PROBING CIRCUMGALACTIC GAS WITH LYMAN LIMIT SYSTEMS

Abstract

by

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The statistical and physical nature of the circumgalactic gas giving rise to Lyman limit systems (LLSs) has been studied with mulit-wavelength observations of absorption line spectroscopy and imaging.

The statistical nature of the gas giving rise to LLSs over the last ~ 10 Gyr was investigated using 249 QSO spectra observed with FOS and STIS on the *Hubble Space Telescope (HST)*. Care was taken to reduce observational bias by removing observations specifically targeted due to the presence, or absence, of strong H I absorption. This survey of LLSs at $z < 2.6$ is the most complete sample of observations to probe the low redshift regime for strong H I absorption. The results of the survey are combined with ongoing high redshift ($z > 2.6$) studies to understand the nature and evolution of the gas giving rise to LLSs over the majority of cosmic time.

Extending the analysis of the gas giving rise to LLS absorption, the galaxy-absorber connection was examined for LLSs found in the spectra of 31 QSOs observed with the *Galaxy Evolution Explorer* in the Cosmic Evolution Survey deep imaging galaxy field. Galactic environments within a projected 200 kpc from the QSO line of sight were examined to understand the covering factor of strong H I absorption and the impact galaxy morphology has on these absorbers.

Lastly, the connection between the gas giving rise to a LLS and the nearby galactic environments was examined in depth for one absorber. The gas detected at $z \sim 0.274$ in the line of sight of QSO PG1630+377 was examined with observations from COS onboard *HST* and HIRES on the Keck I telescope. Additional galaxy field imaging and spectroscopy was obtained from the LBC on the Large Binocular Telescope and LRIS on the Keck II telescope, respectively. The absorption features in the QSO spectra were measured directly from the flux values and these measurements were used to constrain ionization models. The origin of the gas was determined from metallicity measurements of the gas and potential nearby host galaxies.

The main results include: (1) The gaseous environments giving rise to LLSs underwent a significant change from $z \sim 5$ to 2 and have remained relatively stable since. In addition, the observed distribution of LLSs cannot be accounted for in only $L > L_*$ galaxies, rather the circumgalactic gas of low mass, low luminosity galaxies ($L \sim 0.1L_*$) must contribute significantly to the LLS population. (2) For $z < 2.6$, the H I frequency distribution cannot be fit by a single power-law over the range $14 < \log N(HI) < 21$ and this work suggests two inflection points in the distribution are needed to agree with observations. (3) The covering factor of strong H I absorbers is $\sim$ 60% out to 25 kpc and falls off to $\sim$ 5% out to 200 kpc from the galaxies in our sample. For the 12 LLSs considered, we find all strong H I absorbers can be associated with nearby star forming galaxies. (4) The gas seen at $z \sim 0.274$ is a low metallicity absorber within 37 kpc of a near solar metallicity, $0.3L_*$ galaxy. The physical properties of the gas are fully consistent with the predictions of cold accretion stream models, suggesting we have detected a cold accretion stream. (5) If the properties of this LLS are representative of the