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Below the Lyman Edge: UV Polarimetry of Quasars

Anuradha Koratkar

Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218

Robert Goodrich

California Association for Research in Astronomy, W.M. Keck Observatory, P.O. Box 220, 65-1120 Mamalahoa Highway, Kamuela, HI 96743

Robert Antonucci

Physics Department, University of California, Santa Barbara, CA 93106

Abstract.
The Lyman edge at 912Å is an important diagnostic region for studying quasi-stellar objects (QSOs). In particular, it reveals a great deal about the physical conditions within the atmospheres of accretion disks, a ubiquitous component of QSO theories. Observations of the Lyman edge regions of QSOs have shown scant evidence for the predicted features - few QSOs show the broad, partial Lyman edges expected to be common according to most theories. The FOS in its polarimetry mode has been instrumental in studying the Lyman edge region in QSOs. One of the most exciting discoveries is that the polarization rises, not at wavelengths longward of the Lyman edge, but at wavelengths well below it! Here we present the status of polarimetry observations at the Lyman edge and discuss their implications to accretions disks.

1. Introduction

The standard paradigm of energy production in quasars includes an accretion disk surrounding a supermassive blackhole. Two important consequences of such disks is a feature at the Lyman edge (912Å) and significant polarization parallel to the disk plane at most viewing angles. Considerable effort has been spent in trying to identify observational signatures of accretion disks. Searches for the Lyman edge features associated with accretion disks have found only a few partial edges (Antonucci, Kinney, & Ford 1989; Koratkar, Kinney, & Bohlin 1992). Proving the existence of radiating disks in even a few cases would be a major step in our understanding of the quasar phenomenon.

Spectropolarimetry of the region near the Lyman limit, is a powerful diagnostic of the emission mechanism for the UV flux in AGN. Polarization observations provide information regarding the spatially unresolved geometry of the system that is being studied, which is especially powerful when combined with a

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knowledge of the source symmetry axis. For observations in polarized light, accretion disk models predict that if electron scattering is dominant, polarization upto 12% parallel to the disk plane. Further, if absorption opacity is included, polarization is expected to be wavelength dependent with a strong feature at the Lyman edge (Laor, Netzer & Piran 1990, Blaes & Agol 1996).

2. Spectropolarimetry of the Lyman Edge with the HST/FOS:

Spectropolarimetric observations of the Lyman edge region have been obtained for only five radio quite quasars (Impey et al. 1995 and Koratkar et al 1995). In three of the five objects observed by FOS, polarization increases for wavelength shorter than the Lyman edge. In PG 1338+416, the rise in polarization is consistent with the partial Lyman edge observed in the total flux spectrum. The polarization in the shortest wavelength bin is 8%±2.4%. The polarization at wavelengths longer than 912Å is consistent with zero. In PG 1630+377, the polarization rise is dramatic and reaches nearly 20%. Another important feature in the polarized spectrum is the polarized Lyα emission line. After correcting for the underlying continuum we measure P(Lyα) = 7.3%±1.6%. In PG 1222+228, the polarization in the shortest wavelength bin is ~5%. Wavelengths longer than 912Å are polarized at ~2% , and unlike PG 1338+416 and PG 1630+377, this object does seem to have an absorption edge at 912Å in polarized light.

3. Implications to Models:

The high degree of polarization measured in PG 1630+377, and the steepness with which this polarization increases with wavelengths < 912Å is inconsistent with any simple disk models, even those containing pure scattering atmospheres. Models of Blaes & Algol (1996) with realistic optically thick atmospheres, show that absorption opacity can increase the polarization above the pure scattering value in the wavelength region shortward of the Lyman edge. These models have only been able to fit the PG 1228+228 observations. They cannot reproduce the steep rise in polarization observed in both PG 1338+416 and PG 1630+377.

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