The redshifts of QSOs imply very large distances, and since they are visible to us, this implies very high *intrinsic* luminosities. Energy output from QSOs covers a few orders of magnitude; $\sim 10^{44-48}$ erg s^{-1} ($\sim 10^{11-15}$ solar luminosities), or more than 100 times brighter than the largest normal (non-AGN) galaxies. The flux can vary by as much as a factor of 10 or more on timescales on the order of days, weeks, or months, implying that the source must be contained within a volume no more than a light year across. To reconcile these facts, workers have attempted to construct models of massive black holes and accretion disks where a large amount of energy can be generated in a relatively small volume. Despite any direct evidence for the existence of such massive black holes, this model has persisted, mainly due to the qualitative consistency between observations and theory.

The study of QSOs gives us insight into the formation of galaxies, the nature of the universe at times back to 10% its present age, and possibly the structure of the universe itself. The environment around QSOs can be studied by several means. The emission lines arising from both high- and low- ionization resonance transitions and forbidden and semi-forbidden transitions, can yield information about the gas surrounding the QSO. The range of redshifts seen in QSOs is $\sim$0.1 to 4.9. Studies in the optical are constrained to observations of certain rest wavelength regions and emission lines depending on redshift. At low redshifts we observe lines like H-α and forbidden lines like [O III] λ5007; at higher redshifts we observe broad resonance lines like Mg II λ2800, C IV λ1549, and Lyman-α.

1.2 : QSO Absorption Lines

Also present in the spectra of QSOs are absorption lines. QSO absorption line systems can be divided into five categories:

(1) Lyman-α forest lines. The absorption redshift (z_a) of these Lyman-α lines range from zero to the emission-line redshift of the QSO. They generally have small velocity widths ($\sim$30 km s^{-1}), and typically do not show detectable corresponding metal (non-hydrogen) lines. The neutral hydrogen column densities, N(HI), are typically 10^{14-15}