IMPLICATIONS OF NONLINEAR LINE RESPONSE IN VARIABLE SEYFERT NUCLEI

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Variable Seyfert nuclei exhibit correlations between emission-line and continuum luminosity consistent with photoionization, although the emission lines (including recombination features such as Lyα) tend to respond nonlinearly to changes in the continuum. A nonlinear response will result if some of the broad-line region (BLR) clouds become fully ionized in hydrogen, such that their emission measure does not then vary in proportion to the incident continuum flux. For thin clouds, emission in transitions from heavy elements may grow or decline with increasing incident flux, reflecting changes in the ionization structure of the cloud. Direct evidence for a fully ionized component within the BLR is provided by correlation analysis of ultraviolet line response in NGC 5548 (Sparke, 1993).

We have completed photoionization calculations with the code Cloudy for a BLR cloud population containing a mix of thick and thin clouds. The results are capable of producing good agreement with the observed slopes of line response relative to the continuum for high ionization lines. In particular, the inverse relation between the C IV λ1549/Lyα ratio and continuum luminosity observed in NGC 5548 and other Seyferts can be reproduced in this scenario. Understanding this behavior remains problematic if the clouds are all thick (Shields & Ferland, 1993).

A thin cloud population can also act as a "warm absorber" for soft x-rays. One signature of a warm absorber is an inverse relation between apparent absorbing column and luminosity, resulting from changes in the degree of oxygen ionization. Thin clouds with high covering factor can generate significant ultraviolet line emission, and also display warm absorber behavior when the continuuum luminosity is increased only slightly, if the ionizing continuum is relatively hard. Such a scenario may be appropriate for NGC 5548, for which the continuum is approximately described by a power-law $f_\nu \propto \nu^{-1.2}$ from the ultraviolet to soft x-ray region (Clavel *et al.*, 1992).

References

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