Multiwavelength Surveys within the DEEP Fields

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Abstract. DEEP has launched DEEP2, a major new Keck spectroscopic survey of 50,000 galaxies at redshift $z \sim 1$ using a new spectrograph (DEIMOS). We give an overview of the project's science goals and why DEEP2 is especially attractive to support complementary coverage by a suite of faint multiwavelength imaging surveys. We highlight one such effort already underway in the DEEP2 field called the Extended Groth Strip - (EGS).

1 What is DEEP, DEEP1, DEEP2, & DEIMOS ?

DEEP (Deep Extragalactic Evolutionary Probe) was initiated over 10 years ago to use the Keck 10 m Telescopes for a major spectral survey of faint field galaxies. The use of DEIMOS (DEep Imaging Multi-Object Spectrograph) divides DEEP into two phases (see Table 1). The first (DEEP1) is comprised of a suite of pilot surveys using pre-DEIMOS spectrographs on Keck. DEEP1 was designed to establish the technical feasibility and scientific scope of the second phase (DEEP2) that does use DEIMOS.

DEEP2 is distinguished from prior redshift surveys, including DEEP1, by its large sample of 50,000 galaxies to $R_{AB} \sim 24$. The survey uses BRI two-color diagrams to preselect galaxies near $z \sim 1$ for three of its four fields. The exception is the EGS (see below). A competitive survey currently underway is the VMOS-VLT Deep Survey (see Le Fèvre in these proceedings).

DEEP2 is also distinguished by using spectral resolution high enough to yield rotation curves and linewidths. Such internal kinematics of galaxies provide a powerful new dimension related to masses of galaxies. Such masses are intimately tied to the dark matter halo masses which in turn are the fundamental components best modeled by theoretical simulations of galaxy formation.

The key to DEEP2's success is DEIMOS. This spectrograph allows about 120 targets per mask and uses a huge (8K x 8K) red sensitive CCD mosaic. Together with other design advances, DEIMOS achieves roughly a 7 fold increase in efficiency compared to LRIS. The reader can check papers [2] and [3] for more details on the reduction of data from and performance of DEIMOS, as well as to URL: http://www.ucolick.org/ ∼loen/Deimos/deimos.html. For more information about the DEEP, DEEP1, and DEEP2 projects, the reader is referred to URL: http://deep.ucolick.org/ and http://deep.berkeley.edu.

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Table 1. DEEP Survey Characteristics

-	DEEP1	DEEP2
Telescopes	Keck I & II; HST	Keck I & II
Instruments [a]	LRIS, ESI, HIRES, NIRSPEC	DEIMOS, LRIS-B
Survey Period	1995-2001 (30 Nights)	2002-2005 (120 Nights)
Fields [b] (FOV)	HDF-N & FF ($8' \times 8'$)	0230+00 ($30' \times 120'$)
-	GSS 1417+52 ($4' \times 42'$)	1417+52 ($16' \times 120'$) EGS
-	SA68 0017+15 (five $4' \times 7'$)	1652+35 ($30' \times 120'$)
-	-	2330+00 ($30' \times 120'$)
-	-	GOODS-N & S
No. Galaxies	1000 to $I \sim 23.5$ (1-4h)	1HS: 50,000 to $R_{AB} \sim 24$ (1h)
& Depth (exp)	-	3HS: few 1000 to $I \sim 24$ (3-10h)
Photometry	KPNO ($UBRI$); HST(VI)	UH (BRI); HST(TBD)
Science	Spheroid/Bulge Evol.	1HS: non-HST DEEP1 Science &
-	Disk Surface Brightness Evol.	Clustering Evol. at z $\sim$ 1
-	Compact & High z Galaxy Evol.	Lum. Funct. (z, color, etc.)
-	Tully Fisher & Fund. Plane Evol.	Volume Test (Dark Energy)
-	Red & Blue Galaxy Evol.	3HS: HST DEEP1 Science &
-	AGN/Variability/Lum. Funct.	"desert $z \sim 1.4 - 2.5$" galx Evol.
-	Star Form. & Metallicity Evol.	Red Galaxy Age & Metallicity
[a] ESI:	Echelle Spectrograph Imager	
LRIS:	Low Resolution Imaging Spectrog.	B - Blue side (UV sensitive)
HIRES:	High Resolution Echelle Spectrog.	
NIRSPEC:	Near Infrared Spectrog.	
DEIMOS:	DEep Imag. Multi-Obj. Spectrog.	
[b] HDF:	Hubble Deep Field;	N-North & FF-Flanking Fields
GOODS:	Great Obs. Origins Deep Surveys	N-North & S-South
GSS & EGS :	Groth Strip Survey	Extended Groth Strip
SA68:	Selected Area 68	-

2 Science Goals

The main theme that arises from our DEEP1 studies is that galaxy evolution is a complicated problem. Distant field galaxies are diverse in size, luminosity, structure; are composed of subcomponents which experience different star formation and dynamical histories and evolution; and reside in a wide range of environments that are likely to engage different physical mechanisms for their evolution. Results from our DEEP1 programs have established that kinematics are feasible with 10 m class telescopes for distant galaxies, and that such information provide new information not possible otherwise to extract from luminosity and colors alone [5].

DEEP2 will be pushing entirely new ground with its much larger sample spread over four fields. We hope to tackle several scientific puzzles in cosmology today: the nature of dark matter; the nature of dark energy; and the formation