The UKIDSS Ultradeep Survey – Mapping the Early Stages of Galaxy Formation

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Abstract. The UKIRT Infrared Deep Sky Survey (UKIDSS) is scheduled to commence in mid 2004, using the new Wide-Field Camera (WFCAM) to carry out a major series of long-term public surveys. Data will become public to the entire ESO community immediately. In this paper I briefly describe the camera and the UKIDSS survey plans, highlighting the Ultra-Deep Survey in particular which plans to reach depths of K=23, H=24 and J=25 over an unprecedented 0.8 deg^2 region. This will map an enormous volume of the high-redshift Universe, providing the first detailed picture of large scale structure at $z \sim 3$.

1 The UKIRT Wide-Field Camera

WFCAM is a cryogenic near-infrared camera currently under construction at the UK Astronomy Technology Centre (ATC) in Edinburgh. The focal plane will hold four 2048×2048 Rockwell HgCdTe arrays, spaced at 90% detector width. Using a 0.4 arcsec pixel size the instantaneous field-of-view is 0.2 square degrees, allowing a 0.8 square degree region to be tiled seamlessly in four pointings. A purpose-built f/9 secondary is combined with the existing tip-tilt hexapod to provide optimal image quality. The optical (instrumental) image quality is < 0.26 arcsec rms. To improve image sampling, and mitigate the effects of the large pixels, a 2×2 microstepping technique will be adopted as standard.

The large WFCAM focal plane has been achieved using a new forward-Cassegrain quasi-Schmidt design, which allows a high-degree of off-axis correction. This design also employs a cold-pupil stop for maximum K-band sensitivity. The instrument is due to be commissioned in the Spring of 2004. Further information on the camera and its progress towards completion can be obtained from the project website at http://www.roe.ac.uk/atc/projects/wfcam/.

2 The UKIDSS Surveys

Once commissioned, approximately 50% of all time on UKIRT will be dedicated to carrying out a major series of public surveys. These five surveys explore both low and high galactic latitudes to a variety of depths and will require 7 years to complete. The UKIRT board have approved this programme on a 2-year rolling basis. Originally a UK project, the raw and processed data will now be made available to the entire ESO community. The scope of these surveys is briefly outlined below, with further details in Table 1.

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Table 1. Details of the five elements of UKIDSS. The quoted depths are total magnitude 5σ for a point source. The estimated number of nights for each survey includes an allowance for poor weather.

Survey	Filter	Area sq. degs	Mag. limit (Vega)	Nights
	Y		20.5	
Large Area Survey	J	4000	20.0	262
LAS	H		18.8	
	K		18.4	
	J		20.0	
Galactic Plane Survey	H	1800	19.1	186
GPS	K		19.0	
	H_2	300	...	
	J		19.7	
Galactic Clusters Survey	H	1600	18.8	84
GCS	K		18.7	
	J	35	22.5	
Deep Extragalactic Survey	H	5	22.0	118
DXS	K	35	21.0	
	J		25.0	
Ultra Deep Survey	H	0.77	24.0	296
UDS	K		23.0	

The Large Area Survey (LAS) aims to cover 4000 square degrees to a depth which will match the Sloan Digital Sky Survey (SDSS), reaching a depth of K=18.4 and matching depths in J, K and Y-bands. This combination of area, depth and multi-filter coverage make it a powerful tool for determining statistics on common objects (stars, galaxies, clusters of galaxies) and isolating extreme objects (low mass dwarfs and high redshift quasars). Multiple epoch observations in the J-band will allow proper motions to be determined. In addition we will use a new "Y" filter (Hillenbrand et al. 2002), covering 0.97 to 1.07 microns. This is specifically designed to detect extremely high redshift ($z = 7$) quasars, and to distinguish them from low mass L,M,T dwarfs.

The Galactic Plane Survey (GPS) will map a large fraction (1800 square degrees) of the galaxy, surveying a strip $\pm$ 5 degrees above and below the galactic plane along a length of 180 degrees. This will allow star formation regions to be mapped throughout the Milky Way and provide an order of magnitude increase in the known number of Young Stellar Objects (YSOs). We expect to map 10^{8-9} stars in total.

The Galactic Cluster Survey (GCS) aims to measure the sub-stellar mass function in approximately 10 galactic clusters, covering a total of 1400 square degrees. The mass limit reached is typically around 30 Jupiter masses. The aim is to determine the fundamental initial mass function (IMF) for stars as a function of environment and age.