Modeling of CIV absorption lines in BAL QSOs using CLOUDY

(McD)

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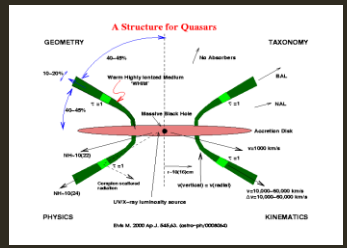
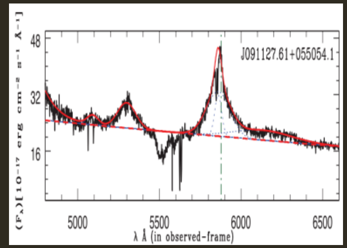
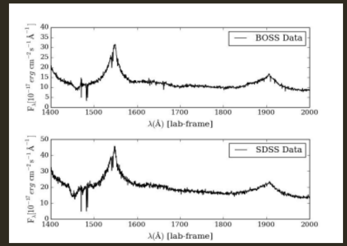
Abstract

We present the results obtained after modeling the C IV absorption lines in Broad Absorption Line QSOs using CLOUDY simulations. We have simulated absorption features of C III and C IV lines using different ionization fractions. The physical interpretations for each simulation is discussed.







Introduction

Broad Absorption Line QSOs (BALQSOs) comprise about 10-20% of QSO population and shows strong blue-shifted broad absorption lines. This outflows are interpreted as signature of Accretion Disk. Outflow velocities are in general 10-30k kms^{-1}. Strength of the BAL troughs change with time. The observed behavior of the appearance or disappearance of BAL troughs, absorption strength variation and the kinematic shift in the absorption profile in general depends on (i) changes in the ionization state (ii) changes in the acceleration profile and/or geometry of the outflow from the disk, (iii) actual line of sight acceleration of a shell of material and (iv) transverse motion of the absorbing cloud. Here we have studied J091127+055054 which is a gravitationally lensed QSO with X-ray luminosity ~ 4 × 10^{46} ergs s^{-1} and Z = 2.793, α(ox) = −1.58.

Motivation

- J091127+055054:
- Observed average deceleration for whole BAL profile ~−2.0 ±0.1 cm s^{-2}over time-span of 2-3 years.
- Physical conditions, acceleration mechanisms, location of QSO outflows are poorly understood.
- Studies of BAL trough intensity and outflow velocity variability are rare and important to shed light on the structure and dynamics of the outflowing gas.
- CLOUDY will enable us to probe these out flowing gas from C IV line variability and the ionization state of two observations.

Methodology

We concentrate on the simulation of ionization state of the two observations:

- ✓ The maximum value of I.F. from the log (U) vs. log (I.F.) will be given as input for SED modeling.
- ✓ We model SED for which CIII/CIV ratio best matches with the observed SED from two observations.

Results

Fig. 1: Plot between log (U) and log (I.F.).

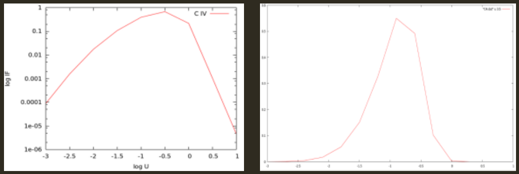


Fig. 2 : Comparison of I.F. for CIII and CIV line(left) and ratio of CIII/CIV (right)

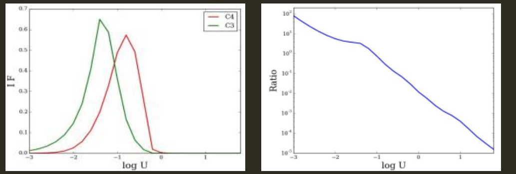
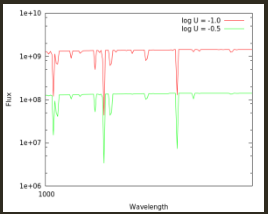


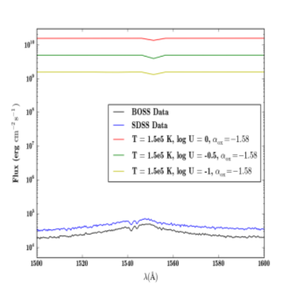
Fig. 3 Over plotted model spectra for log(U) = -0.5 and -1.0

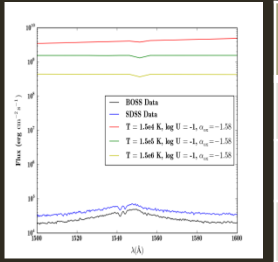


$$U = \frac{Q(H)}{4\pi n_H r^2 c}$$

U = Ionization parameter
R = separation [cm] between the center of the source and illuminated face of the cloud.
n(H) = total hydrogen density
c = the speed of light
Q(H) = number of hydrogen-ionizing photons

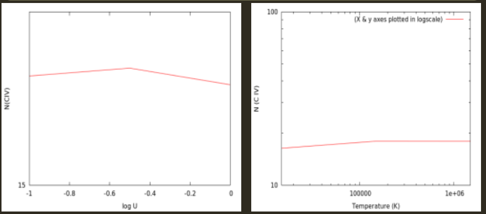
log(U)	N (C IV) (in log scale)
0.0	17.25 cm $^{-2}$
-0.5	18.22 cm $^{-2}$
-1.0	17.78 cm $^{-2}$





T (in K)	N (C IV) (in log scale)
1.5× 10^4	16.367cm $^{-2}$
1.5× 10^5	17.983cm $^{-2}$
1.5× 10^6	17.965cm $^{-2}$

Fig. 4 Variation of :- (i) N (C IV) with ionization parameter(left) , (ii) N (C IV) ionizing photon temperature(right):



Conclusion

Observed results:
N1 (at 55896 MJD) = 2.9237×10^{14} cm $^{-2}$
N2 (at 52652 MJD) = 3.8307×10^{14} cm $^{-2}$
(N1-N2) ~ 9.0692×10^{13} cm $^{-2}$
N1/N2 ~ 1.3102
Calculated result:
N1 (log U = -1)/N2(log U = 0) = 1.8113 (at same T)
Hence results indicate towards a possible variation in ionization state between two observations.

Reference

- Joshi et al 2014
- Hamann, Barlow & Junkkarinen 1997
- Srianand & Petitjean 2001
- Gary J Ferland & D E Osterbrock; Astrophysics of Gaseous nebulae and active galactic nuclei

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