Discovery of a Rapidly Variable LoBAL QSO with an Ultraviolet Jet

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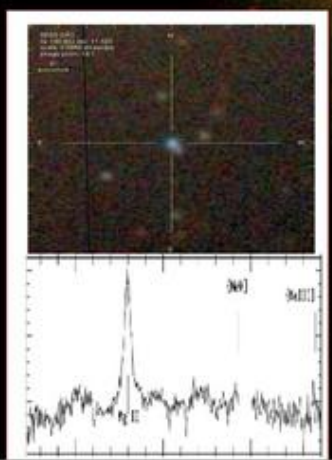
From our spectroscopic observations, we have discovered four Low-ionization Broad Absorption Line (LoBAL) radio-quiet QSOs, which are highly luminous and variable in X-rays, without intrinsic absorptions. These results go contrary to our present understanding of LoBALs. Here we present the results of one LoBAL QSO (redshift ~ 1.195), which displayed X-ray flux variability on the time scales of hour. In addition, we have detected a jet-like feature in its ultraviolet (at the source frame) image. These observations can be explained in the frame work of a bipolar jet-model, based on our 3-D magnetohydrodynamic (MHD) simulation results.

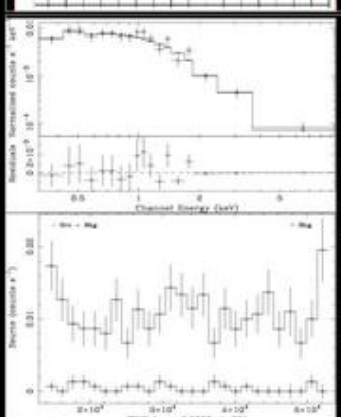
Ultraviolet Results

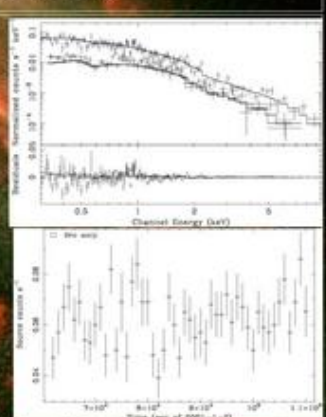


LoBALs are BAL quasars with one or more low-ionization lines of Mg II, Al III, Fe II and Fe III. In X-rays, they are weak and heavily absorbed (10^{21} – 10^{24} cm^{-2}). Most likely, X-rays from these QSOs reach to the observer along an indirect line of sight (scattering/reflection), which makes them weak. Presently, no rapid variability has been detected in LoBAL quasars.

Sloan digital sky survey image of SDSS J124336.5+113009 is shown at the top left figure, which is in the UV-band (1550 – 3000 A) at the source frame of this object. It can be seen from this figure that a small jet-like feature is present. In addition, the spectrum of this object is shown at the left (bottom), which shows a broad absorption (~25000 km s^{-1}) at the blue wing of Mg II (2800 A). No radio and 2MASS counterparts of this quasar are detected. Emission strength of the Mg II line and the monochromatic luminosity at 2500 A were used to determine the mass of the black hole and the bolometric luminosity. These results suggest that SDSS J124336.5+113009 is accreting at sub-Eddington rate.

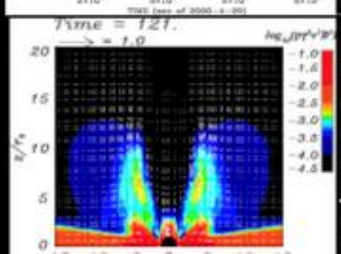
X-ray Results

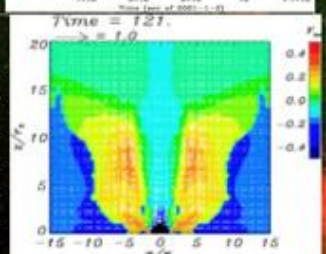




Chandra spectrum and light curve of SDSS J124336.5+113009 is shown to the left and that of XMM-Newton is shown to the right. Excess variance and KS-test results clearly suggest that this quasar displayed variability on the time scales of less than an hour, at the source frame. No significant spectral variability was detected between the Chandra and XMM-Newton observations (N_H consistent with the Galactic value and photon-index ~ 2.1). However, the 0.2-10 keV flux varied by more than a factor of three and the intrinsic luminosity was ~10^{46} ergs s^{-1}.

3-D MHD Simulation Results





Synchrotron emissivity and total velocity structure are shown at the left and right sides, respectively. From our simulation results we find that, if magnetic pressure dominates over the radiation pressure, then relativistic jet will be formed, which will strongly emit through synchrotron process. Details will appear in Ghosh et al. 2006 (in preparation).