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Reverberation Mapping of High-Redshift, High-Luminosity Quasars

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Abstract. We present preliminary results from a reverberation mapping program to measure the Broad Line Region size in high-redshift, high-luminosity quasars. The observations are carried out at the *Hobby-Eberly Telescope* and at the *Wise Observatory*. The data cover 8 yr of photometric monitoring of 11 quasars, and 2.5 yr of spectrophotometric monitoring of 7 of these sources. Thus far we detected continuum variations but no line variations. We find that the continua of the high-luminosity quasars have smaller variability amplitudes and longer variability timescales compared with low-luminosity AGNs.

1. Introduction

While the origin of the continuum variability of Active Galactic Nuclei (AGN) is still unclear, it is possible to use reverberation mapping to study AGN emission-line gas. In such studies, the time lags between the variations in the continuum flux and the emission-lines' fluxes are used to estimate the Broad Line Region's (BLR) size and map its geometry. Twenty low-luminosity AGN (Seyfert 1 galaxies) were spectrophotometrically monitored and their BLR sizes were measured using this method. Kaspi et al. (2000, ApJ, 533, 631) measured BLR sizes for 17 high-luminosity AGN (quasars) which increased the luminosity range of objects with known BLR size by two orders of magnitude. Kaspi et al. used all those BLR size measurements to determine for the first time the size–mass–luminosity relations over a luminosity range of 5 orders of magnitude.

The above sample is luminosity and redshift limited because of the small telescopes used. In order to increase the luminosity beyond 10^{46} erg s^{-1} we need to monitor high-redshift, high-luminosity quasars.

2. Monitoring Program and Preliminary Results

For the past 8 yr we have been monitoring photometrically a sample of 11 high-redshift ($2.1 \lesssim z \lesssim 3.2$), high-luminosity ($10^{45.6} \lesssim \lambda L_\lambda(5100\text{Å}) \lesssim 10^{47}$ erg s^{-1}) quasars. The choice of the objects in this sample is purely observational (limits on redshift, declination, observed flux, etc.). The observations are carried out every month at the *Wise Observatory* using broad-band filters (B & R); thus we have good coverage of continuum variability. Most of the objects show 10%

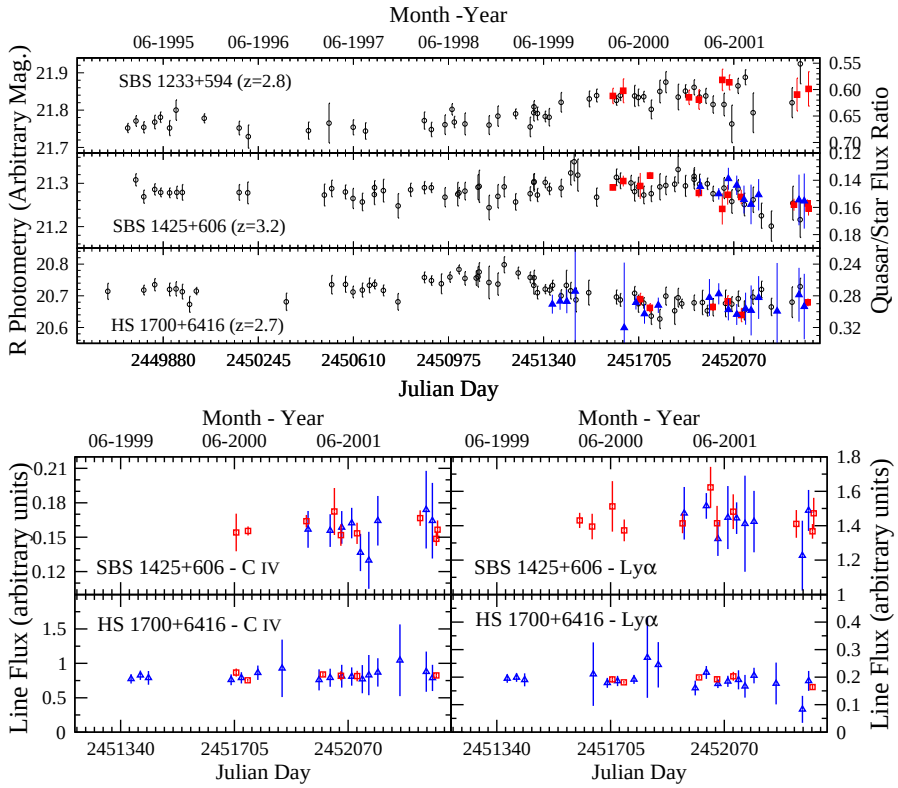

Figure 1. *Top*: Continuum light curves of three high-luminosity quasars. Open circles are data obtained from R-band photometry at the *Wise Observatory* over 8 yr. The ~ 0.1 magnitude variations are apparent in all objects. Squares are data obtained from *HET* spectra, and triangles are data obtained from *Wise* spectra over the past 2.5 yr. These data are represented by the quasar/star flux ratios which were shifted and stretched to fit the R-band photometry light curves. For most objects the shapes of the light curves from the two data sets are similar. *Bottom*: Light curves for C IV and Lyα for two objects. Symbols are as above. No line variations are detected in the data.

peak-to-peak continuum variations (Fig. 1 top). For the past 2.5 yr we have also monitored part of this sample, spectroscopically, with the 9 m *Hobby-Eberly Telescope (HET)* and the *Wise Observatory* telescope to check for the line (Lyα and CIVλ1549) response to the continuum variations.

First results indicate that although continuum variations are detected no line variations are yet seen (Fig. 1 bottom). Our typical upper limit for the line variability is $\lesssim 25\%$. This is not surprising since these high-luminosity quasars are expected to have BLR sizes of order 3 light years which correspond, in our frame, to about a decade. In addition, significant continuum variation are needed to produce a detectable line response. Comparison with low-luminosity AGN shows that the continua of the high-luminosity quasars have smaller variability amplitudes and longer variability timescales. We expect that, when this long-term project is concluded, reverberation measurements of the BLR size will cover the luminosity range of 10^{41}–10^{47} ergs s^{-1}.