Final Report

NAGW4433, SUNY 431-0307A

The Gaseous Content of the Universe at $z < 1.6$

Together with graduate student Hsiao-Wen Chen, I have measured and analyzed structural and morphological parameters of 38 galaxies in eight fields for which sensitive measurements of corresponding Lyα absorption toward background QSOs are available. These measurements are based on Wide Field Planetary Camera 2 (WFPC2) observations obtained with the Hubble Space Telescope (HST) and provide a first look at how the incidence and extent of tenuous gas around galaxies depends on galaxy luminosity, size, and morphological type and on geometry of the impact. The primary result of the analysis is that the amount of gas encountered along the line of sight depends on the galaxy impact parameter and B-band luminosity but does not depend strongly on the galaxy average surface brightness, disk-to-bulge ratio, or redshift. This result confirms and improves upon an anti-correlation between Lyα absorption equivalent width and galaxy impact parameter found previously. More importantly, this result provides the first quantitative means of relating statistics of faint galaxies to statistics of Lyα absorption systems, which we plan to exploit to constrain the luminosity function of galaxies beyond the realm of current surveys. Results have been submitted for publication by Chen, Lanzetta, Webb, & Barcons (1997, ApJ, submitted). An additional 14 orbits of HST time have been allocated for this project in Cycle 7, which will greatly improve our statistical conclusions.

Together with graduate student Noriaki Yahata, I have measured and classified spectral properties of over 1000 faint galaxies and stars obtained in our low-resolution spectroscopic survey. The goal of this project is two-fold: (1) to exhaustively characterize the spectral properties of all faint galaxies that comprise our current survey, and (2) to gain experience with our measurement and classification code, which ultimately will be used on a data base of 20,000 galaxies to be obtained with the Two-Degree Field (2df) spectrograph at the Anglo-Australian Telescope (AAT). The results will ultimately be used for many goals, but so far we have concentrated on using the results to make a binary classification of the galaxies (i.e. early type versus late type) and to then exploit the density–morphology relationship to obtain a crude density indicator. The primary result of the analysis is that the incidence and extent of tenuous gas around galaxies shows no strong preference for local galaxy environment, at least over the range of densities spanned by the current observations.

Along a similar line, I have examined two instances of Lyα absorption lines that arise in groups or clusters of galaxies. Based on Goddard High Resolution Spectrograph (GHRS) spectra obtained with HST, the lines are resolved into discrete individual components, suggesting that the absorption arises within individual galaxies that comprise the groups or clusters. The primary result of

the analysis is a demonstration that at least some groups or clusters can produce corresponding Lyα absorption lines and that Lyα absorption lines do not avoid high-density galaxy environment, as was commonly believed previously. Results will be submitted for publication by Ortiz-Gil, Lanzetta, Webb, & Barcons (1997, in preparation).

I have completed a new measure of the galaxy–absorber cross-correlation function, based on a very large sample of galaxies and Lyα absorption systems. The primary result of the analysis is that it defines the statistical criterion by which galaxies and absorber pairs are to be matched, which is essential for the goal of using absorption systems to probe the gaseous extent of galaxies at large galactocentric distances. Results are in press by Lanzetta, Webb, & Barcons (1997, Proceedings of the 18th Texas Symposium on Relativistic Astrophysics, in press), and a much longer manuscript is in preparation.

I have identified a damped Lyα absorption system at redshift $z \approx 0.16$ on the basis of a new GHRS observation obtained with HST. The absorption system is the lowest-redshift confirmed damped Lyα absorption system yet identified. An early-type galaxy just 16 h^{-1} kpc from the line of sight was identified with the absorption systems, and a high-resolution spectrum of the galaxy was obtained using the William Herschel Telescope (WHT). The most important results of the analysis are (1) the metal abundances of the absorption system are less than 10% of the solar metal abundance and (2) the absorbing gas is not rotating with the galaxy disk. Results are submitted for publication by Lanzetta, Wolfe, Altan, Barcons, Chen, Fernandez-Soto, Meyer, Ortiz-Gil, Savaglio, Webb, & Yahata (1997, ApJ, submitted).

In addition to the results described above, several other results have been obtained. These include (1) the first measurement of extragalactic deuterium made with HST (Webb, Carswell, Lanzetta, Ferlet, Lemoine, Vidal-Madjar, & Bowen 1997, Nature, in press), (2) an analysis of infrared images of the highest-redshift galaxy candidates detected in the Hubble Deep Field (HDF) image (Lanzetta, Fernandez-Soto, & Yahil 1997, ApJ, submitted), and (3) an empirical upper limit to limit extremely high redshift galaxies in the HDF (Lanzetta, Yahil, & Fernandez-Soto 1997, AJ, submitted).