END OF AN ERA: THE 6DF GALAXY SURVEY TAKES ITS FINAL SPECTRUM

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Observing for the 6dF Galaxy Survey (6dFGS) finished on the 5th of January this year after nearly five years of collecting spectra on the UK Schmidt Telescope. This ambitious programme seeks the redshifts of 150000 southern galaxies and the peculiar motions for around 10000 of the brightest. Being a public survey, the redshift and spectral data for some 90000 sources have been made available in prior data releases in 2002, 2004 and 2005. Accessing the data is possible through an online database maintained by the Wide Field Astronomy group at the Royal Observatory Edinburgh (http://www-wfau.roe.ac.uk/6dFGS/). The final instalment of data will be released later in 2006.

The key science drivers for 6dFGS seek the total stellar mass of the local universe and its relationship to environment and bulk flow motions. To this end, the main survey targets were selected from the Two Micron All Sky Survey (2MASS). Such near-infrared selection not only furnishes a source list of the most evolved stellar populations, but also provides a direct link to the luminous mass of the system as contained in stars. This single feature is what sets 6dFGS apart from its optically selected counterparts such as the SDSS and 2dFGRS.

Meeting the survey goals has been a challenge for the 6dFGS, but it has been in the fortunate position of capitalising on lessons learned from forerunners such as the FLAIR and 2dF surveys. Instrument design, survey strategy and software are just some of the areas in which the 6dFGS has benefited in this way.

The Final Data Release for 6dFGS will necessarily be more comprehensive than all its predecessors. Being the last time we update the database, several months of exhaustive scrutiny of the dataset will need to take place. Manual examination of questionable redshifts, application of zero-velocity template shifts as well as heliocentric corrections, and manual cross-checking of associated field book-keeping are just some of the tasks that will be undertaken during this time. For the online database itself, there are plans to broaden its content as well as provide additional links to supplementary information about certain fields and the data they contain.

Recent work by Tom Jarrett (IPAC/Caltech) has examined the issue of fibre cross talk, a difficult but (thankfully) rare occurrence in 6dFGS data. Astigmatism

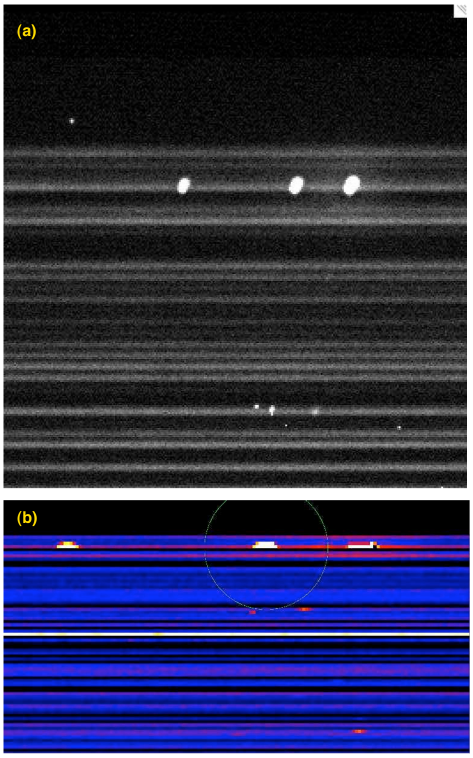

Figure 1. (a) Close-up view of a portion of unreduced spectra showing [O III] and Hα features in a bright emission-line source at z=0.00247. Astigmatism at the field edge causes the lines to de-focus slightly. (b) Same spectra, now reduced, showing how the spread of light has produced false emission-lines in the adjacent spectrum above the emission-line source.

towards the edges of the 6dF spectrograph means that strong emission-lines can spread and contaminate adjacent spectra if sufficiently bright (Figure 1). As a consequence, neighbouring spectra gain additional emission-line-like features that in some cases can confuse redshift identification. Tom has software tools to identify instances of this, which we will use to flag potentially affected spectra in the database.

Figure 2 shows the map of 6dFGS field coverage as it stands at the end of the survey. It shows how the survey has essentially covered the entire southern sky. The original survey target was the completion of all 1595 fields by the end of July 2005. However, a slightly higher than expected fibre breakage rate meant that the average number of useful fibres turned out closer to 100 than the 120 originally expected per field. Consequently, by mid-2005 the survey was 155 fields short of complete coverage, with many of these spring and summer fields around 02 to 06 hrs in RA. Negotiations with the RAVE Project underway on the UK Schmidt Telescope led to the acquisition of 49 nights after July 2005 by way of *swap and purchase* so that 6dFGS could meet its goals.

Alas, Mother Nature was not kind to 6dFGS during the spring of 2005, and cloudy skies wiped many of the

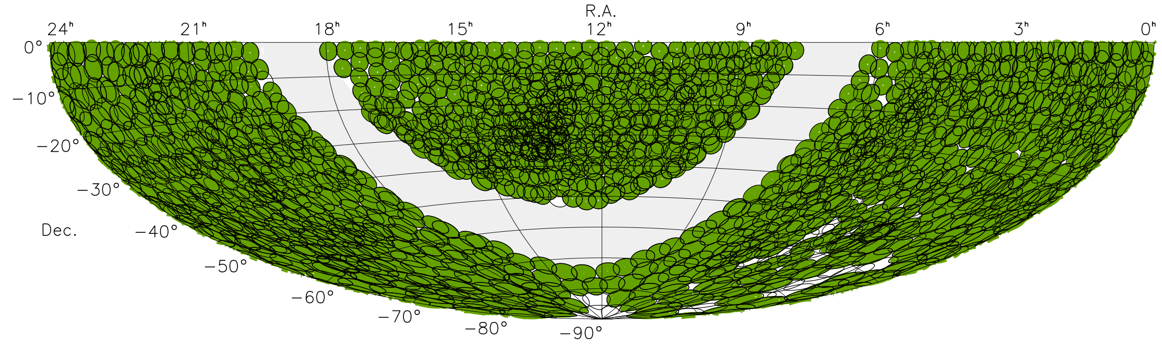

Figure 2. Equal area Aitoff projection of 6dFGS field coverage. Open circles denote all fields on the target list and filled circles denote those comprising the survey.

October and November 6dFGS nights out. What remains, as Fig 2 shows, is virtually full coverage except for some areas around the LMC and the pole. The central band is the Zone of Avoidance which 6dFGS did not attempt to cover. The final number of fields observed was 1539, or 96.5% of the total. The actual fraction of the survey sky area covered is higher, since many of the unobserved fields overlap with observed fields.

The paper that accompanied the First Data Release (Jones et al. 2004) describes the main attributes of the 6dF Galaxy Survey, including the instrument, target selection and redshifting procedures. A comprehensive introduction to the online database is also given. The Second Data Release paper (Jones et al. 2005) summarises the main features of this second public release and discusses limitations that current users of the data should be mindful of. A final data paper will coincide with the Final Data Release and will characterise the survey in its finished state, as well as provide luminosity functions and densities.

Figure 3 shows the K and b_J luminosity functions from Jones et al. (2006), from a larger set covering $KHJb_Jr_F$. Luminosity function fits from a number of recent surveys are also shown for comparison. By this juncture in the survey, a little more than half the redshifts were in hand. The luminosity functions shown here improve on previous 6dF measurements in a number of ways. First, the sample sizes are much larger than before □the *K*-band survey alone totals some 60000 galaxies. Second, the magnitudes used in *K* have been updated with the latest 2MASS total magnitudes, and no longer rely on our original total magnitudes, which were inferred from a combination surface brightness and isophotal magnitude (see Jones et al. 2004). Furthermore, the b_Jr_F magnitudes are the re-calibrated SuperCOSMOS magnitudes from which plate-to-plate zero-point variation has been removed (see Jones et al. 2005). Third, we have made field flow corrections to our line-of-sight velocities using software by J. P. Huchra, thereby removing the peculiar velocity component of each galaxy.

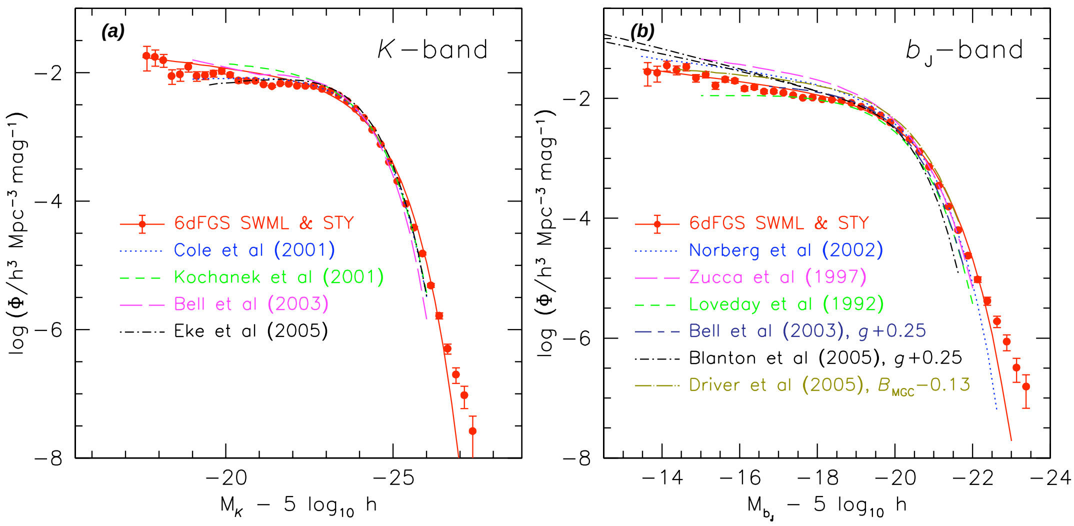

Figure 3. Luminosity functions in *K* and b_J from the 6dFGS. Those from other recent surveys are also shown. Magnitude offsets for different passbands (where required) have been indicated in the key.

Finally, the Schechter fit has been convolved with the magnitude error distribution in each passband.

Of particular interest in Figure 3 is the upturn in galaxy numbers at the bright-end, an effect that has been noted by several authors previously. This excess of luminous objects is due to the brightest cluster galaxies, which are produced by the special merger and accretion processes that come into effect in the high-density regime at the centre of cluster gravitational potentials. We examined the galaxies responsible for this upturn in some detail, to confirm that the effect was real and not some measurement artifact. Figure 4 shows example spectra from this luminous subset alongside 2MASS and SuperCOSMOS images. The imaging reveals that there are a number of close galaxy pairs in this sample. While they are not close enough to have inflated magnitudes due to image blending — 2MASS can individually identify sources 5 arcsec apart — it supports the idea that many of these galaxies inhabit dense environments.

Figure 5 shows the luminosity density — a sort of volume-averaged spectral energy distribution (SED), obtained by integrating over all five 6dFGS luminosity functions. The 6dFGS values agree with most estimates, finding a *K*-band value at the lower end of recent results for this band. This is also the expectation of the SED for a 12 Gyr-old stellar population with a 4 Gyr *e*-folding exponentially decreasing star formation rate (dashed line, after Bell et al. 2003). Models with more rapidly declining star formation rates (say 2 Gyr) can produce SEDs more luminous in *K*, but at the expense of overestimating optical luminosities by factors of two or more.

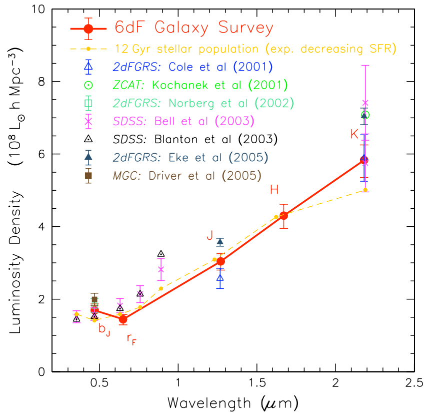

Figure 5. Integrated luminosity density for 6dFGS across $b_J r_F JHK$. Comparative values from other recent surveys are also shown. We have also reproduced the spectral energy distribution for a 12 Gyr-old stellar population from Bell et al. (2003). Details in the text.

With the final 6dFGS photon captured, we celebrate the closing of another chapter in the illustrious history of the UK Schmidt Telescope. We are grateful for the talent and hard work of all Schmidt observers — past and present — whose contributions to the 6dFGS have helped in no small part to shape it into the excellent dataset it has become. Our sincere thanks are extended to Donna Burton, Paul Cass, Kristin Fiegert, Malcolm Hartley, Dionne James, Ken Russell, Fred Watson and the late John Dawe. The legacy of the 6dFGS will be the public availability of these data to general users, until such time as a more sensitive survey with equivalent full-sky coverage pushes south of the equator.

More information on the 6dF Galaxy Survey can be found at our web site: http://www.aao.gov.au/local/www/6df/ .

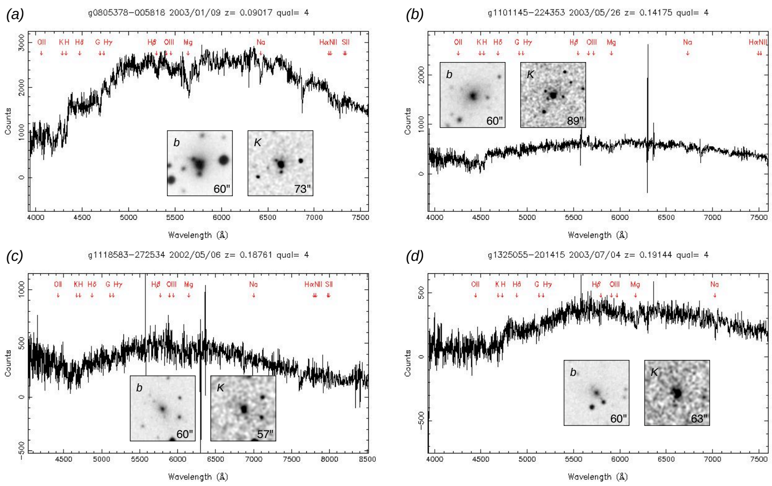

Figure 4. Example spectra of the most luminous contributors to 6dFGS. Images from 2MASS (*K*-band) and SuperCOSMOS (b_J-band) are also shown. In these, north is up, east is left, and the field size in arcsec indicated in each corner.

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