Early Results from the 2dF Galaxy Redshift Survey

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Abstract. The 2dF Galaxy Redshift Survey is a major new initiative to map a representative volume of the universe. The survey makes use of the 2dF multi-fibre spectrograph at the Anglo-Australian Telescope to measure redshifts for over 250,000 galaxies brighter than b_J=19.5 and a further 10,000 galaxies brighter than R=21. The main goals of the survey are to characterise the large-scale structure of the universe and quantify the properties of the galaxy population at low redshifts. This paper presents some early results from the first 10,000 galaxy redshifts to be measured.

The 2dF Galaxy Redshift Survey at the Anglo-Australian Telescope aims to map the optically-luminous galaxies over a statistically-representative volume of the universe in order to characterise as fully as possible the large-scale structure of the galaxy distribution and the interplay between this structure and the properties of the galaxies themselves. In doing so, the survey will address a variety of fundamental problems in galaxy formation and cosmology.

The major scientific goals include: (i) measuring the power spectrum of the galaxy distribution on scales up to a few hundred Mpc; (ii) measuring the distortion of the large-scale spatial clustering pattern in redshift space due to the peculiar velocity field produced by the mass distribution; (iii) determining whether the density distribution is Gaussian on large scales; (iv) studying the variations in the spatial and velocity distributions of galaxies as a function of galaxy properties, including luminosity and spectral type; (v) tracking the galaxy luminosity function, clustering amplitude and mean star formation rate out to a redshift of $z{\sim}0.5$; (vi) defining large, homogeneous samples of groups and clusters of galaxies and other large-scale structures; (vii) correlating the galaxies in this survey with sources found at other wavelengths.

The survey design seeks to achieve the above goals using the capabilities of the 2dF multi-fibre spectrograph on the Anglo-Australian Telescope (AAT) in approximately 100 nights of telescope time. The main features of the survey design are given in Colless (1998). The first data for the survey was taken at the start of 2dF's commissioning in November 1996. The first survey observations with all 400 fibres were obtained in October 1997. As of this writing (August 1998) we have obtained ∼10,000 redshifts for the survey in 49 different fields (many of which were observed with only 200 fibres and most of which were shared with the QSO survey—see Shanks, these proceedings). The success rate in identifying redshifts for survey galaxies is currently 90–95%; with

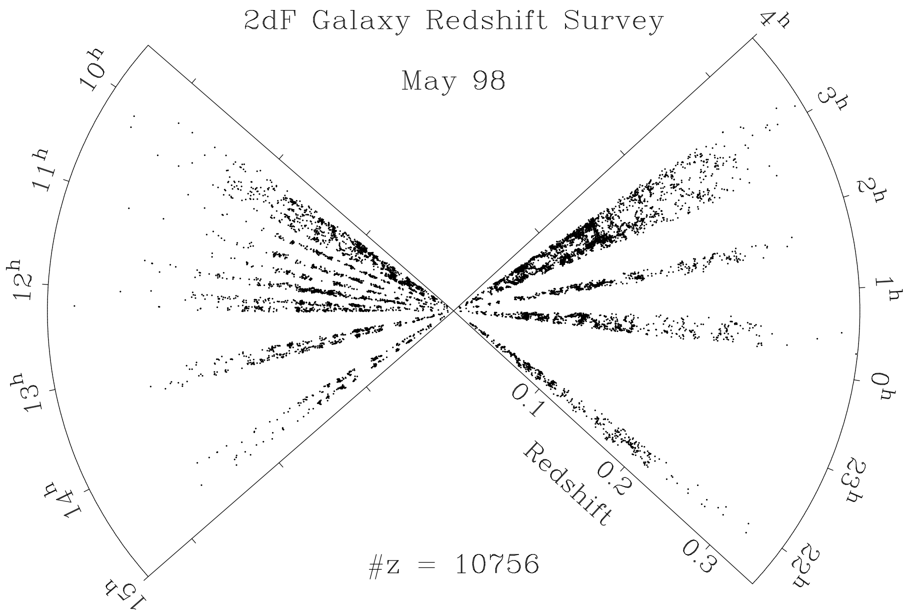

Figure 1: A redshift slice for the galaxies observed to date, combining northern and southern strips and including ∼10000 galaxies (4% of the full sample).

minor improvements to the reductions procedures we should achieve an overall success rate in excess of 95%. We expect to complete the survey before the end of 2000.

At present the survey is still in its infancy, with only 4% of the total number of redshifts measured. Moreover the fields observed so far are scattered over the survey volume, making the analysis of the large-scale structure of the distribution problematic. Nonetheless, the preliminary results presented here do provide some hints of the power and scope of the full survey.

Figure 1 is a cone plot showing the distribution of the 10,000 galaxies observed so far. The mean redshift is 0.11, as expected. Note that fields at all declinations are projected onto this right ascension slice through the galaxy distribution, which combines both the northern and southern strips. Even with the highly incomplete filling of the slice by the fields obtained to date, there are clear glimpses of significant large-scale structures. This figure should be compared to the mock 2dF surveys that have been produced by Cole et al. (1998) using on N-body simulations and various recipes for galaxy biasing.

A preliminary measurement of the redshift-space distortion of the distribution is illustrated in Figure **??**, which shows $\xi_s(\sigma,\pi)$, the correlation function in redshift-space as a function of separation in the plane of the sky (σ) and along the line-of-sight (π). At small separations we see that the correlation function is flattened along the line of sight due to the finger-of-god effect. At

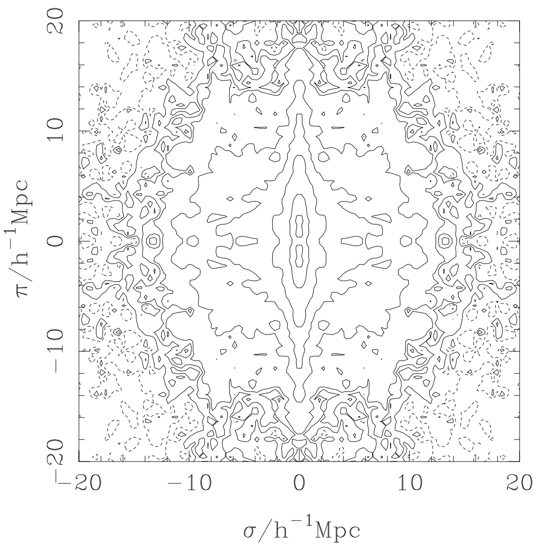

Figure 2: The correlation function in redshift space ($\xi_s(\sigma,\pi)$) as a function of separation in the plane of the sky (σ) and along the line-of-sight (π). The spatial resolution of this contour plot is $0.5\,h^{-1}$ Mpc, and the contours are -0.1, 0, 0.1, 0.2, 0.5, 1, 2, 5, 10, 30 and 50.

sufficiently large separations (i.e. in the linear regime) we expect a flattening in the plane of the sky that depends on $\beta = \Omega^{0.6}/b$, although the preliminary determination of $\xi_s(\sigma,\pi)$ presented here is too noisy on large scales to permit an estimate of β. We can project $\xi_s(\sigma,\pi)$ in the plane of the sky (i.e. onto the σ axis) to obtain the projected real-space correlation function $\Xi(r)/r$, which for $r{<}10\,\mathrm{h}^{-1}$ Mpc is in excellent agreement with the prediction by Baugh and Efstathiou (1993) from the deprojection of the angular correlation function for the full APM galaxy survey. On larger scales $\Xi(r)/r$ is as yet poorly determined due to the small number of fields and their irregular geometry.

Although so far we have observed too few fields to effectively address questions of large-scale structure, we do have a sufficiently large sample of redshifts to begin to look at the properties of local galaxies. Figure 3 shows the galaxy luminosity function for the entire sample. This preliminary determination uses a single global K-correction and is normalized by the number counts from the APM input catalogue, so that the both the shape and normalization may change in the final analysis. Note however that we are achieving a good determination of the luminosity function 5 magnitudes below L^* even with this small subset of the full survey. The LF is generally well represented by a Schechter function with $M^* \approx -19.5$, $\alpha \approx -1.1$ and $\phi^* \approx 0.02$.

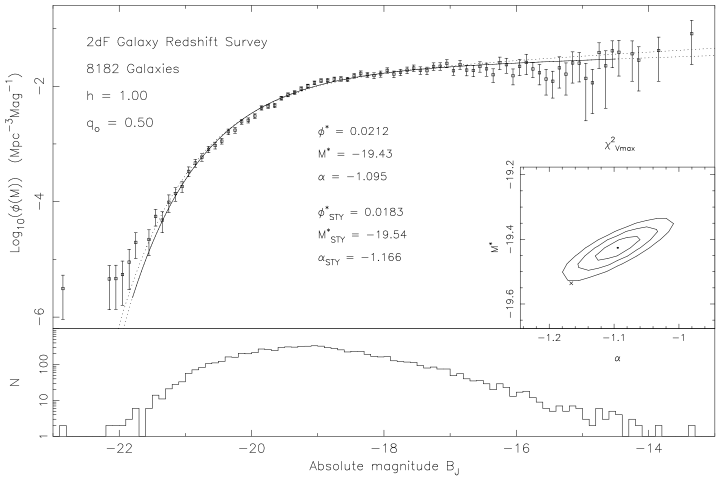

Figure 3: A preliminary galaxy luminosity function from the 2dF survey using mean K-corrections and normalised to the APM number counts. The points are the $1/V_{max}$ LF, the solid curve is the χ^2 fit of a Schechter function to the points and the dotted curve is the STY fit of a Schechter function. The parameters of these fits are given on the figure. The inset shows the 1, 2 and 3-σ contours of the χ^2 fit in M^* and α; the cross marks the STY fit.

Further information on the 2dF galaxy redshift survey can be found in Colless (1998), Maddox (1998) and Colless & Boyle (1998), and on the WWW at `http://msowww.anu.edu.au/~colless/2dF/`.

Acknowledgements. *This paper presented on behalf of the 2dF Galaxy Redshift Survey Team:* Matthew Colless (MSSSO), Richard Ellis (IoA), Joss Bland-Hawthorn (AAO), Russell Cannon (AAO), Shaun Cole (Durham), Chris Collins (LJMU), Warrick Couch (UNSW), Gavin Dalton (Oxford), Simon Driver (UNSW), George Efstathiou (IoA), Simon Folkes (IoA), Carlos Frenk (Durham), Karl Glazebrook (AAO), Nick Kaiser (IfA), Ofer Lahav (IoA), Ian Lewis (AAO), Stuart Lumsden (AAO), Steve Maddox (IoA), John Peacock (ROE), Bruce Peterson (MSSSO), Ian Price (MSSSO), Will Sutherland (Oxford), Keith Taylor (AAO)

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