A First Close Look at the Balmer-edge Behavior of the Quasar Big Blue Bump

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Abstract.

We have found for the first time a Balmer edge feature in the Big Blue Bump emission of a quasar. The feature is seen in the polarized flux spectrum of the quasar, where all the emissions from outside the nucleus are scraped off and removed. The existence of the Balmer-edge absorption feature directly indicates that the Big Blue Bump is indeed thermal and optically-thick.

1. Introduction

Among the various components of a quasar emission, the optical/UV component, called Big Blue Bump (BBB), is energetically the most dominant. The BBB is often assumed to be from optically-thick thermal emission from an accretion flow, such as an accretion disk. However, this fundamental issue (i.e. the emission mechanism of the BBB) is actually very far from being solved, since observations are hardly said to be well described by disk models. Among several serious problems are the continuum slope and apparent lack of continuum edges. In order to explain the observed optical/UV slope (e.g. $F_\nu \propto \nu^{-0.3}$, Francis et al. 1991), the disk has to be rather cool. However, naively, in a cool disk, its atmosphere would show large continuum edges (but see below). Apparently, we do not see such features.

2. Balmer edge feature and our strategy

In the sophisticated disk atmosphere models (e.g. Hubeny et al. 2000), when the spectrum is integrated over radii and smeared through the relativistic Doppler shifts and gravitational redshifts, the flux discontinuity at the Lyman limit is rather well smeared. However, the Balmer edge, which arises further out in radius where relativistic smearing is not too severe, can still be substantial. The only problem is that it is very hard to be observed due to the Balmer and FeII emission lines and nebular continuum from the Broad Line Region (BLR) and outer regions (called 3000Å bump).
However, we can remove all these unwanted emissions by taking a polarized flux spectrum. Many quasars are found to be polarized at $P \sim 1 \sim 2\%$, and in many cases, emission lines (broad and narrow) are unpolarized - the polarization is confined only in the continuum (Antonucci 1988, Schmidt & Smith 2000). This indicates that the polarization mechanism resides interior to the BLR in these cases. Then the polarized flux should show the intrinsic shape of the BBB (except for a synchrotron possibility which is ruled out by the result below at least for that object), revealing the underlying behavior of the BBB.

3. Results and Conclusions

Figure 1 shows our recent Keck spectropolarimetry data of a quasar. Thick line is the polarized flux spectrum, while the dotted line is the total flux spectrum scaled to roughly match the polarized flux at the red side. Emission lines are essentially all absent in the polarized flux (see Fig.2 which shows that the polarization clearly decreases at the line wavelengths). The slope of the polarized flux at the red side is roughly the same as that of the total flux. However, we find that the slope changes at the bluer side of $\sim 4000\AA$ in the rest frame, just where the 3000Å bump starts in the total flux (there might also be a possible up-turn at the bluer side of $\sim 3600\AA$). This is an expected Balmer-edge absorption feature, and directly indicates that the Big Blue Bump is indeed thermal and optically thick, without involving any particular model of the nucleus.

References

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