3.4 : Estimating the Ionization Parameter using Time Variability

If we could take the values for fractional abundances in figure 3-4 literally, we could estimate the ionization parameter from the column densities measured for the various BALs. However, since we do not know the relative total abundances of the elements we do not know how to scale the column densities of the various elements. This can be partially solved by attempting to use several different lines. Such an attempt was made by Morris *et al.* 1986 for the QSO GC 1556+335, which contains several associated absorption line systems. However, each new element adds an additional parameter unless transitions from the same element are used. Unfortunately, it is fairly rare that several easily measurable BALs from the same element are observed. Although, *HST* should enable us to view many more high-ionization BALs. Also, different troughs generally introduce different errors depending on the depth of the trough and the surrounding emission and continuum.

Time variability of the BALs allows a much less problematic determination of the ionization parameter. As the ionization level changes, we expect BALs to increase or decrease in strength depending on the initial value of U, which direction the ionization level is changing, and the positions of U_p for the different ions (*cf.* Smith and Penston 1988). In this manner, we can set definitive upper and lower limits on U simply from the qualitative estimates of the time variability of various lines. Note that this does not depend on any assumptions on the relative total abundances of the elements, nor even on the precise values for the fractional abundances of the ions.

A more precise estimate of U can be derived by measuring the fractional change in the column densities between epochs as a function of time. As stated above, the change in U depends only on the change in the flux of ionizing photons. Here, we will assume