinematic structure in AGN outflows: Intrinsic absorption in Mrk 279

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Abstract. We present the analysis of intrinsic UV absorption in the Seyfert 1 galaxy Mrk 279, observed simultaneously with *HST*/STIS (40 ks) and *FUSE* (92 ks). To derive the absorption covering factors and ionic column densities, we employ an algorithm based on minimizing errors in simultaneous fits to multiple lines. This technique allows for the treatment of more complex (and physically realistic) scenarios of the absorption-emission geometry, giving more accurate measurements and unique geometrical constraints on the mass outflow.

Analyses of UV absorption doublets have shown that intrinsic AGN absorbers typically only partially cover the background emission sources. Separating the effects of covering factor (C_f) and optical depth (τ) is crucial for correct interpretation of the mass outflow. However, the standard method of solution, using the two lines of a doublet, has some important limitations. It can only treat the background emission as a single source, neglecting the physically distinct nature of the continuum and emission-line regions. Also, the doublet solution can be very sensitive to noise in the spectrum, exhibiting non-linear behavior and often giving misleading results.

Thus, we fit the absorption in Mrk 279 by minimizing errors in simultaneous fits to multiple lines, solving for the continuum and BLR covering factors (C_f^c, C_f^{BLR}), and the ionic column densities (N_{ion}). There are two methods to incorporate the additional lines needed for this analysis: (a) Fitting of multiplets: The Lyman lines are ideal for this since the full series is sampled in the far-UV spectrum, they span a large optical depth range, and have substantially different underlying BLR fluxes. (b) Global fitting approach: In this case, the absorption equations for different ions are linked through physically based assumptions about the covering factors, which can then be assessed by the quality of the fit. For our analysis, the CNO doublets were assumed to share the same covering factors.

Velocity-dependent results from both fits are plotted in Figure 1 and comparison of the derived and observed profiles are in Figure 2, showing very good fits in both cases. Some highlights and implications of these results:

• The two independent fits give very similar C_f solutions: the continuum source is fully covered and the BLR covering factors are virtually identical (for regions where the Lyman lines are uncontaminated by other absorption).

• The covering factor solutions are consistent with the continuum source being much more compact than the BLR.

• The velocity-dependent C_f^{BLR} translates to a decreasing projected size of the outflow (in our line-of-sight to the AGN): reverberation mapping of the BLR in Mrk 279 (Maoz et al. 1990) implies projected sizes of ≈ 8 lt-days in the absorption cores, and trailing off in the velocity wings.

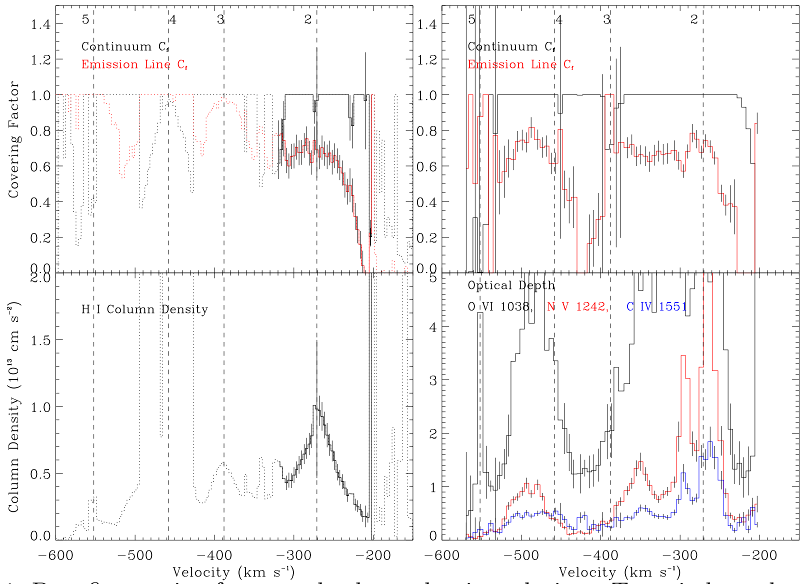

Figure 1. Best-fit covering factor and column density solutions. Top windows show continuum and BLR (red) covering factors with error bars, solved independently for the Lyman series (left panels) and CNO doublets (right). The contaminated (unreliable) region of Lyman absorption is plotted with dashed lines (see Scott et al. 2004). Bottom panels show the H I column density and C IV, N V, and O VI optical depth solutions.

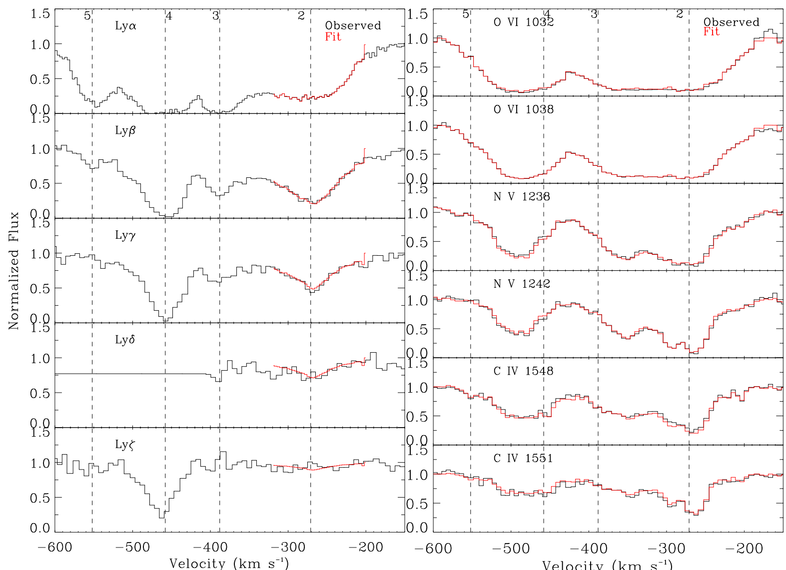

Figure 2. Best-fit intrinsic absorption profiles for Mrk 279. Results from independent analysis of Lyman multiplets (left) and combined CNO doublets (right). Fitted profiles (red) are derived from the best-fits to C_f^c, C_f^{BLR}, and N_{ion} shown in Figure 1; observed normalized profiles are plotted in black. The high-velocity Lyman line absorption could not be fit due to contamination with other absorption.

References

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