The Future Utilisation of Schmidt Telescopes
ASP Conference Series, Vol. 84, 1995
J. M. Chapman, R. D. Cannon, S. J. Harrison and B. Hidayat (eds)

A Deep Multicolour CCD Survey for Quasar Candidates with the OCA Schmidt Telescope

O. Moreau[1], E. Gosset[2] and P. Royer

Institut d'Astrophysique, Université de Liège, Avenue de Cointe 5, B-4000 Liège, Belgium

Abstract. We intend to perform a deep multicolour survey for quasar candidates using the CCD equipment recently installed at the Schmidt telescope of Observatoire de la Côte d'Azur (OCA). As a first step, we will study small areas of 0.3 square degrees but we are especially interested in the forthcoming full coverage of the Schmidt field with a CCD mosaic. In order to prepare the selection of quasar candidates, we have computed their predicted colours on the basis of a composite quasar spectrum.

1. Introduction

In order to obtain a better understanding of the physics, evolution and spacetime distribution of quasars, it remains necessary to increase the number of known objects. Moreover, there is nowadays a justified increasing interest towards high redshift quasars that is related to questions about quasar formation and far Universe probing. Last but not least, quasar surveys are also a direct source of new potential gravitational lens candidates. With these scientific aims, we are currently conducting a UBVRI photographic survey for quasar candidates in two equatorial 30 square-degree fields, around NGC 450 and NGC 520 respectively, using digitized Schmidt plates (Moreau et al. 1994). As a matter of fact, the analysis of photographic plates presently remains the best way to perform a wide-field selection of quasar candidates. We nevertheless are looking towards the utilisation of large CCD mosaics at Schmidt telescopes.

2. Use of a CCD at the OCA Schmidt telescope

Recently, a CCD detector has become available at the Schmidt telescope of Observatoire de la Côte d'Azur (OCA, France) allowing the imaging of 0.3 square-degree areas at the moment (Maury 1994). We intend to use this equipment for a deep quasar candidate survey in two small selected regions of the fields labelled NGC 450 and NGC 520, with the multicolour possibilities offered by the B, V, R, I and Z passbands (U will become available after the appropriate coating of

[1]European Space Agency fellow

[2]Chercheur qualifié au Fonds National de la Recherche Scientifique (Belgium)

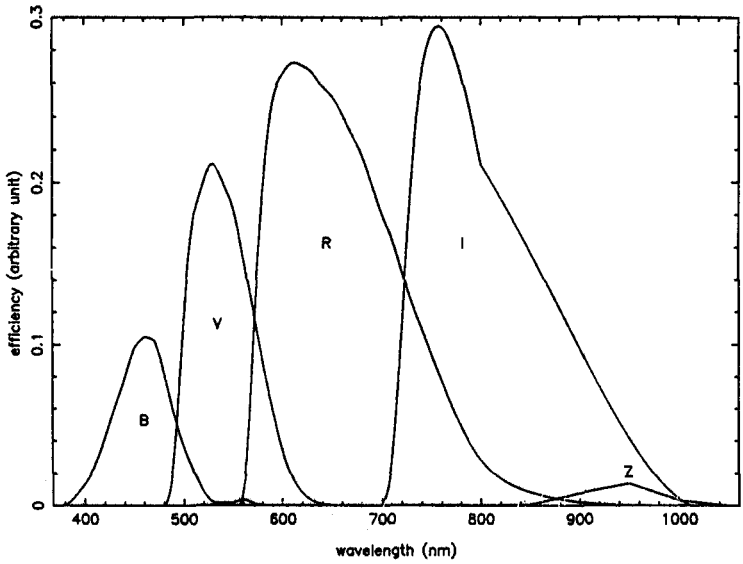

Figure 1. B_{CCD}, V_{CCD}, R_{CCD}, I_{CCD} and Z_{CCD} passbands

the CCD). This first step is considered as a test; we aim at getting prepared for the utilisation of a wide field CCD camera associated with this telescope for multicolour quasar surveys. Such a first attempt nevertheless has its own scientific interest: with such colour material and the advantages of CCDs (larger depth, more accurate photometry), we expect to realize a more efficient quasar candidate selection and then to be able (after follow-up spectroscopy) to estimate the completeness achieved with our photographic surveys. In particular, we should also be especially sensitive to high redshift quasars though the field is quite small.

3. Prediction of quasar colours for candidate selection

The relatively large number of different available passbands will allow an accurate selection of quasar candidates. In order to prepare this extraction, we have performed simulations investigating the typical colour indices of quasars as a function of redshift; full details about these predictions are given by Royer (1994). Suffice it to say here that we integrated in the appropriate passbands a synthetic quasar spectrum which is essentially the composite assembled by Francis et al. (1991) from the compilation of 718 individual bright quasar spectra. We applied a correction to suppress the Ly α forest absorption. This spectrum has been extended beyond 600 nm with a scaled version of the Cristiani and Vio (1990) composite spectrum (the agreement between both sources is reasonable).

The passbands expected from the combination of the filters and of the CCD detector are displayed in Fig. 1. Since the filters used at the OCA Schmidt

https://doi.org/10.1017/S0252921100022478 Published online by Cambridge University Press

telescope comply with his prescriptions, we should have good agreement with the passbands defined by Bessell (1990) as B_{CCD}, V_{CCD} and R_{CCD}. Concerning the I passband, the cut-off at long wavelength is defined by the loss of sensitivity of the CCD and not by the sole RG9 filter. Therefore, our response curve in Fig. 1 is more reminiscent of the I_{CCD} passband described in Bessell (1986). For the same reason, the Z_{CCD} passband has no similarities with the standard Z passband (provided it is defined) and, as can be seen in Fig. 1, is essentially included in the I_{CCD} one.

The quasar spectrum below Ly α was depressed as a function of redshift according to the Ly α forest absorption (D_A) published by Irwin et al. (1991) and to the main contribution of the other Ly transitions. The quasar was redshifted and then integrated in the different passbands. The resultant fluxes through B_{CCD}, V_{CCD}, R_{CCD} and I_{CCD} were calibrated using spectrophotometric standards of Stone and Baldwin (1983), Baldwin and Stone (1984) and Hamuy et al. (1992), which were photometrically observed by Landolt (1992). Since no observation exists in Z, we arbitrarily chose to impose $I_{CCD}-Z_{CCD} = 0$ for Vega whose spectrum from Hayes (1985) was integrated in these two pass bands. We thus obtained typical colour indices for quasars and plotted in Figs 2–4 a few interesting colour diagrams. The expected locus of stars is given, according to Bessell's (1990) computations (in B, V, R and I) on Vilnius spectra; indices were transformed to the CCD passband system using colour transformations suggested by himself (1986, 1990). The main sequence turn-off is not illustrated in the figures. Finally, in order to estimate the typical $I_{CCD}-Z_{CCD}$ indices of stars, we integrated six de-reddened star spectra of types ranging from B to K.

Our colour predictions confirm the possibility of selecting high redshift quasar candidates (with z larger than about 3.7) using V_{CCD}, R_{CCD} and I_{CCD} bands. It is also worth noting that our results in B, R and I are compatible with the observations from Irwin et al. (1991) but due to a better sensitivity of the CCD, it will be easier for us to use the V_{CCD} passband rather than the B_{CCD} one. In the B−V/V−R diagram appears the possibility to extract strong-lined quasars of redshifts between say 3.2 and 3.5. Low redshift quasars seem also to present a small departure from the locus of stars thanks to the I_{CCD} passband but for a more secure study of this redshift range, a U_{CCD} passband is essential. On the contrary, the Z_{CCD} passband seems not to be very interesting according to these computations. Indeed, from Fig. 4, we notice that quasars lay roughly near $I_{CCD}-Z_{CCD} = 0$ for almost any z. This is also approximately the colour index of stars of spectral type B to K. There is nevertheless an exception for quasars of redshift 0.4–0.5 which appear redder due to the presence of the Hα line in Z_{CCD}. It is unfortunate that the Z_{CCD} passband does not extend beyond 1100 nm because quasars would then be red up to z = 0.7–0.8 and this property would be useful to prevent the loss, in UV-excess surveys, of strong-lined quasars due to the presence of the MgII resonance lines in the B filter. Also, the $I_{CCD}-Z_{CCD}$ index is expected to be large for cool stars, therefore the Z_{CCD} passband could perhaps help to disentangle very high redshift quasars from late M stars. In any case, we expect to soon get multicolour data from the telescope in order to investigate better the distribution of the objects in a multicolour BVRIZ hyperspace. We are also waiting for a larger CCD field.

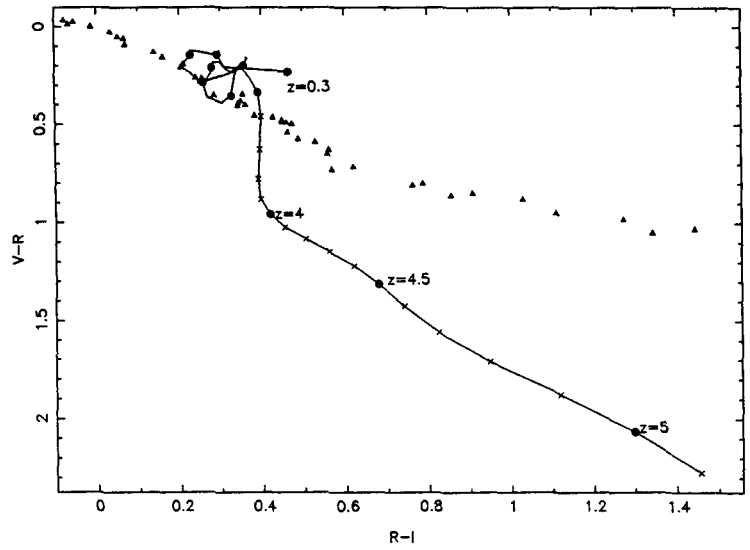

Figure 2. Quasar VRI CCD colours (solid line) as a function of redshift (z). The expected locus of stars is represented with triangles; the halo main sequence turn-off should be around V−R = 0.25

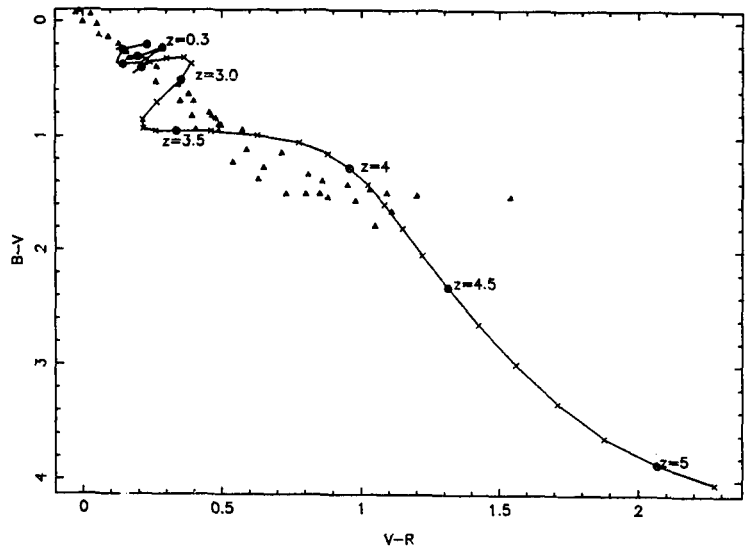

Figure 3. Quasar BVR CCD colours as a function of redshift. The halo main sequence turn-off should be around B−V = 0.45

https://doi.org/10.1017/S0252921100022478 Published online by Cambridge University Press

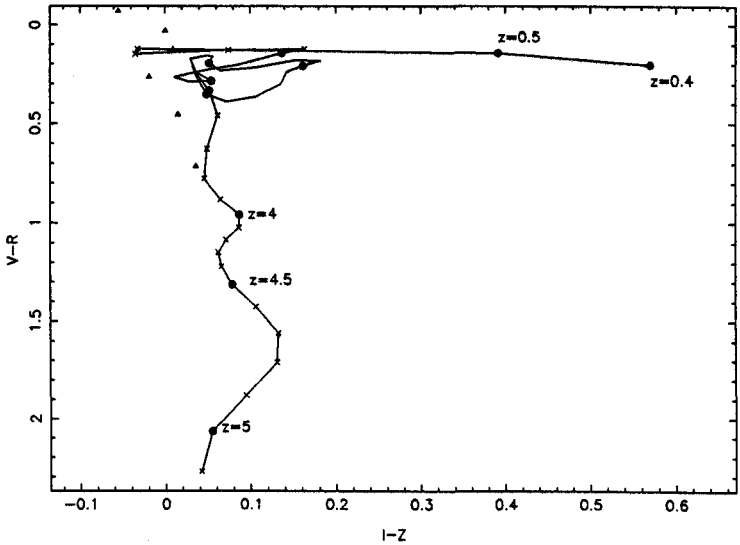

Figure 4. Quasar VRIZ CCD colours as a function of redshift

Acknowledgments

We are grateful to the OCA Schmidt team and especially to A. Maury for his help in collecting data about passbands. We also would like to thank P. J. Francis and P. C. Hewett who have kindly made available a computer-readable version of their composite quasar spectrum.

References

Baldwin J. A.& Stone, R. P. S., 1984, MNRAS, 206, 241

Bessell M. S., 1986, PASP, 98, 1303

Bessell M. S., 1990, PASP, 102, 1181

Cristiani S. & Vio R., 1990, A&A, 227, 385

Francis P. J., Hewett P. C., Foltz, C. B., Chaffee F. H., Weymann R. J. & Morris S. L., 1991, ApJ, 373, 465

Hamuy M., Walker A. R., Suntzeff N. B., Gigoux P., Heathcote S. R. & Phillips M. M., 1992, PASP, 104, 533

Hayes D. S., 1985, in *Calibration of Fundamental Stellar Quantities*, D. S. Hayes et al., eds, (Reidel, Dordrecht), p.225

Irwin M., McMahon R. G.& Hazard C., 1991, ASP Conf. Ser. 21, p.117

Landolt A. U., 1992, AJ, 104, 372

Maury A., 1994, these proceedings

Moreau O., Gosset E., Reboul H. & Vanderriest C., 1994, Proc. IAU Symp. 161, in press

Royer P., 1994, *Mémoire de fin d'études d'ingénieur*, Université de Liège (Belgium)

Stone R. P. S. & Baldwin J. A., 1983, MNRAS, 204, 347

Discussion

Hawkins: Are you not likely to have difficulties with galaxy contamination at B = 24, where star/galaxy separation will be extremely difficult, and galaxy colours will be similar to quasars?

Moreau: Yes, we certainly are. However, we will test the possibility of separating galaxies from quasars in a BVRIZ multi-colour space, with the first data we receive.

https://doi.org/10.1017/S0252921100022478 Published online by Cambridge University Press