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A2_1 NGC 5548: Investigating the sensitivity of the intrinsic Baldwin effect to variations in the starlight correction factor

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Abstract

A well investigated phenomenon in the study of Active Galactic Nuclei (AGN) is that of the Broad-Line Baldwin Effect. Many correction factors are used in the process of reducing data to the direct form of the Baldwin Effect, including removal of time delay, narrow line components, galactic starlight surrounding the nucleus, and the reddening of the data. In this paper the variation in the Baldwin slope, ξ, with variations in the value of the galactic starlight correction factor is examined quantitatively.

Introduction

The variation of the ultraviolet and optical continua from Active Galactic Nuclei has been an active research topic ever since its discovery over 25 years ago [**1**]. It is now generally accepted that a shell of unresolved clouds surround most AGN, named the "Broad line region" (for the broad emission features seen in its spectra). Strong theoretical evidence exists to suggest that this region is photoionised by a central source of photons. Emission line photons are then thought to be produced upon recombination of the electrons and Ions. Importantly, any variations observed in the flux of this central source (which we now choose to name the continuum) are usually observed to occur in the Emission line flux, some time later due to light travel time. This time is denoted as $<\tau>$.

An interesting phenomenon that arises from the results of the continuum variations is the intrinsic Baldwin effect, which is described by the relationship between the continuum flux, F_C , integrated broad line flux, F_L , and responsitivity, ξ. ξ is a dimensionless factor that incorporates all of the relevant atomic and gas physics. The Baldwin effect is then mathematically represented by

$$F_L(t) \propto F_C(t)^{\xi}, \quad (1)$$

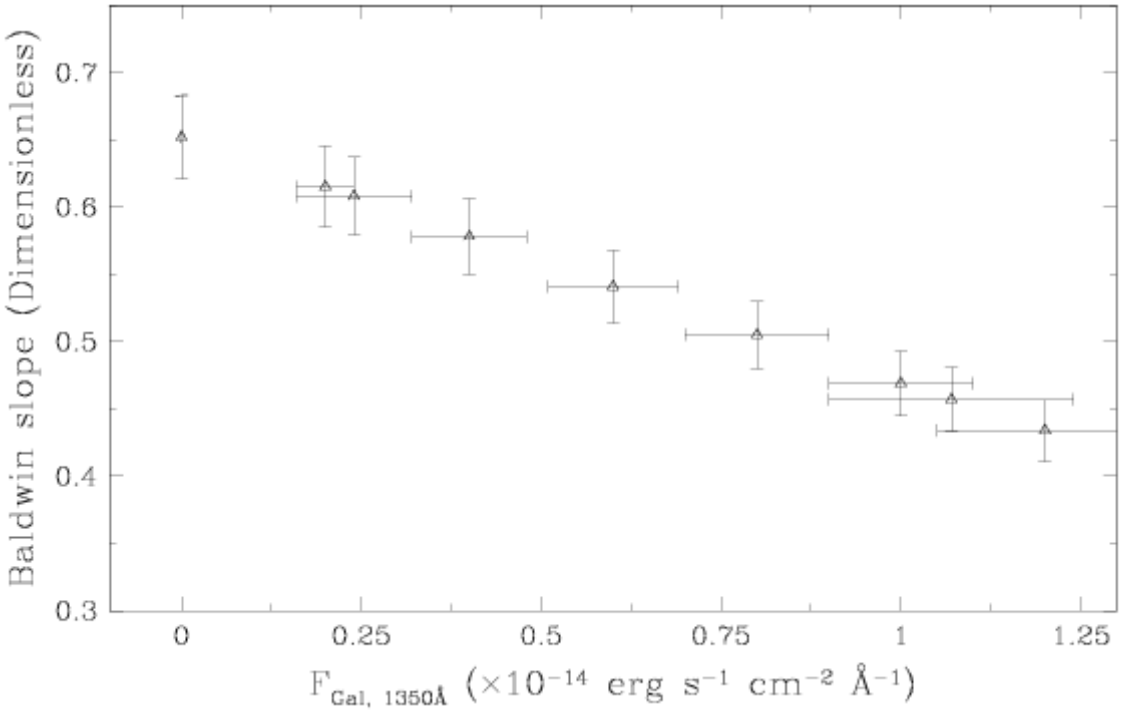
where t is the instantaneous time. F_L has been corrected for $<\tau>$ and is coincident in time with F_C because the instantaneous response of F_L with varying F_C is investigated. After subtracting the narrow line correction factor, f_{NL}, from the left hand side of (1), and the Galactic starlight correction factor, F_{GAL} , from the right hand side, taking the natural logarithm of both sides yields equation (2).

$$\ln(F_L(t) - f_{NL}) \propto \xi \ln(F_C(t) - F_{GAL}), \quad (2)$$

Equation (2) forms a linear relationship with slope ξ. The Galactic starlight correction factor F_{GAL} accounts for non-variable continuum flux coming from outside the active galactic nucleus.

Data Analysis

Whilst f_{NL} has been well calculated for most of the UV broad features in NGC 5548 [**2**], there is no accepted F_{GAL} value for this object in the UV. Figure 1 shows calculated values of ξ for the Broad CIV feature (1549Å) against a range of theoretical F_{GAL} values (flux data from 1993 UV monitoring campaign of NGC 5548 by Hubble Space Telescope) [**3**]. The minimum value that F_{GAL} can take is zero (which is physically unlikely), whilst the maximum value it can take is that of the lowest UV continuum flux ever recorded for this AGN ($F_{GAL,\,MAX}$ = 1.20 (±0.15) x 10^{-14} erg $s^{-1}cm^{-2}Å^{-1}$)



(Figure 1)

Figure 1 shows that ξ is very sensitive to variations in F_{GAL}, varying by up to 30%. Recent measurements of an 'all time low' continuum flux for the galaxy give $F_{GAL,\,MAX}$ = 2.4 (±0.8) x 10^{-15} erg $s^{-1}cm^{-2}Å^{-1}$ [**4**]. This constrains F_{GAL} to lie between the first 3 points in figure 1. By taking F_{GAL} as the average of these three points, a good estimate of ξ is 0.625 ± 0.023, the uncertainty here being less than the error in ξ due to F_L vs F_C scatter. In conclusion, this value forms a suitable estimate for F_{GAL} and will have no noticeable effect on the final value of ξ given the scatter inherent in the HST data.

References

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[**4**] D.M. Crenshaw, S.B. Kraemer, H.R. Schmitt, J.S. Kaastra, N. Arav, J.R. Gabel, K.T. Korista, Astrophysical Journal, vol. **698**, pg 281-292, 2009