cumstantial evidence suggests that most of the dense clouds, those having absorption systems with damped Ly-α lines, are also galactic disk complexes, despite their surprisingly frequent occurrence in high redshift quasar spectra (9). The study of the conditions and evolution of these cloud systems can tell us much about the evolution and conditions in the host galaxy itself. The ionic abundances and dust content in disks and outer gaseous envelopes of moderate to high redshift galaxies are important parameters for the study of primeval galactic evolution. Also, the dust content of distant galaxies strongly affects the opacity of the early Universe.

CASPEC observations of the BL Lac object 0215+015, aimed at studying the ionization level of absorption systems with $N(HI) \sim 10^{18}-10^{20} cm^{-2}$, have permitted an estimate of the column densities of Mg II, Mn II and Fe II in the $z=1.345$ absorber (10). In this system the derived abundances of Mg, Mn and Fe are all equal to 0.15 (±0.5) times the solar values, implying no depletion onto dust grains. The abundance of Ni II has been derived in the $z=2.811$ system toward PKS0528-250 (11), suggesting that much less Ni is depleted in this system than in Galactic interstellar clouds. In these two absorbers the abundances are about 0.10 and 0.05 times the solar values and the dust-to-gas ratio is approximately one order of magnitude lower than the Galactic value. In contrast, the damped Lyα ($N(HI) \sim 10^{19}$ cm^{-2}) system at $z=2.523$ toward UM-402 has metal abundances close to solar. Obviously, while there is a spread in the abundances in these high redshift clouds, some high redshift galaxies are able to process hydrogen into heavy metals in short cosmic time scales.

Often the high column density, damped Ly-α line, clouds are accompanied by much lower column density satellite lines (2, 12).These satellite lines may arise from clouds in a turbulent halo phase or in an accompanying galaxy cluster. The total velocity spread of the individual components of the damped Ly-α line rarely exceeds one hundred km s^{-1}, appropriate for a galactic disk, while the satellite lines span a velocity range of several hundred km s^{-1}, and in a few cases up to one or two thousand km s^{-1} comparable with velocity dispersions in galaxy clusters. The evolution of such complexes of lines with z (if any) may give insight into the beginnings of galaxy clusters.

The brighter high redshift quasars can now be studied with high spectral resolution using ESO telescopes and echelle spectrographs. For these studies ESO has some important advantages over its competitors. These include: (a) the EMMI spectrograph is somewhat more efficient (1) than comparable instruments at other observatories and (b) the observing conditions at La Silla are quite good. Furthermore, the Barbieri Key Programme and the Hamburger Sternwarte Key Programme will increase the number of bright, Southern Hemisphere quasars that will be available for study. Together, these advantages represent a significant capability that should be exploited. The experience gained in these initial studies will point the way to future work and give valuable experience in the extraction of the peak performance from the telescopes, their instrumentation and the data reduction facilities. European astronomers will then be in a good position to fully exploit the revolutionary possibilities represented by the future availability of the VLT and its powerful complement of instruments.

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Discovery of the Most Distant "Normal" Galaxy

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Normal galaxies at epochs about one third or less the present age of the universe, t_H, are extremely difficult to detect directly since they are very distant from us and thus have very faint apparent luminosities. However, it is crucial to search for young normal galaxies at high redshift for understanding the formation and evolution of galaxies. The existence of high redshift gas-rich galaxies has already been inferred from the absorption signatures that their interstellar and halo gas imprints on the spectra of more distant objects which may happen to lie on the same line of sight. Such absorption features, due to hydrogen atoms and heavier elements, have been detected in the spectra of distant quasars (see e.g. the first surveys of Weymann et al., 1979, Sargent et al., 1980 and Young et al., 1982). In these studies, quasars are used as background candles to probe all the intervening matter between us and them.

The first identification of a galaxy giving rise to a Mg II absorption system, at a redshift $z = 0.430$ or about ⅔ t_H, was obtained in 1985 at the ESO 3.6-m (Bergeron, 1986). This first identification has been followed by a dozen of others for similar redshifts in a survey done by Bergeron and Boissé (1990). These galaxies have huge gaseous halos, roughly three times larger than the extent of the stellar components and their centres are separated from the quasar image usually by 5 to 10 arcsec. Comparing these observed impact parameters, an average close to 3 Holmberg radii R_H ($R_H = 22$ kpc with $H_o = 50$ km s^{-1} Mpc^{-1}), to those predicted from statistics of Mg II absorption line samples, Bergeron and Boissé conclude that all field galaxies at $z \sim 0.4$, brighter than 0.3 L^* should have extended gaseous halos of roughly spherical geometry. Furthermore, there is also a similar level of [O II] λ 3727 emission, thus of star formation activity, in the absorbing galaxies and in those of faint (field) galaxy surveys at $z \sim 0.3$ (Broadhurst et al., 1988, Colless et al., 1990) which is higher than that observed in local galaxies (Peterson et al., 1986). Consequently, the study of galaxies giving rise to absorption lines in quasar spectra is giving information on the overall field galaxy population. The presence at z ~ 0.4 of extended galactic gaseous halos, which no longer appear to exist today, and of enhanced star formation activity suggest a strong evolution in recent times, and these halos could be the remnants of the initial huge gaseous clouds whose collapse led to galaxy formation.

Encouraged by this successful search for "absorbing" galaxies at z ~ 0.4, J. Bergeron, S. Cristiani and P. Shaver submitted a proposal for an identification survey of intervening galaxies at higher redshifts z ~ 1.0 to 1.5, or $t < ⅓\, t_H$, which was accepted as an ESO Key Programme. Observations have been conducted in March and September 1990 at the ESO New Technology Telescope, and in the September run the first identification of an "absorbing" galaxy at z ~ 1 was obtained. Last March, several candidates have been detected by deep broad-band imaging in the red, but the spectroscopic search for their redshift was then inconclusive due to the faintness of the objects and the absence of strong emission lines in the selected wavelength range for the spectroscopic follow-up. The identified "absorbing" galaxy, G 0102–190, has a redshift $z_g = 1.025 \pm 0.001$, as measured from a strong [OII] emission line detected in a red spectrum of total exposure time of 4.5 hours. The redshift of the MgII absorption doublet present in the quasar (UM 669, $z_Q = 3.035$) spectrum is $z_a = 1.0262$ and, given the accuracy of our galaxy redshift determination, $z_g = z_a$. As shown in Figure 1, the absorbing galaxy lies 4.8 arcsec south of the quasar. The linear separation between the galaxy centre and the line of sight to the quasar gives a lower limit for the radius of the gaseous halo, which is of 53 kpc (adopting $q_o = 0$) or 2.4 R_H. The galaxy has a magnitude in the r band of 23.2 which, at the time of our observations, corresponds to an intensity of 2% that of the sky. Close to the quasar sightline, there are two other galaxies at 12 arcsec south-east and 14 arcsec south-west with measured redshifts of ~ 0.9 and 0.6 respectively. Therefore, contrary to conclusions which could have been derived based solely on imaging data, the absorbing galaxy does not belong to a cluster or tight group. Our pencil-beam observations appear to sample different sheets of galaxies as observed in the large scale distribution of local galaxies (see e. g. Geller et al., 1987).

This first identification of a z ~ 1 absorbing galaxy suggests that galactic gaseous halos were at least as extended at $t \sim ⅓\, t_H$ than at later times, $t \sim ⅔\, t_H$, and confirms the validity of our approach for detecting "normal galaxies" at early epochs $t \lesssim ⅓\, t_H$. The identified galaxy has an absolute luminosity $M_r = -21.6$ similar to those of z ~ 0.4 absorbing galaxies and this is also true for our candidate absorbers assuming that they are indeed at $z_g = z_a$. This points towards a lack of strong evolution for the luminosity of galaxies. Since deep photometric surveys of very faint field galaxies suggest that there is an increase with redshift either in the comoving density or in the luminosity of galaxies, our identification survey will help clarifying this problem.

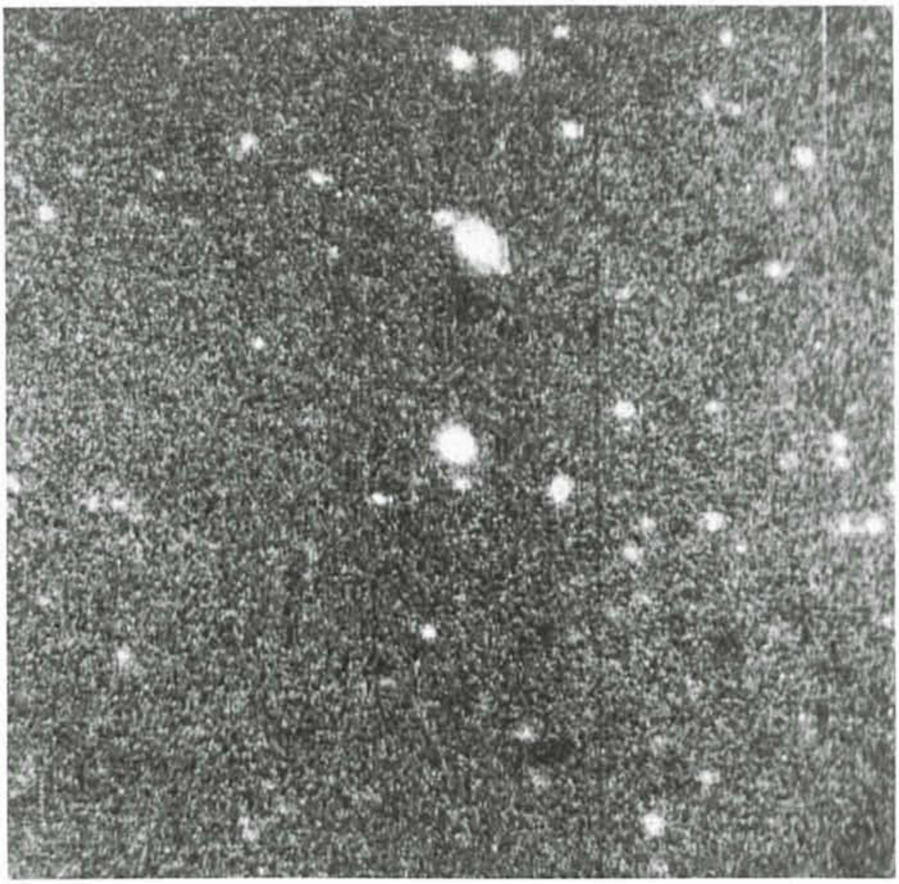

Figure 1: *Broad-band r image of a 120 arcsec square centred on the quasar UM 669. North-east is at the top left corner. The z_g = 1.025 absorbing galaxy is the faint resolved object 4.8 arcsec south of the quasar.*

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ESO Mini-Workshop on Quasar Absorption Lines

A mini-workshop will be held at ESO Garching on 20-21 February 1991 to discuss recent developments in studies of the absorption lines in quasar spectra. Those wishing to attend should contact the Secretariat of the Science Division for further information.