# Emission Line Diagnostics in a "No UV Bump" Quasar PHL909

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**Abstract**

PHL909 is a quasar with unusually low ultraviolet luminosity (blue bump strength $C_{UV/IR} = -0.20$ compared to an average value of 0.4 (McDowell et al. 1989 ApJL 345, L11)). It also has unusually flat hard X-ray spectrum. The UV spectrum of the object shows large fluxes in the emission lines Ly$\alpha$ and CIV and the optical spectrum shows strong emission lines of MgII and the Balmer series. The observed continuum is too weak to produce the emission line fluxes unless the covering factor is very high ($\sim 50\%$ c.f. $< 10\%$ typical). The intrinsic continuum of PHL909 ( i.e. as seen by the BELR ) may thus be similar to the 'standard' continuum, with a big blue bump, reddened along the line of sight.

**Motivation**

The quasar population as a whole covers a wide range of continuum properties such as radio brightness, infrared breaks and most importantly the ionizing continuum: the UV blue bump strength (McDowell et al. 1989) and X-ray brightness (Wilkes *et al.* 1994 ApJS, in press). This range is sufficient to cause a marked difference in the physical conditions of the line emitting gas; so using a "standard quasar" continuum obscures physics in the gas. The relation between observed continuum and BELR physics can best be studied by examining quasars with extreme characteristics in their continuum properties. Mathur (in IAU159 on *Multiwavelength Continuum Emission of AGN* [Kluwer Academic] pp 271), Mathur *et al.* (1994 ApJ, in press ) have discussed the effect of X-ray quietness on the inferred parameters of BELR clouds. In this paper we discuss emission lines properties of PHL909, a weak UV bump quasar.

**PHL909: Continuum Properties**

The Spectral Energy Distribution of PHL909 shows no UV bump (Figure 1). The blue bump strength $C_{UV/IR} = -0.20$ compared to an average value of 0.4 ( McDowell et al. 1989). The optical to X-ray power law slope $\alpha_{OX} = 1.3$ compared to an average value of 1.5 ( Wilkes *et al.* 1994). The hard X-ray spectrum is unusually flat: $\alpha_X = 0.4$ (Average = 0.9 – 1.2, Williams *et al.* 1992 Ap.J. 389, 157). The X-ray spectrum shows excess in soft energies over the hard X-ray slope (Masnou *et al.* 1992 A&A, 253, 35). It has an order of magnitude lower number of ionizing photons in the observed continuum ($3 \times 10^{55}\ s^{-1}$) as compared to the standard one ($7 \times 10^{56}\ s^{-1}$).

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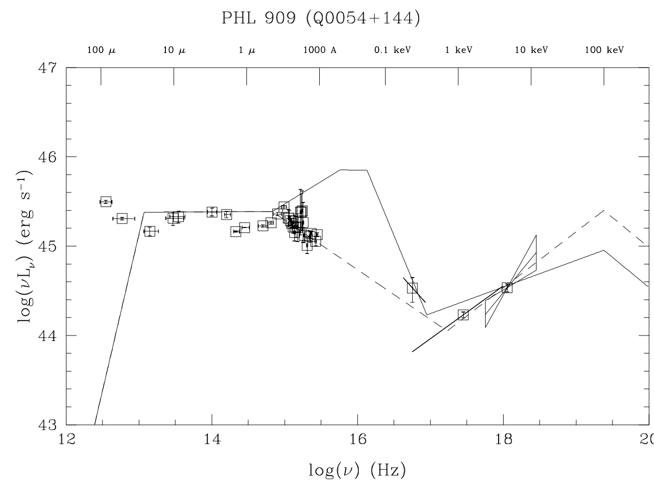


**Figure 1:** The complete rest frame spectral energy distribution of PHL909 (data from Elvis *et al.* 1994 Ap.JS, in press) corrected for Galactic reddening. The dashed line is the best fit observed continuum. The solid line is the 'standard' continuum (as defined in CLOUDY, Ferland 1991 OSU Astronomy department internal report)

**PHL909: Emission Line Properties**

The Ly$\alpha$ equivalent width of PHL909 is $\sim$ 100 Å (Average = 65, Wilkes 1986 MNRAS 218, 331). The number of Ly$\alpha$ photons $=1.3 \times 10^{55}$ $s^{-1}$) is thus comparable to the number of ionizing photons in the observed continuum. The CIV/Ly$\alpha$ ratio is $\sim$ 1 (Average = 0.63, Morton 1991 ApJS, 77, 119). The H$\beta$/Ly$\alpha$ ratio is $\sim$ 0.08 (Average = 0.22, Wills *et al.* 1985 ApJ 288, 94). The H$\beta$ equivalent width = 52 (Average = 47, Wilkes 1986).

**Results**

The observed continuum of PHL909 is unusual as described above. However, the emission line spectrum is not unusual. What is the *intrinsic* continuum of PHL909? It could be:
(1) As Observed: The quasar may have unusual intrinsic continuum with no blue bump. This requires that the ionization parameter U= 0.016 to get the observed line ratio CIV/Ly$\alpha$. The covering required to produce the observed line strengths is then very high ($\sim$ 50%). This is highly unlikely. (2) Similar to the 'Standard' but directed away from us: PHL909 may have the big blue bump in its continuum, but we do not see it. This may be a geometric effect e.g. the accretion disk emitting in UV may be edge on (Cunningham, 1975 ApJ 202, 788). The difference in the UV luminosity between the standard and observed continua can be attributed to the inclination effect in accretion disk models. But the spectrum is not observed to harden as expected for the edge on accretion disk. It is thus unlikely that the observed spectrum is just an inclination effect. (3) Similar to the 'Standard' but reddened along the line of sight: The column density of hydrogen required to produce the "observed" reddening is $\sim 10^{21}$ $cm^{-2}$. This absorber would show absorption lines in the UV and absorption in the X-rays. The IUE data is not good enough to detect absorption lines. In X-rays, the soft excess as observed in the *Einstein* spectrum (Masnou *et al.* 1992) may be due to an ionized absorber. *Einstein* data is consistent with an ionized absorber along the line of sight with the effective column density of neutral hydrogen = few times $10^{21}$ $cm^{-2}$. This can be tested with ASCA data.

If the intrinsic continuum is indeed standard, the covering factor deduced to produce the observed line strengths = 0.06, as is usually observed in quasars (c.f. $< 10\%$) . **Inferring from the emission lines, the intrinsic continuum is highly likely to be standard, with a big blue bump.**