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Two Searches for Primeval Galaxies

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A number of active galaxies are now known at very large redshifts, some of them even have properties suggestive of galaxies in the process of formation. They commonly show strong Lyα emission, at least some of which appears to be ionized by young stars. Inferred star formation rates are in the range $\sim 100 - 500\ M_\odot\ \mathrm{yr}^{-1}$. An important question is: are there radio-quiet, field counterparts of these systems at comparable redshifts? Whereas we are probably already observing some evolutionary and formative processes of distant radio galaxies, the ultimate goal is to observe *normal galaxies* at the epoch when *most* of their stars form. We have thus started a search for emission-line objects at large redshifts, ostensibly young and forming galaxies. Our method is to search for strong line emission (hopefully Lyα) employing two techniques: a direct, narrow-band imaging search, using a Fabry–Perot interferometer; and a serendipitous long-slit spectroscopic search.

The Fabry-Perot Survey: The experiment consists of deep imaging of selected high-latitude "empty" fields in a series of adjacent narrow bands, with spectroscopic follow-up of objects which show a probable line emission excess in one or more bands. A special, low-resolution Fabry-Perot imaging interferometer was designed for this purpose. A three-dimensional data cube (two spatial dimensions plus redshift) is built up by stepping the Fabry-Perot by an amount equal to the instrumental FWHM, chosen to be ~1000 km/s in the restframe for Lyα at any redshift (about 20 – 25 Å), between successive exposures. The field of view is $\sim$ 5.5 arcmin square. We search in several redshift intervals (2.80 – 2.98, 3.27 – 3.45, 4.42 – 4.61, and 4.75 – 4.90), chosen to avoid the night sky emission lines.

To date we have surveyed 3 fields (~0.03 deg^2) in the redshift range 4.42 – 4.61, and 6 fields (~0.06 deg^2) in the redshift range 4.74 – 4.90, down to a limit of $AB_\nu \sim 23$. This corresponds to a surface density of less than $\sim$ 13 objects/deg^2 down to the limiting Lyα flux of $\sim 10^{-16}$ erg/cm^2/s, declining to a surface density of less than $\sim$ 2600 objects/deg^2 down to the limiting Lyα flux of $\sim 3.2 \times 10^{-17}$ erg/cm^2/s, for compact objects ($\leq$ 2 arcsec); for extended objects, the limits are less stringent (about a factor of two worse in the integrated flux).

No immediately obvious primeval galaxy candidates were found, although many faint emission line objects were detected. In a typical data cube, we find 3 or 4 excellent candidates, and up to a couple of dozen other faint emission line galaxies worth following up spectroscopically. We are now trying to obtain their slit spectra. One low-z AGN was detected and confirmed spectroscopically so far, as well as half a dozen starburst galaxies at intermediate redshifts.

The Serendipitous Long-Slit Survey: Our second experiment is a serendipitous long-slit spectroscopic search, using data obtained in the course of other projects. After two-dimensional sky subtraction, the spectroscopic CCD frames are examined carefully for any possible emission-line objects which may have been covered by the slit.

An average set–up for the various runs would cover a wavelength range of 4000–8000 Å, corresponding to a Lyα redshift of 2.3–5.6. One hour exposures reach flux limits comparable to the Fabry–Perot survey, which vary with wavelength, depending on the night sky spectrum. Whereas these exposures have a large, continuous redshift coverage, they cover a much smaller area, typicaly about 2 arcsec by 2 arcmin for a long slit.

To date, about 100 long exposures have been examined carefully, and at least a dozen interesting objects were found, including an apparently normal field galaxy at $z > 1$ (Thompson & Djorgovski 1991, ApJL, 371, L55). They are mostly star forming or mildly active galaxies at moderate redshifts. We anticipate that several tens of additional 1-hour-class exposures will be added to this search over the next year or two.

Even if none of the candidates so far are actually primeval galaxies, our preliminary limits are comparable to, or better than, the best limits obtained to date in other similar experiments. We may already be in conflict with the CDM model predictions by Baron & White (1987), although to do an honest comparison, one must look at the redshift distributions, as well as surface density and flux limits.