Public Release of 2dF data from the Fornax Cluster Spectroscopic Survey

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1 Spectroscopy of Everything

Almost 20 years ago Morton, Krug \& Tritton (1985) made the first complete spectroscopic survey of a given region of sky. They surveyed stellar objects in a 0.3 deg$^2$ region of sky to a limit of $B = 20$, measuring 600 objective prism spectra with the UKST and 100 slit spectra with the AAT. All the objects measured were normal stars except for a small number of QSOs and white dwarfs, the latter being used to put new constraints on the white dwarf luminosity function.

Thanks to the arrival of the 2dF spectrograph on the AAT, we have recently completed the first stage of a complete spectroscopic survey more than one order of magnitude larger than the Morton et al. study, measuring 7000 spectra in a $2\pi$ deg$^2$ area as part of our study of the Fornax Cluster. In this article we describe the public release of 3600 spectra from our first field. We hope that this public release will encourage colleagues making surveys for rare objects to choose these fields, as much of the follow-up spectroscopy that might be required is available from our data.

Our 2dF Fornax Cluster Spectroscopic Survey (FCSS; see Drinkwater et al. 2000a) was designed to make the most complete census possible of low-luminosity galaxies in the Fornax Cluster. As well as the conventional low-surface brightness dwarfs, we already had evidence (Drinkwater \& Gregg 1998) that very compact, high surface brightness dwarf cluster galaxies had been missed in previous work, so we took the unusual step of observing all objects in each 2dF field, both resolved ("galaxies") and unresolved ("stars"). In this way we avoided any morphological bias as to what a cluster galaxy should look like. Observing all the "stars" in each 2dF field leads to a large increase in the number of targets observed: within our magnitude limits (16.5 < $b_J$ < 19.8) over 50\% of the objects in each 2dF field are stars. Thanks to the flexibility of 2dF, however, this only leads to a small increase in total observing time as we schedule the stars at times when we could not usefully observe galaxies, such as twilight or at high airmass or through cloud.

2 Status of the Survey

As of 2001 January we have completed observations of two of our four planned 2dF fields centred on the Fornax Cluster. We have analysed the data from our first field and have released it for public access as described below. The properties of the sample are summarised in Fig. 1, a plot of surface brightness against magnitude for all the objects we successfully observed. The main all-object sample was selected in the magnitude range 16.5 < $b_J$ < 19.8. We extended our observations of the unresolved objects ("stars") to a slightly fainter magnitude limit of $b_J \approx 20.2$. There is some incompleteness for galaxies with surface...
Figure 1: Surface brightness-magnitude diagram for the objects we have successfully observed in our first 2dF field. Resolved objects (“galaxies”) are plotted as (blue) filled triangles and unresolved objects (“stars”) as (red) open circles. The surface brightness measurements are based on exponential fits to the photographic data and are only indicative for the stars (see Drinkwater et al. 2000a).

brightness lower than about $23.5$ $b_J$ mag arcsec$^{-2}$ as we were unable to measure their redshifts (see Drinkwater et al. 2000a).

The diversity of objects in our sample is illustrated by Fig. 2, a cone diagram of the sample in which the distance axis is scaled (as $z^{1/4}$) so as to display both Galactic stars and the most distant QSOs. Note that although we avoid the use of conventional morphological classifications in our analysis (we use redshift, spectral signatures and luminosity instead), we do show the morphological classifications in both Fig. 1 and Fig. 2. The presence of unresolved objects (“stars”) in both the Fornax Cluster and among the background field galaxies demonstrates the importance of our all-object strategy. These objects would have been missed by conventional galaxy surveys only looking at objects that are resolved on UKST sky survey plates.

The scientific highlight of our results to date has been the discovery of a new population of Fornax Cluster dwarf galaxies so compact they were previously mistaken for Galactic stars (Drinkwater et al. 2000b). They can be seen among the more normal, resolved Fornax Cluster dwarf galaxies in Fig. 2. These “ultra-compact dwarf” (UCD) galaxies are unlike any known type of stellar system. They are smaller and more concentrated than any known dwarf galaxy, but are 2-3 magnitudes more luminous than the largest Galactic globular clusters. Numerical simulations have shown that the UCDs could have been formed by tidal stripping of nucleated dwarf galaxies in close orbits around the central galaxy of the cluster, NGC 1399 (Bekki, Couch & Drinkwater 2001). We are making detailed follow-up observations of the UCDs with Hubble Space Telescope imaging to measure their sizes along with high resolution spectroscopy on the VLT to measure their velocity dispersions and hence masses.

Other results from the early stages of our survey include the first large QSO sample selected purely from spectroscopic identification without any pre-selection bias (Fig. 3; see Meyer et al. 2001) and the identification of a population of $L_*$ compact field galaxies also unresolved from the ground (Drinkwater et al. 1999). We have also shown that some low surface brightness galaxies previously assumed to be members of the Fornax Cluster are in fact background objects (Jones et al., in preparation).
Figure 2: Cone diagram of the objects we successfully observed in our first 2dF field. The “redshift” axis measures $z^{1/4}$ in order to display the four orders of magnitude in distance spanned by our sample. Resolved objects (“galaxies”) are plotted as (blue) filled triangles and unresolved objects (“stars”) as (red) open circles. Note that unresolved sources appear in the Fornax Cluster ($z^{1/4} \approx 0.25$) and among the background field galaxies ($z^{1/4} \approx 0.6$).
Figure 3: $U_bJ_R$ colour-colour diagram of QSOs and stars from our first field. The multicolour selection cutoff used by the 2dF QSO Redshift Survey is shown by the dotted line. We derive completeness values for this multicolour selection of 90 ± 4 per cent for $0.3 < z < 2.2$ quasars and $80^{+9}_{-13}$ per cent for $z > 2.2$ quasars (see Meyer et al. 2001 for details). The two quasars in the sample too faint to appear in the $R$ data are plotted with arrows and a location corresponding to an upper magnitude limit of $R=20.3$.

3 Public Web Access

The 3600 2dF spectra from our first field are now available for public access at our web site [http://astro.ph.unimelb.edu.au/data/](http://astro.ph.unimelb.edu.au/data/) in Melbourne. The main function of the web site is to allow searches of our database by position on the sky and to return our 2dF spectra and redshift measurements of the selected objects. The complete database of measurements is available from the website as a plain text file as well as additional help material and references. The database consists of all the objects for which we have measured reliable redshifts (about 95% of the sample at present). Our 2dF spectra were all obtained with the same observing configuration as for the 2dF Galaxy Redshift Survey: a wavelength coverage of 3600–8010 Å and a resolution of 9 Å (dispersion of 4.3 Å per pixel). The spectra have typical signal-to-noise ratios of 10 or more per pixel. The redshifts were measured by cross-correlation with star and galaxy templates; this gives velocities accurate to about 65 km s$^{-1}$ for galaxies (see Drinkwater et al. 2000a for details).

The database is searched by entering a co-ordinate and search radius, with a table listing the parameters of any objects observed within that radius being returned. The parameters listed include magnitudes and classifications from the APM Catalogues (Irwin, Maddox & McMahon, 1994) as well as our own redshift measurements. Following our philosophy of avoiding morphological bias in classifications, we do not specifically classify objects in the database (although the APM classifications are listed for reference). Instead we recommend the use of our spectroscopic redshifts (in conjunction with the magnitudes if necessary) to make classifications on a more physical basis, e.g. classifying objects with redshifts less than 700 km s$^{-1}$ as Galactic stars.

To obtain the 2dF spectrum of any object returned in the output table, click on the “plot” button for that object. When you click on the plot button, the spectrum will appear in a new window. The spectrum can then be replotted with different axis limits if necessary and downloaded in text, GIF, PostScript or FITS format. An example of the PostScript output is shown in Fig. 4.
Figure 4: A $z = 2.43$ QSO from our sample (see Meyer et al. 2001), as plotted by the web interface.

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