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HIDDEN BLAZARS AND EMISSION LINE VARIABILITY OF HIGH REDSHIFT QUASARS

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RESUMEN

Hemos realizado una búsqueda de 'blazares' escondidos en una muestra de cuasares radio-intensos de $z{\sim}2$. La idea se basa en nuestra predicción que debería existir gran variabilidad en la línea C IV que no estuviera asociada con las variaciones observadas en el contínuo o en la mayoría de las otras líneas de emisión en los cuasares intensos en radio. Aquí reportamos los resultados iniciales, incluyendo el descubrimiento de grandes variaciones de la línea C IV en dos cuasares.

ABSTRACT

We have carried out a survey to search for hidden blazars in a sample of $z{\sim}2$ radio–loud quasars. The idea is based on our prediction that we should be able to see large C IV line variability not associated with observed continuum variations or most other emission lines in every radio–loud quasar. Here we report the initial results including the discovery of large C IV line variations in two quasars.

Key Words: **GALAXIES: ACTIVE — QUASARS: EMISSION LINES — QUASARS: GENERAL**

1. INTRODUCTION

Jet–disk systems may exist in many astronomical objects such as gamma–ray bursters, proto–stars and radio–loud quasars. Beamed emission associated with jets is often not observable if the beam is pointing away from the observer. A belief in a simple representation of nature leads people to seek unification, adopting, for radio–loud quasars, a "unified scheme". With increasing viewing angle from the jet, we see blazars, core–dominant quasars, lobe–dominant quasars or radio galaxies. If the unified scheme is correct, every quasar should harbor a blazar even though we do not see most of them because they are beamed away from the line of sight. Blazars outburst every ${\sim}10$ years (Fan et al. 1999), and each burst last ${\sim}1$ year. If we assume the blazar beam illuminates 2% of the gas in Broad Emission Line Region (BELR), we were able to predict (Ma & Wills 1998): 1. collisionally excited lines such as Si IV $\lambda1397$ and C IV $\lambda1549$ are strongly enhanced by an outbursting blazar (Fig. 1); 2. other emission lines including Lyα and C III] $\lambda1909$ are little affected; 3. for any radio–loud quasars we should be able to see C IV and Si IV lines increase by over 50% once every ${\sim}30$ years (for $z{\sim}2$), and they last ${\sim}3$ years; 4. if we examine a sample of radio–loud quasars, ${\sim}10\%$ of them should show stronger C IV and Si IV, i.e., their hidden blazars are in outburst. This phenomenon is distinguishable from emission line variations responding to "normal" (non–blazar) AGN continuum in that Lyα, C IV $\lambda1549$ and C III] $\lambda1909$ vary at similar amplitude responding to the ionizing continuum (Kaspi & Netzer 1999).

2. OBSERVATIONS

Using the Large Cassegrain Spectrograph on the 2.7–m Harlan J. Smith telescope at McDonald Observatory, we have observed the spectra of 53 radio–loud quasars of $z{\sim}2$, and have compared 45 of them with historical data taken over 10 years ago. The 45 objects in our sample can be classified as five classes (Table 1). The flux is not always absolutely calibrated, and the difference in continuum levels is likely to be the result of clouds or wavelength–dependent slit losses caused by atmospheric dispersion. We scale two spectra to match their

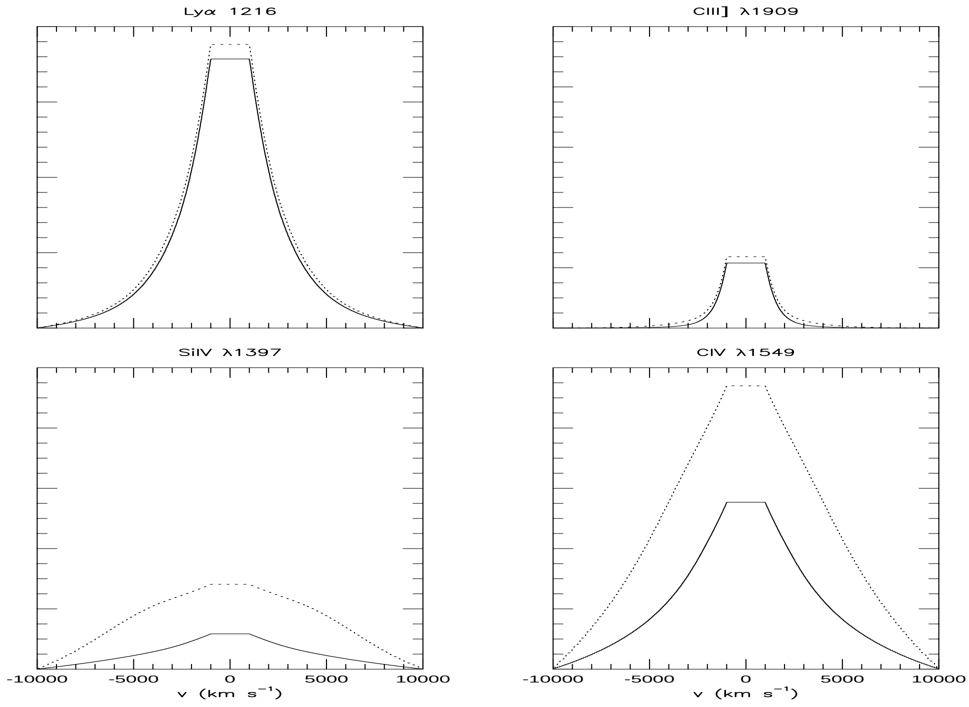

Fig. 1. Theoretical prediction of emission line variations during an outburst of the hidden blazar. Lyα and C III] λ1909 are little affected by the hidden blazar, while Si IV λ1397 and C IV λ1549 are dramatically enhanced.

continua, and the line ratio is preserved during the scaling unless there is an (unreasonably) large variation in the continuum shape. Some spectra from our sample are given in Fig. 2. PKS 0038−019 (z = 1.67) and MRC 0238+100 (z = 1.83) are both lobe–dominant quasars and show little optical variability from Digitized Sky Surveys I and II, and hence their C IV line variations are unlikely caused by large continuum shape change.

3. DISCUSSION

Our discovery of two hidden blazars via emission line variability strongly supports the unified scheme. The idea in this work suggests a new way to look for hidden beamed emission via reprocessed, more isotropic line emission, which can be applied to other jet–disk systems such as gamma–ray bursters. The observations suggest that there is BELR gas in the polar regions and thus challenges the disk–wind model (Murray et al. 1995) for the BELR. While the stellar model (Alexander & Netzer 1994) has been challenged by line profile studies (Arav et al. 1998), we may need a new source responsible for at least a bulk of gas in BELR. We consider a BELR made of tidally disrupted stars (Shields 1989; Roos 1992) with winds blowing off the tidal streams by the radiation pressure. This model gives satisfactory line ratios and line profiles (Ma 2000).

In this model the tidal forces stretch the disrupted stars with a large and continuous distribution in velocity and density, solving the discrete clouds model problems such as confinement. A rotating black hole will eject stars very differently, due to the flattened event horizon and local dragging of inertia frames. Consequently, this may explain the differences between radio–loud and radio–quiet quasars. Most of the BELR parameters are determined by the central black hole mass and the disruption process, and hence there is no need to introduce free parameters such as density distribution and covering factor. The winds from the tidal streams

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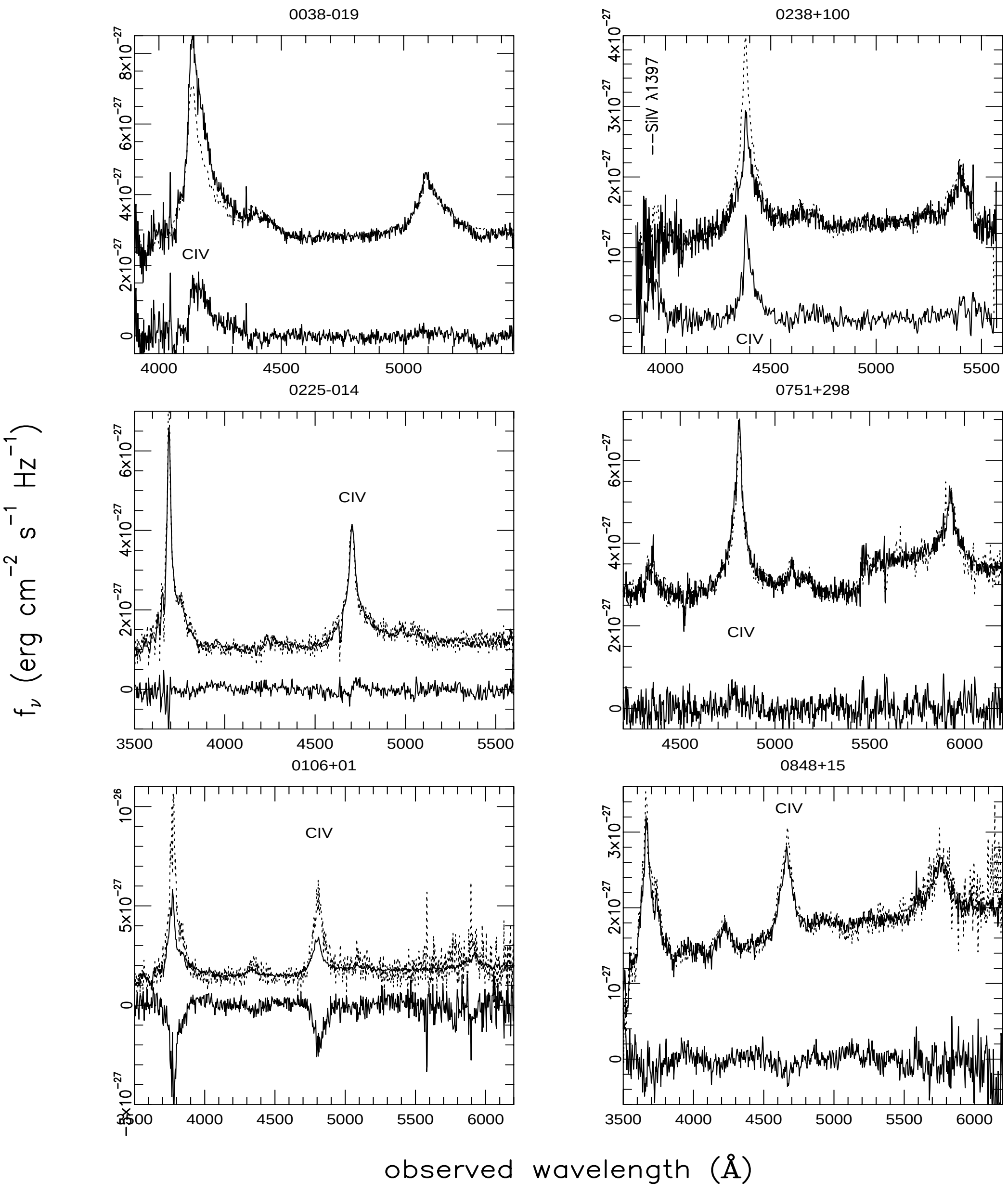

Fig. 2. The continua at different epochs have been scaled to the same level. The differences of the spectra are also shown. 0038−019 and 0238+100 show large C IV variations (class A) when comparing spectra in 1999 (dotted lines) and in 1986 (solid lines, Barthel, Tytler & Thomson 1990). 0225−014 and 0751+298 are examples of class C whose spectra taken over a time interval of 10 years are in excellent agreement. The apparent continuum jump in 0751+298 is due to the different flux levels in the red and blue channel of a double spectrograph. The Lyα/C IV ratios in 0106+01 and 0848+15 at the two epochs remain unchanged and they belong to class D.

TABLE 1

CLASSIFICATION OF OBJECTS IN THE SAMPLE.

Class	#	Description	Interpretation
A	2	>30% variations in C IV	outbursting hidden blazars uncovered
B	7	∼15% variations in C IV	hidden blazars or C IV more variable
C	20	no variations in any lines	high-z and high-L quasars less variable; observations and comparison are valid
D	14	all lines "vary" in proportion	continuum difference at different epochs; line response to normal AGN continuum
E	2	Lyα show ∼15% variations	continuum more variable in the blue

have comparable covering factor compared with the tidal streams themselves, hence lowering the requirement of high tidal disruption rate. The winds and the tidal streams have very distinct density (10^{6-8}cm^{-3} vs. 10^{10-13}cm^{-3} at *similar* spatial location. The winds also have higher velocities. The two components give different line ratios and profiles for different lines, and may solve long standing puzzles such as Mg II deficiency. Finally, this model helps drawing a picture of quasar–galaxy connection, that AGN activity may be triggered in only 1% of all galaxies during galaxy mergers. The merging boosts the tidal disruption rate dramatically from 10^{-4}yr^{-1} to ~ 1 yr^{-1} (see e.g., Roos 1992 and references therein). The bound part of tidal remnants offers a bulk of material to the accretion disk while the ejected unbound part supplies the BELR. We note that there could be more than one source for BELR gas. Besides the tidal remnants, accretion disk winds, stellar atmosphere and stellar winds, remnants from stellar collisions and star–disk interactions may all play a role in emitting broad lines even though none of them is a solely responsible for BELR.

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