UNVEILING THE ENGINES IN QSOs: MULTI-WAVELENGTH STUDY

NASA Grant No. NAG5-6410

Final Report

For Period 1 November 1997 through 31 October 2004

Principal Investigator
Dr. Paul Green

January 2005

Prepared for:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this Grant is Ronald Oliversen, NASA/GSFC, Code 681, Greenbelt, MD 20771

UV/optical emission lines offer some of the most detailed information obtainable about the intrinsic properties of quasars. Studies of the density, ionization and metal abundance of gas near the accreting black hole are probed through an intriguing but poorly understood complex of correlations between emission lines and overall quasar spectral energy distributions that has long suffered from a lack of large, consistently measured samples. As part of a broader effort to expand and systematize the data upon which these studies are built, we proposed to NASA to model, fit, and measure UV/optical emission line parameters in large samples of quasar spectra.

As part of the project, we developed an automated measurement technique that accounts for galactic reddening, includes iron emission blends, galactic and intrinsic absorption lines, and performs multi-component fits to the emission line profiles. We present measured line parameters (equivalent width and FWHM) for a large number of (28) different UV/optical lines, including upper limits for undetected lines.

We completed the measurement and publication of emission lines in some 1300 quasars. The first sample measured 993 quasars from the LBQS sample. We published 2 related papers in ApJ. Te first was to describe the techniques for continuum and emission line measurement (K. Forster, P. J. Green, T. L. Aldcroft, M. Vestergaard, C. B. Foltz, \& P. C. Hewett 2001, ApJS, 134, 35) and included a large electronic data table with the spectral measurements and luminosity calculations. The second shows that quasars evolve with cosmic time as the abundance of heavy elements increases towards redshift zero (P. J. Green, K. Forster, \& J. Kuraszkewiecz 2001, ApJ, 556, 727).

We next turned our software to publish an atlas of HST FOS pre-COSTAR spectral measurements, with the results published in J. Kuraszkiewicz, P. J. Green, K. Forster, T. Aldcroft, I. N. Evans \& A. Koratkar (2002, ApJ, 143, 257). Another major set of measurements - continuum, emission line and absorption line measurements for the full FOS post-COSTAR sample - were derived and published in J. Kuraszkewicz et al. 2004 (ApJS, 150, 165).

The new sensitivity of this FOS spectral sample to narrow absorption lines enabled us to measure and detect evidence for a strong abundance correlation between emission and absorption lines in AGN (Kuraszkewiecz and P. J. Green 2003, ApJL, 581, L77). We measured both emission and absorption lines in an HST FOS sample of objects with both CIV and NV NALs within 5000km/s, of the systemic redshift, finding a strong (>99.5% confidence) linear correlation between the NV/CIV ratio in broad emission lines and NALs. Our finding thus identified an additional test for the intrinsic nature of NALs in any given object. The correlation shows that the chemical enrichment histories and/or ionization parameters of the NAL clouds are closely related to those of cloud