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C IV λ1549 Emission-Line Profile Variations in AGN

Marc Türler[1] and Thierry J.-L. Courvoisier[2]

[1]*Geneva Observatory, ch. des Maillettes 51, CH–1290 Sauverny, Switzerland*

[2]*INTEGRAL Science Data Centre, ch. d'Écogia 16, CH–1290 Versoix, Switzerland*

Abstract. We study the C IV λ1549 emission-line profile variations in 18 Seyfert 1-type objects observed with the *IUE* satellite from 1978 to 1991. The core and the two wings of the line are integrated separately in order to study differences between the wings and the core and between the blue and the red wings. A principal component analysis is applied to spectra of each object. The results suggest the presence of a significant infall component in the line-emitting region of several AGN.

1. Introduction

The C IV λ1549 emission-line variations are studied in a sample of 18 Seyfert 1-type objects, including 5 quasars, with more than 15 'good quality' *IUE* spectra taken between 1978 and 1991.

The emission-line flux is directly integrated above a straight-line continuum joining the mean fluxes in two line-free windows on each side of the C IV λ1549 line. The continuum flux is defined at $\lambda_{\rm rest} = 1549$ Å. The line flux is emitted by matter with a line-of-sight velocity smaller than 10,000 km s^{-1}. The separation between the line core and the line wings is chosen arbitrarily at 2500 km s^{-1}. A detailed description of the work is in preparation (Türler & Courvoisier 1997).

2. Line Response to Continuum Variations

The slope of the line flux vs. continuum flux log-log relation in individual objects measures the line response to continuum variations. This response is smaller than unity in all AGN in our sample, implying an intrinsic Baldwin effect (Pogge & Peterson 1992).

There is a good trend (Spearman's test probability = 93%) in the sense that this response is weaker in luminous AGN than in faint AGN. For the two extreme objects, NGC 4151 and 3C 273, this slope is respectively 0.67 and 0.18. This anticorrelation with luminosity is expected if the size of the line-emitting region is increasing with object luminosity, as expected in photoionization models. A larger line-emitting region in more luminous objects implies a longer line response time and therefore a more pronounced averaging out of continuum variations in the line response.

The line-to-continuum response is generally different for each line part. This response was found to be significantly stronger in the wings than in the core in six objects: ESO 141−55, Mrk 926, NGC 3783, NGC 4151, NGC 4593, and 3C 273, and significantly weaker in Mrk 509 and GQ Comae.

Asymmetric differences are found to be more common than expected. A stronger response in the red wing than in the blue wing is observed in eight objects: 3C 120, Mrk 335, Mrk 509, Mrk 926, NGC 3516, NGC 4151, NGC 5548, and NGC 7469, whereas a weaker response is only observed in 3C 382 and Fairall 9. A slightly negative blue-wing response was even observed in 3C 120, Mrk 509, and NGC 7469, in strong contrast to a red wing that is well correlated with the continuum.

3. Principal Component Analysis

A principal component analysis allowed us to decompose the mean line into three independently varying components (Türler & Courvoisier 1997).

The following general results apply to most objects in the sample. The strongest varying component describes correlated continuum and broad-line variations. This broad-line component is probably emitted in the innermost part of the emission-line region. In some objects, it has a double-peaked shape suggesting the presence of a rotating disk.

A less-variable component describes asymmetric line variations: a flux increase on one side of the line implies a flux decrease on the other side. Such variations can either be due to a spectral shift of the line or to an anticorrelation between the blue-wing and the red-wing emission.

A nearly non-varying component has a clearly narrower line shape than the most variable component. In some objects, the line width corresponds to velocities of $\sim$1000–1200 km s^{-1}, which suggests that this component is the signature of the narrow-line region emitted at greater distances from the ionization source.

4. Discussion

Asymmetric line variations are significantly detected in our analysis. Such variations can occur only if there is a radial component in the velocity field of the line-emitting region. A stronger line-to-continuum response in the red wing than in the blue wing suggests infall, because in this case the red wing is emitted on the near side of the emission-line region, whereas the blue wing is emitted on its far side and thus responds later and longer to the continuum. The opposite applies in the case of outflow.

Our study suggests that there is significant infall in many AGN, although chaotic or rotational motion is usually predominant in the velocity field of the emission-line region.

References

Pogge, R. W., & Peterson, B. M. 1992, AJ, 103, 1084.
Türler, M., & Courvoisier, T. J.-L. 1997, in preparation.