- MIDAS supports several data structures. These are outlined below:
  - Images, a collection of data of the same physical significance (cf. IHAP).
  - Tables, data which can be arranged in rows and columns and not necessarily of the same physical significance. Tables are extremely useful in handling the results of various operations such as lists of magnitudes.
  - Descriptors, the information which is associated with images or tables. These would typically be the name of an image and the number of pixels on each axis as well as many other things.
  - Keywords, variables which provide communication between different MIDAS application programmes. For example, the position of the cursor is normally stored in a keyword and then passed to a subsequent application programme.
- Input to MIDAS is either via the terminal keyboard or from ASCII files, which are the MIDAS command procedures. These files may contain any supported MIDAS command but also the control structures similar to those of high-level programming languages.
- MIDAS users keep a reasonable amount of their data on disk during the time they wish to work. Thus no time is lost in moving data from magnetic tape to disk and vice versa. For this purpose, several "public" disk areas of various sizes have been established for which a MIDAS user can obtain exclusive access for a certain time.
- Two commands have been created to read and write magnetic tapes. These procedures support IHAP, FITS and DEC's BACKUP format on input as well as FITS and BACKUP on output.

Applications

At the present time MIDAS provides a comprehensive set of basic image processing functions. There are currently about 175 commands available in the MIDAS system. A short overview of the most interesting ones is given below:

- Load images and colour-lookup-tables into the image display and read them back into VAX memory.
- Modify the colour-lookup-table interactively to enhance various image features.
- Zoom and scroll images interactively or with fixed values.
- Single images may be viewed in monochrome or with pseudo colours. If the 3-colour components of an image exist, they may be overlaid to work in real-colour mode (cf. Fig. 2, page 27 in *Messenger* 30, Dec. 1982).
- Extract subimages interactively via cursor window or at fixed coordinates.
- Plot scan lines, contours and perspective views.
- Rotation, flip, rebin and filter images.
- Execute arithmetic operations and the usual FORTRAN functions on images and tables as well as Fast Fourier transformations.

It is envisaged that several application programme packages will be developed within the MIDAS environment. These will function and be documented along the lines of the IDS reduction package that has been available in the IHAP system for several years.

The first astronomical application package implemented in MIDAS handles CCD frames. The CCD images are cleaned by minimizing permanent instrumental defects, such as low sensitivity columns, bad rows and hot spots and by removing various kinds of random artifacts. In its present state, MIDAS will be most useful for astronomers wishing to reduce CCD data.

Other astronomical applications in the areas of 2D-photometric and spectroscopic reductions are currently being developed for MIDAS and will be fully integrated soon.

Documentation

An extensive users guide has been written which describes the MIDAS system as it currently exists and how to use these features. As new features are added, the users guide will be updated. This includes descriptions of the data structures, detailed descriptions of the individual commands, and information on how to use the special-purpose peripherals such as the Dicomed image recorder.

A guide to writing an application programme for the MIDAS system is also available. It describes the FORTRAN interfaces to the MIDAS data structures. This will prove useful to those people who wish to generate special-purpose commands for their own particular application.

Finally, a MIDAS installation guide and MIDAS system description have been written, but their status is less well developed than the previous two.

Absorption-Line Spectroscopy of Close Pairs of QSOs

P. A. Shaver, ESO, and J. G. Robertson, Anglo-Australian Observatory

Introduction

QSOs can be used as sensitive probes of the intergalactic medium. They are strong and distant sources of continuum radiation, against which intervening material may be discerned in absorption and mapped as a function of redshift. Close QSO pairs, which by chance have small separations ($\lesssim$ few arcmin) on the plane of the sky, expand these possibilities; they provide twin lines of sight over vast distances, giving direct information on the lateral sizes of the intervening absorbing regions distributed along these lines of sight, and on the presence of absorbing material in the immediate vicinity of the foreground QSOs themselves.

Two distinct types of absorption lines are found in QSO spectra. There are broad absorption troughs adjacent to the emission lines in about 10 per cent of QSO spectra; these are high-excitation systems, and are thought to be due to gas which has been expelled from the QSO nuclei. The origin of the other type of QSO absorption lines is more controversial: narrow absorption lines (widths of a few hundred km s^{-1} or less) are found in most QSO spectra, with *any* redshift up to approximately that of the QSO. They could conceivably also be due to matter which has been expelled from the QSO at highly relativistic velocities, but the most widely accepted view is that they are due to matter cosmologically distributed along the line of sight to the QSO and unassociated with it. These in turn fall into two categories: systems containing heavy-element absorption lines in addition to Lyα, and the far more numerous systems in which only Lyα is detected and which comprise the so-called "Lyα forest" of absorption lines shortward of the broad Lyα emission line of the QSO.

What types of intervening objects could cause the narrow absorption lines? For the heavy-element absorption-line systems – possibly protogalaxies, spiral galaxies or large (100–200 kpc) galactic halos. If, as has been suggested, many of the Lyα absorption lines do not have heavy-element absorption-line counterparts (to very low levels), they would be due to comparatively unprocessed material, perhaps intergalactic hydrogen clouds (~10 kpc), or extremely large hydrogenic halos around galaxies or clusters of galaxies.

Direct evidence that at least some narrow heavy-element absorption lines originate in the extended halos of intervening galaxies has been obtained in a few cases in which absorption is seen at the redshift of a galaxy close to the QSO on the sky but with z (gal) $\ll z_{em}$ (QSO). In almost all of these cases, the absorption lines are Ca II or Mg II, and the redshifts are relatively small. Indirect evidence further suggests that high excitation absorption lines of high redshift may also be due to intervening galactic halos: the detection of C IV absorption arising in the outer halo of our own galaxy, and statistical studies of high-redshift C IV absorption lines.

By looking for *"common absorption"* in close QSO pairs, i.e. absorption in both spectra at the same redshift, one may obtain more direct information on the nature of narrow absorption lines of high excitation and redshift: evidence regarding their origin (intrinsic vs. intervening), and the sizes and clustering of the absorbing regions.

One may also look for *"associated absorption"*, i.e., absorption at the redshift of the foreground QSO in the spectrum of the other member of the pair. This would give information on the clustering of absorbing material with QSOs and on the presence and nature of gaseous halos surrounding QSOs (which may be expected, if QSOs are the nuclei of galaxies). It would also address the intrinsic/intervening question of origin, and provide a new test of the cosmological interpretation of QSO redshifts.

Observations: Prospects and Results to Date

There are several suitable pairs listed in published catalogues. For every 100 QSOs, there is roughly one pair of separation ~1 arcmin with both members brighter than 20th magnitude. The number of such pairs is consistent with a random distribution of QSOs on the sky, and can be expected to increase rapidly as the vast amount of presently unpublished objective prism material becomes generally available. The advent of the Space Telescope will make still more pairs accessible to this kind of study. Gravitational lens pairs are of special interest in studying common absorption at very small angular separations, but the number of these is expected to remain small. Physical pairs of QSOs are also useful because

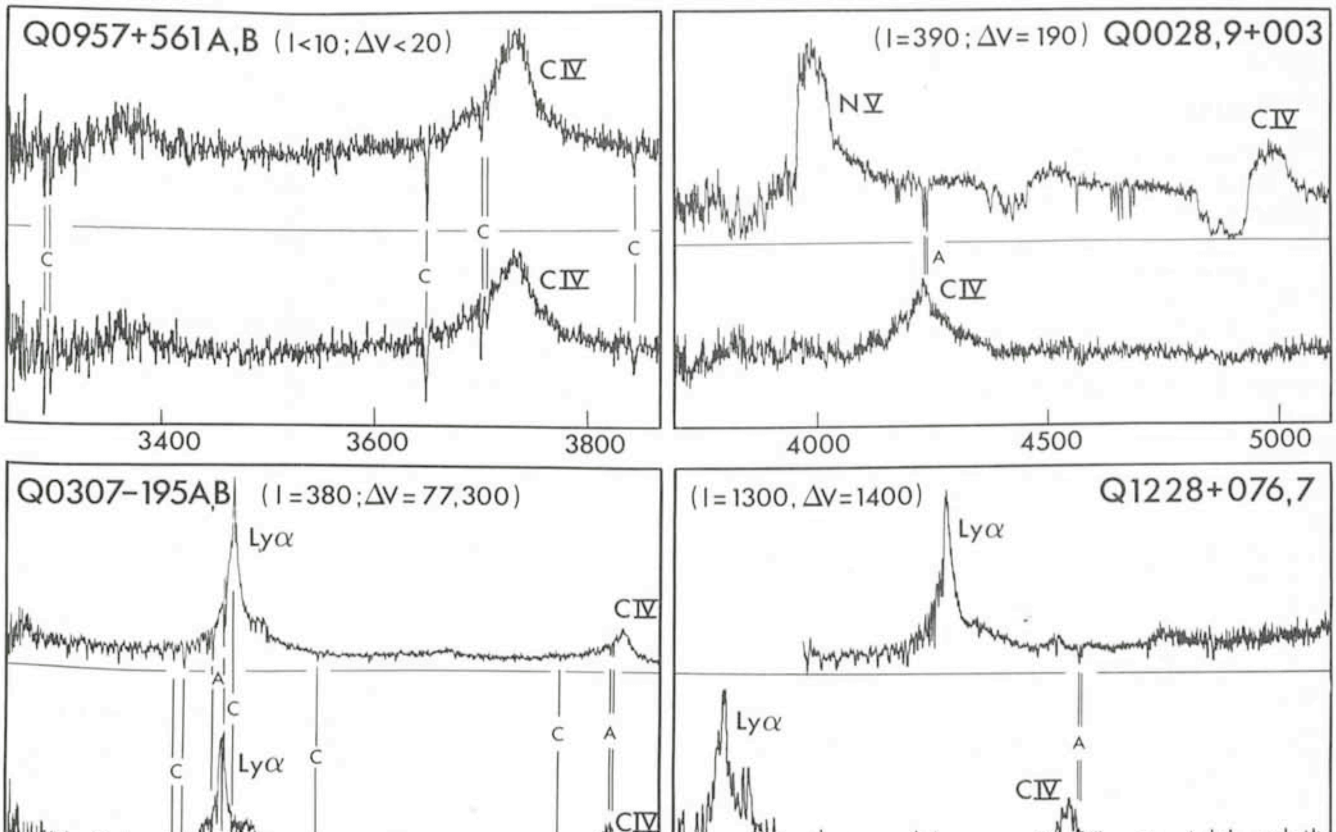


Figure 1: *Spectra of four QSO pairs, showing common (C) and associated (A) absorption. Also indicated are the projected separation (l, in h^{-1} kpc) and the velocity difference (ΔV, in km s^{-1}). References are as follows: Q0957+561A,B (Young et al. 1981,* Astrophysical Journal **249,** *415), Q0307−195A,B (Shaver and Robertson 1983,* Astrophys. J. *in press), Q0028,9+003 (Shaver, Boksenberg, and Robertson 1982,* Astrophys. J. **261,** *L7), and Q1228+076,7 (Robertson and Shaver 1983,* Nature, *in preparation).*

of their small angular separations, but their small redshift differences may make them difficult to use unambiguously in studies of associated absorption.

Our programme of absorption-line spectroscopy of close QSO pairs, now just over a year old, involves the 3.6 m telescope at La Silla and the Anglo-Australian Telescope at Siding Spring. Both the IDS and the IPCS are used; a special advantage of using the IPCS for this kind of work is that both QSOs can be observed simultaneously, cutting integration times in half. We already have useful data on 8 QSO pairs, which, combined with data on a further 4 pairs observed by others, gives information on 20 heavy-element absorption systems for which common absorption could be detected and 11 QSO pairs in which associated absorption could be detected.

We have found several cases of associated absorption and a few of common absorption. The probability of any of these coincidences occurring by chance is small, about 1 per cent per QSO pair for a redshift coincidence of ± 200 km s^{-1}. This, therefore, provides the first direct evidence that at least some high-redshift absorption systems are due to intervening matter.

"Typical" Absorption Systems

Of the 20 heavy-element absorption systems found in the spectra of these QSOs and having much smaller redshifts than the QSOs themselves, only a few have definite counterparts in the spectrum of the other member of the pair ("common absorption"). Two of these occur in the gravitational lens pair Q0957+561A,B, for which the projected separations are very small. In the other case, Q0307−195A,B, the velocity difference is 297 km s^{-1} and the projected separation at the relevant absorption redshift is 376 h^{-1} kpc (H_0 = 100 h km s^{-1} Mpc^{-1} and $q_o = 0$). These cases are shown in Fig. 1. In view of the small incidence of common absorption, it therefore appears that typical heavy-element absorption systems may be no larger than several hundred kpc, and that, if they are clustered together at all, the absorption cross-sections of the clusters are small. Therefore, if the absorption systems are due to extended galactic halos, these results may provide constraints on the fraction of galaxies in clusters which can have such halos. By the same token it seems unlikely that the sub-structure found in these heavy-element absorption lines can be due to several galaxies clustered together, as has sometimes been suggested, unless the absorbing halos are very small. These inferences, however, must remain tentative until more data become available.

The Lyα absorbing regions are also not extended or clustered over very large scales. Sargent et al. (1982, *Astrophysical Journal* **256,** 374) found no significant correlation between the Lyα absorption lines in the spectra of the QSOs Q1623+268,9. The linear separation is $\sim$1 h^{-1} Mpc over the relevant range of redshift. In the Q0307−195A,B pair (separation $\sim$0.4 h^{-1} Mpc) we found a marginal tendency for the Lyα lines to correlate, but more QSO pairs of separation $<1'$ must be examined before firm conclusions can be drawn.

Absorption Systems Associated with Foreground QSOs

By contrast with the relatively few cases of common absorption, "associated absorption" (absorption in the spectrum of the higher-redshift QSO at the redshift of the other member of the pair) has been found in a comparatively large fraction of QSO pairs. Some of these cases are shown in Fig. 1. Of all available QSO pairs (projected separations up to 2 h^{-1} Mpc), half exhibit associated absorption, and for separations less than 500 h^{-1} kpc the fraction with associated absorption approaches three-quarters. Evidently QSOs are located in regions of high matter density – plausibly clusters of galaxies (which would then be the most distant known, with look-back times over half the age of the universe). The higher incidence of associated absorption (compared with common absorption) suggests that the absorption cross-section may be enhanced in the vicinity of QSOs; this is plausible since the UV flux from a typical QSO dominates the metagalactic flux over a radius comparable with that of a cluster of galaxies.

The very small velocity differences in the cases of Q0307-195A,B and Q0028,9+003, however, 77 and 190 km s^{-1} respectively, suggest that the absorption here may arise in extended halos or disks physically associated with the foreground QSOs themselves. Thus, we may be looking through one QSO at another. This interpretation receives strong support from the observations by Bergeron et al. (1983, *Monthly Notices of the Royal Astronomical Society* **202,** 125) of *emission* lines around the QSO MR2251−178 which extend out to at least 150 h^{-1} kpc and define a smooth rotation curve centred on the QSO redshift. The absorption measurements are sensitive to smaller column densities, and show that such halos may extend out to 400 h^{-1} kpc. If this interpretation is correct, it implies that a large percentage of QSOs possess Mpc-diameter halos.

The nature of these halos remains uncertain at present, but the example of MR2251−178 does suggest a disk-like geometry. If these halos really are the quiescent disks of the parent galaxies containing the QSOs, the implied masses of the disks and the total systems are $\gtrsim 10^{10}$ $M_\odot$ and $\gtrsim 10^{12}$ $M_\odot$ respectively.

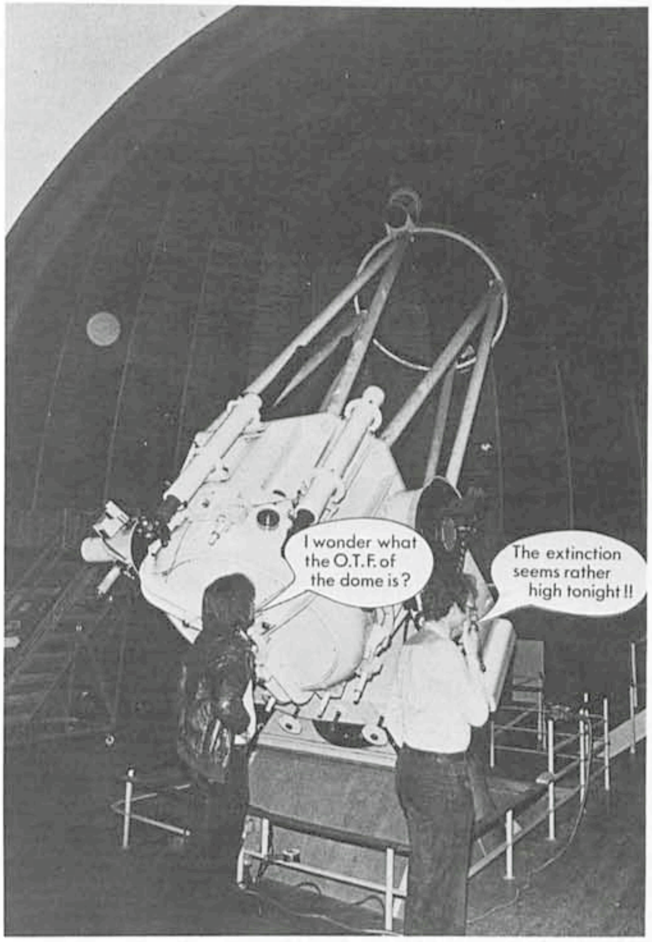
Cosmological Interpretation of QSO Redshifts

The discovery of associated absorption in close pairs of QSOs opens the way to a new test of the cosmological interpretation of QSO redshifts. According to the cosmological interpretation the foreground QSO in a pair should always have the lower redshift. On the other hand, if QSO redshifts are unrelated to their distances, there should be as many cases in which the foreground QSO has the *higher* redshift of the two. Thus, by using associated absorption to distinguish which of the two QSOs in a pair is in front of the other, we have a simple and straightforward test of the cosmological interpretation.

In all cases of associated absorption so far discovered, the foreground QSO has the lower redshift of the pair. *No* cases have been found in which the foreground QSO has the higher redshift. Application of statistical tests to the existing data (Shaver and Robertson, 1983, *Nature,* in preparation) already shows that the hypothesis that QSO redshifts are unrelated to distance is highly improbable.

Indeed, the mere existence of the phenomenon of associated absorption presents severe obstacles to non-cosmological interpretations of redshifts. The fact that several cases are now known establishes beyond doubt that these are not chance coincidences – the absorption is really associated with the foreground QSO. A non-cosmological (emisson) redshift of that QSO would therefore require an identical non-cosmological origin for the absorption redshift – yet the absorption presumably arises in a region of quite different physical conditions.

This work can be expected to advance rapidly, as there are many published close pairs of QSOs still to be studied, and many more soon to emerge from the present objective prism surveys. Much more definite conclusions regarding the cosmological interpretation of redshifts, the origin of heavy-element and Lyα absorption lines, and the relative incidence of common and associated absorption will soon be possible, and one may begin to explore statistically the sizes, cross-sections, and other properties of the absorbing regions.



When engineers observe by themselves! R. Wilson and B. Delabre at the 1.37 m at Merate. Photo O. Citterio.

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Arrivals

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DUFLOT, Jean-Christophe (F), 31.1.1983.

ALGUNOS RESUMENES

Llegó a La Silla el telescopio de 2.2 m

El día 19 de enero arribó a Valparaíso el telescopio de 2.2 m a bordo del mercante chileno "Maule". El instrumento fabricado por Zeiss, fue embarcado en el puerto alemán de Bremen. Fue embalado en 46 cajones con un peso total de 112 toneladas. La descarga comenzó de inmediato y duró la noche entera. Al próximo día fueron cargados todos los cajones en 5 camiones que los llevaron a La Silla. El día 21 de enero se descargó el último cajón y todos ellos fueron colocadas en los lugares previstos. Se abrió el cajón que contenía el espejo principal para examinarlo. El espejo se encontraba en perfecto estado.

El montaje del telescopio comenzó el 14 de febrero y se espera que concluirá en julio.

Fibras ópticas en ESO

Durante observaciones experimentales hechas en noviembre de 1982 se llevaron a cabo algunos tests con fibras ópticas en el telescopio de 3.6 m. Para uno de los tests se interconectaron por fibras el foco primario del 3.6 m y el Espectrógrafo Coudé Echelle. Para ese propósito se prepararon tres cables de fibras ópticas, con un largo aproximado de 38 m cada uno y diámetros interiores de 85, 100 y 125 μ.