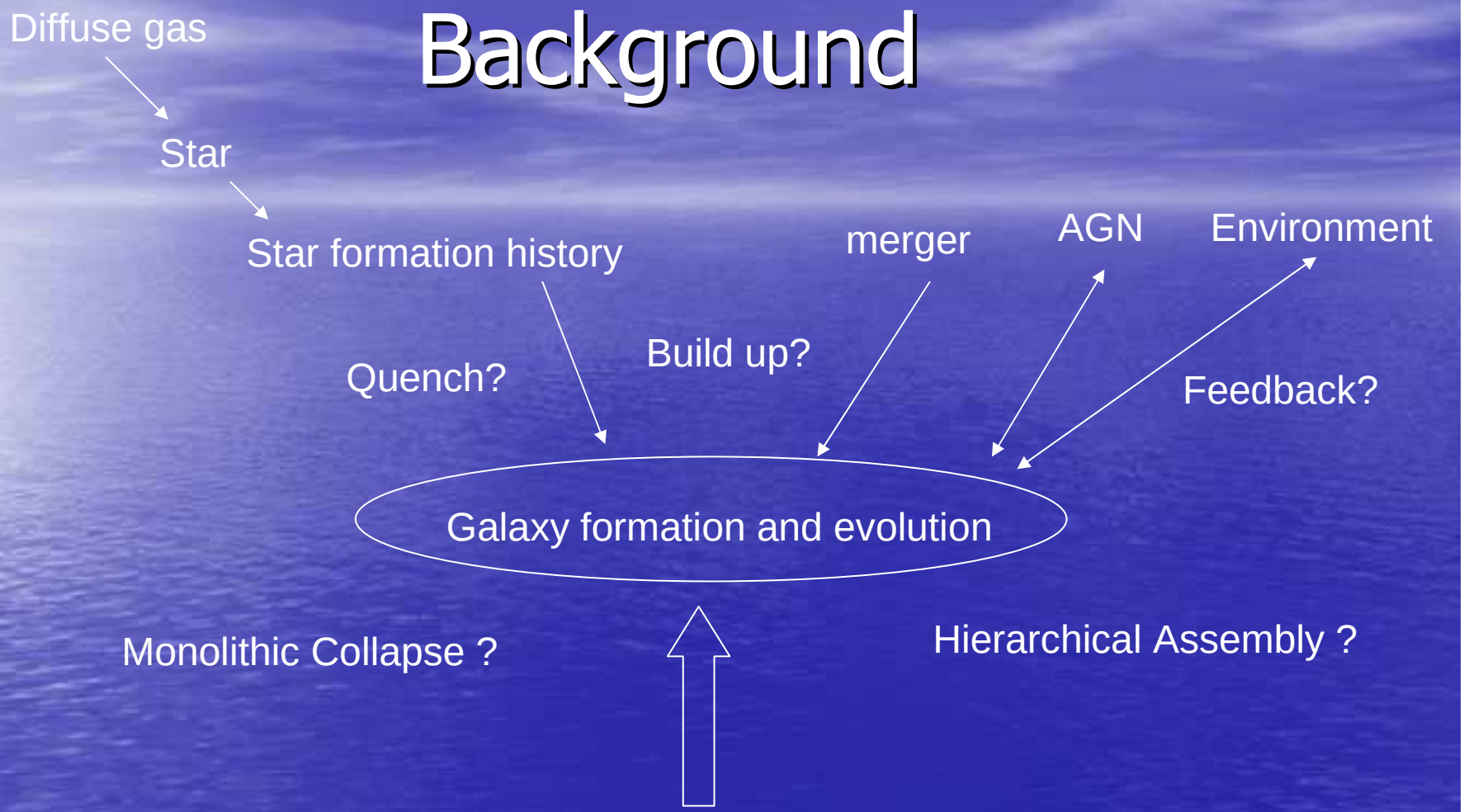
Galactic Mass Assembly from z=0 to z=4

Chih-Chiang Hsieh
Supervisor: Wei-Hao Wang
National Tsing Hua University
ASIAA
TIARA Winter School 2012

Outline

- Background and goal
- Observational data
- Data analysis

Background

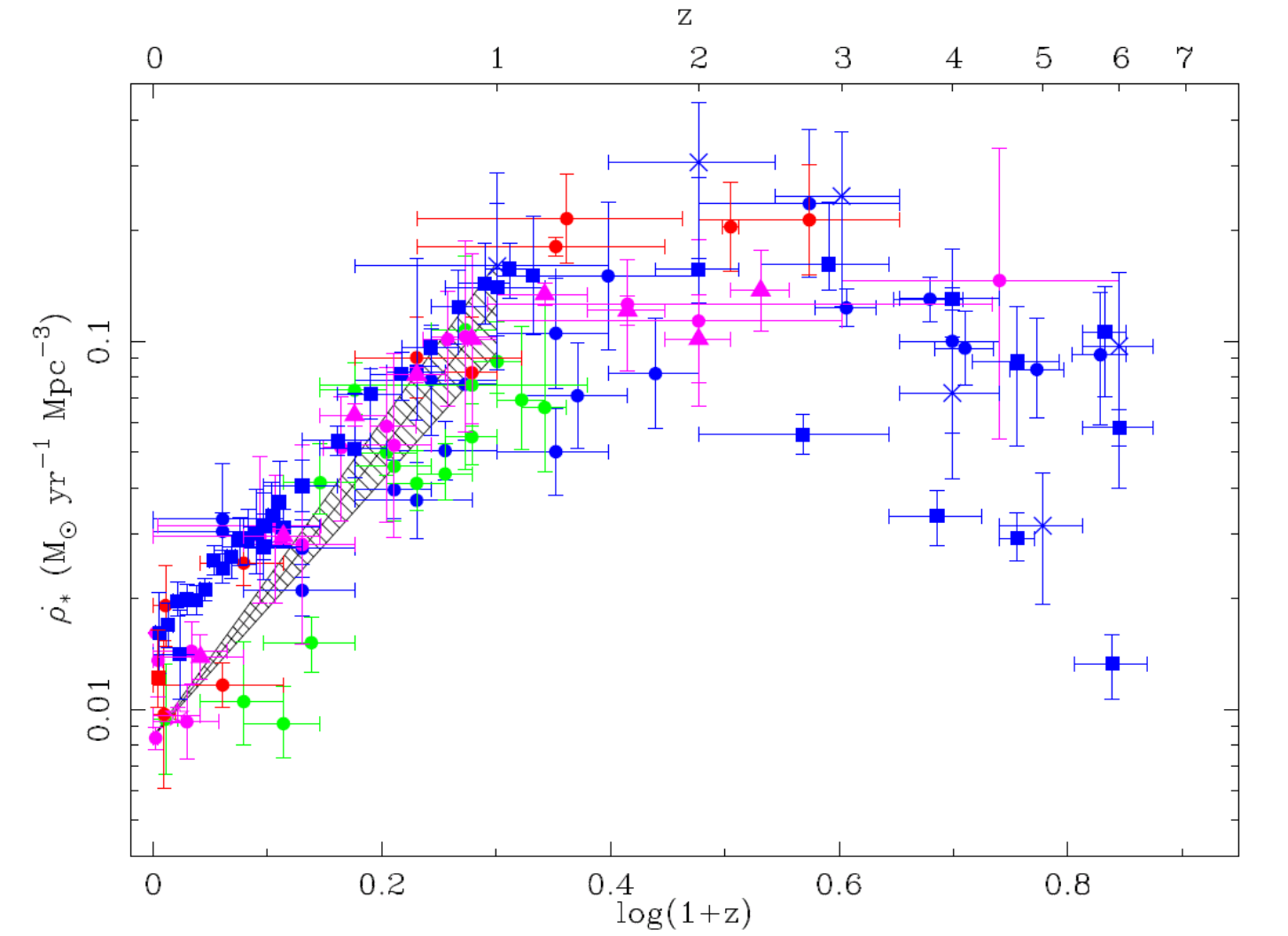


1.Ongoing star formation rate density

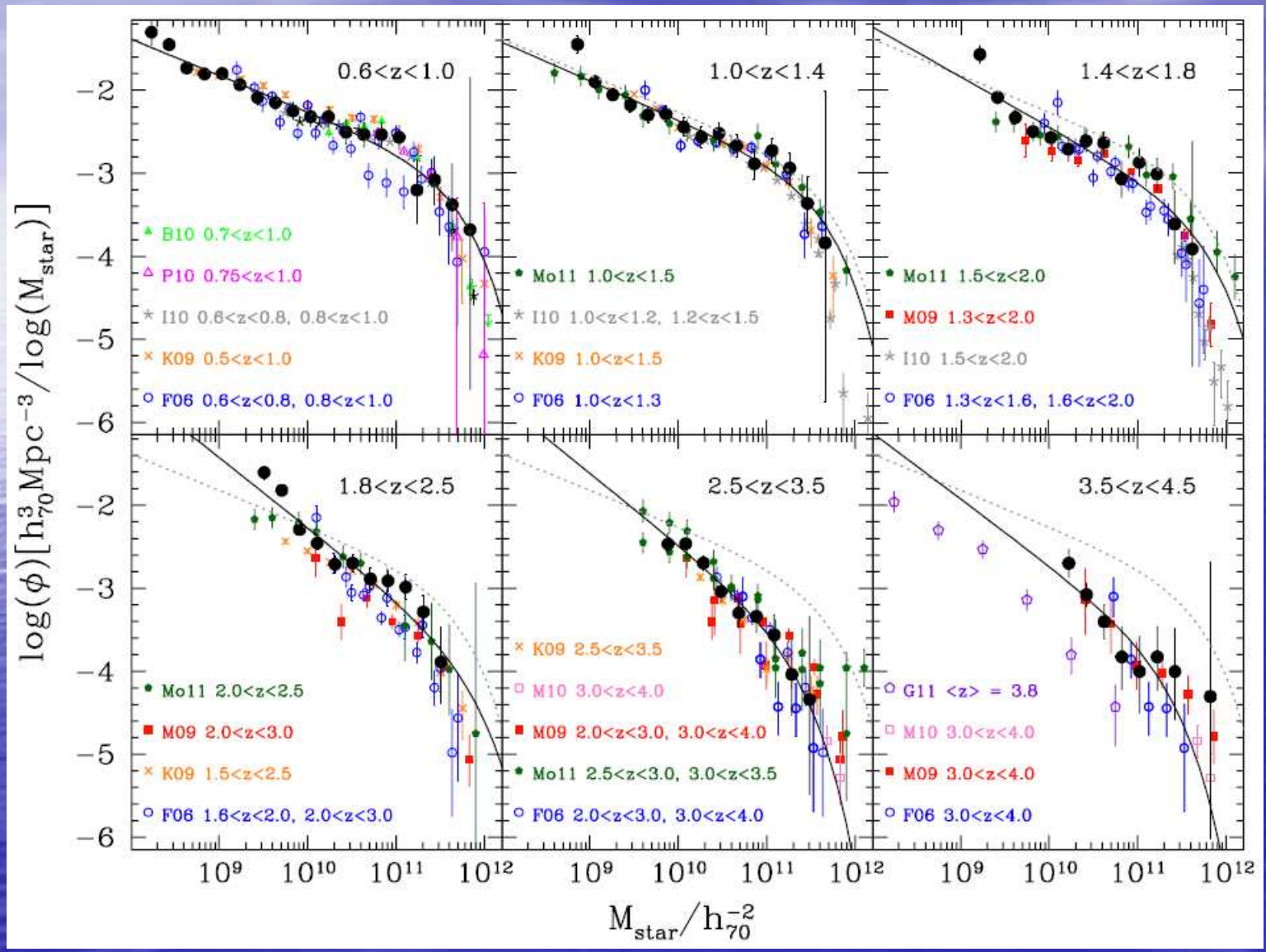
2. Stellar mass function

Ongoing star formation rate density

(Lilly-Madau plot)



Stellar mass function

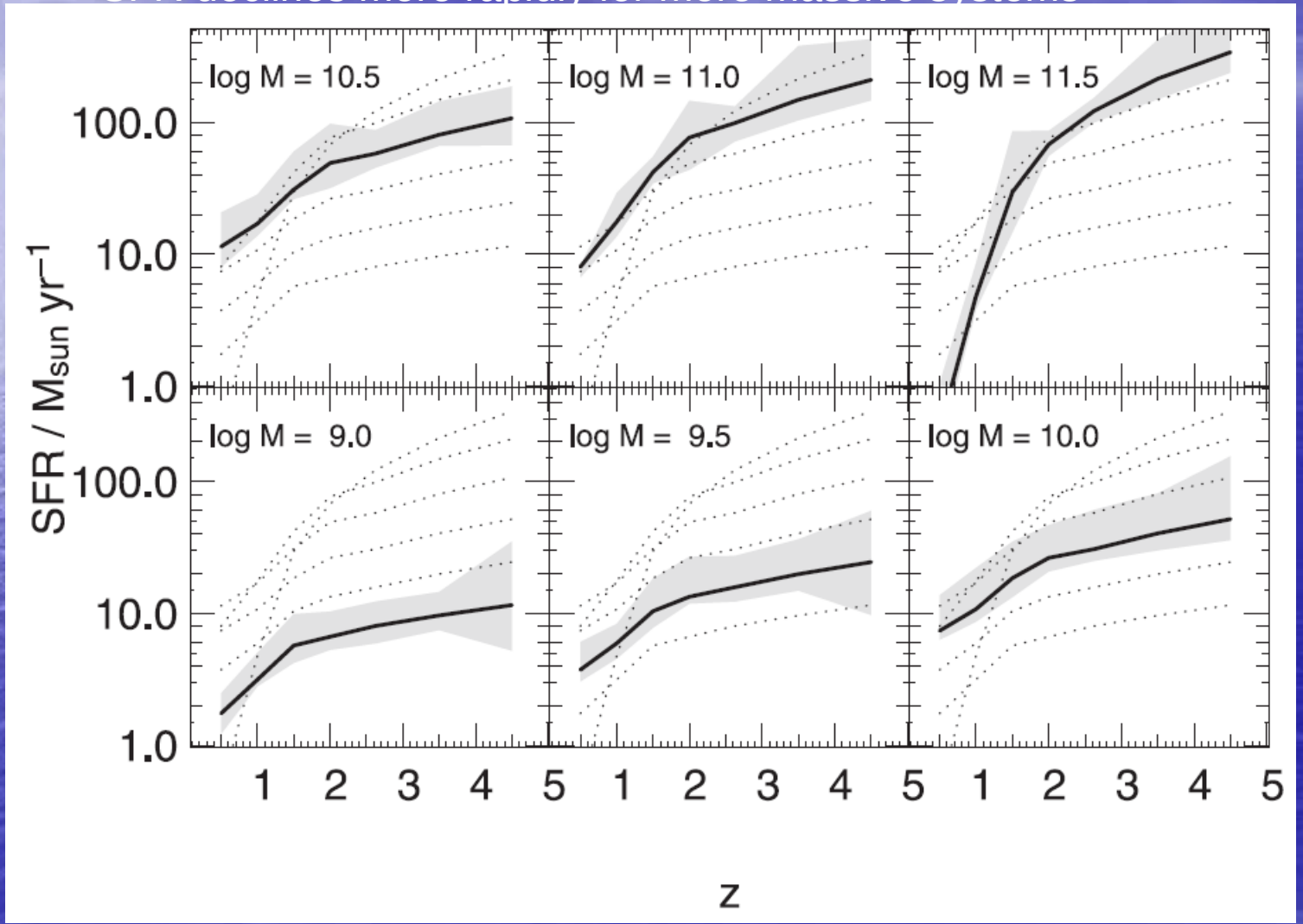


(F06): Fontana et al. (2006)
(B10): Bolzonella et al. (2010)
(P10): Pozzetti et al. (2010)
(I10): Ilbert et al. (2010)
(K09): Kajisawa et al. (2009)
(M09): Marchesini et al. (2009)
(M10): Marchesini et al. (2010)
(Mo11): Mortlock et al. (2011
(G11): González et al. (2011)

Santini et al. 2012

Downsizing—star formation rate

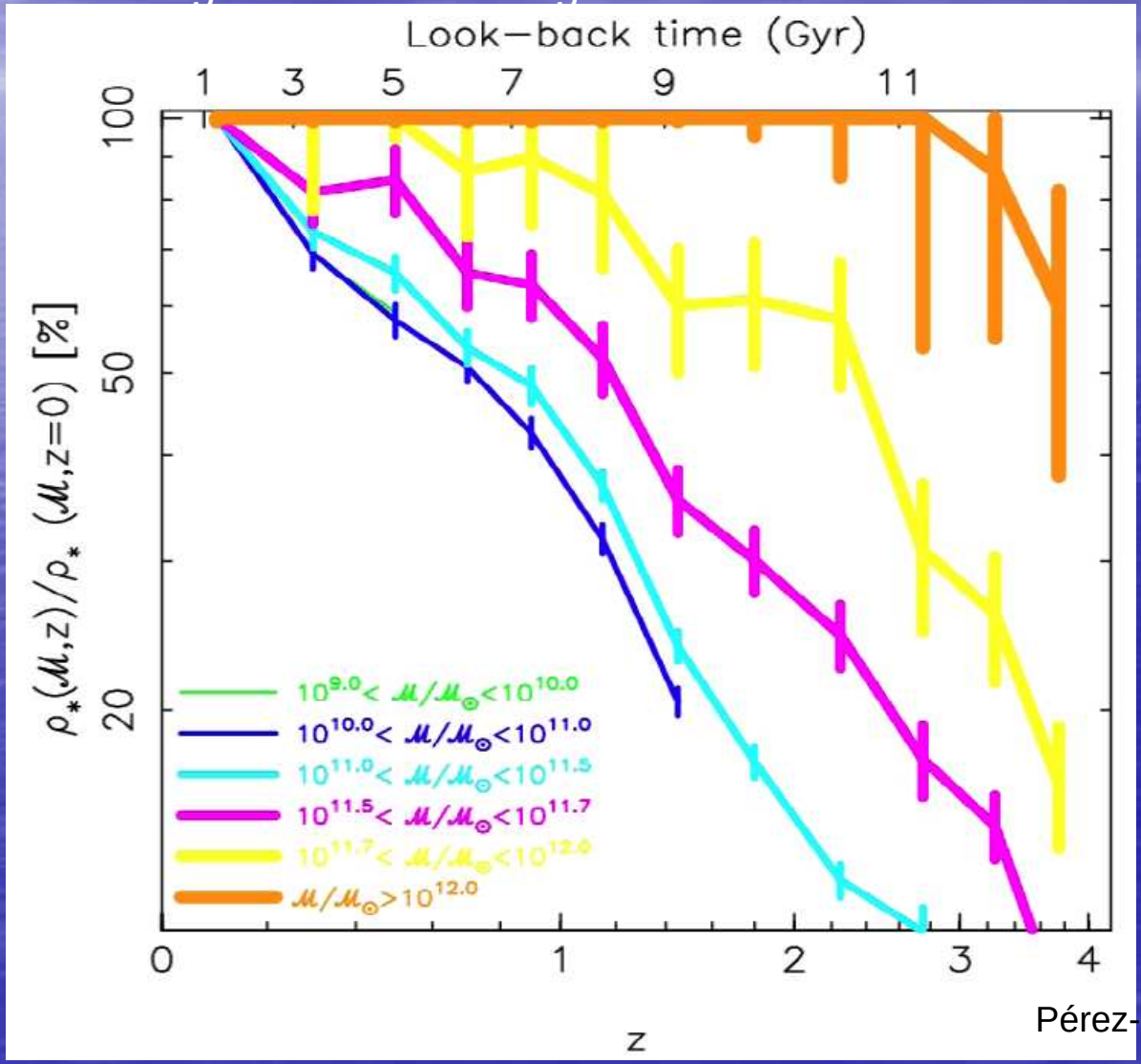
SFR declines more rapidly for more massive systems



Drory & Alvarez 2008

Downsizing—stellar mass

high mass galaxies have completed their mass build up at high redshift, while mass continues to grow in low mass galaxies at lower redshift



Fraction of stellar mass density

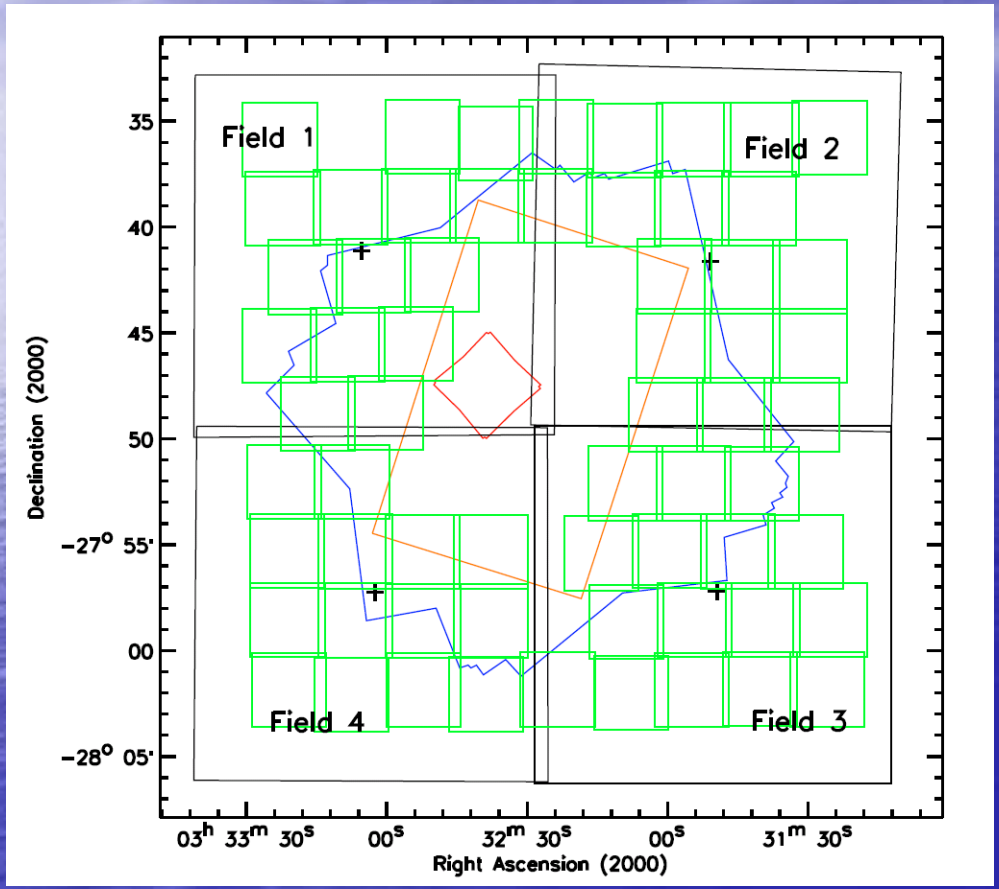
Pérez-González et al. 2008

Observational data

- Field selection
- Deep WIRCam Images—TENIS (Taiwan ECDFS Near-Infraded Survey)
- Multi-wavelength Images
- Available Spectroscopic Redshift

ECDFS

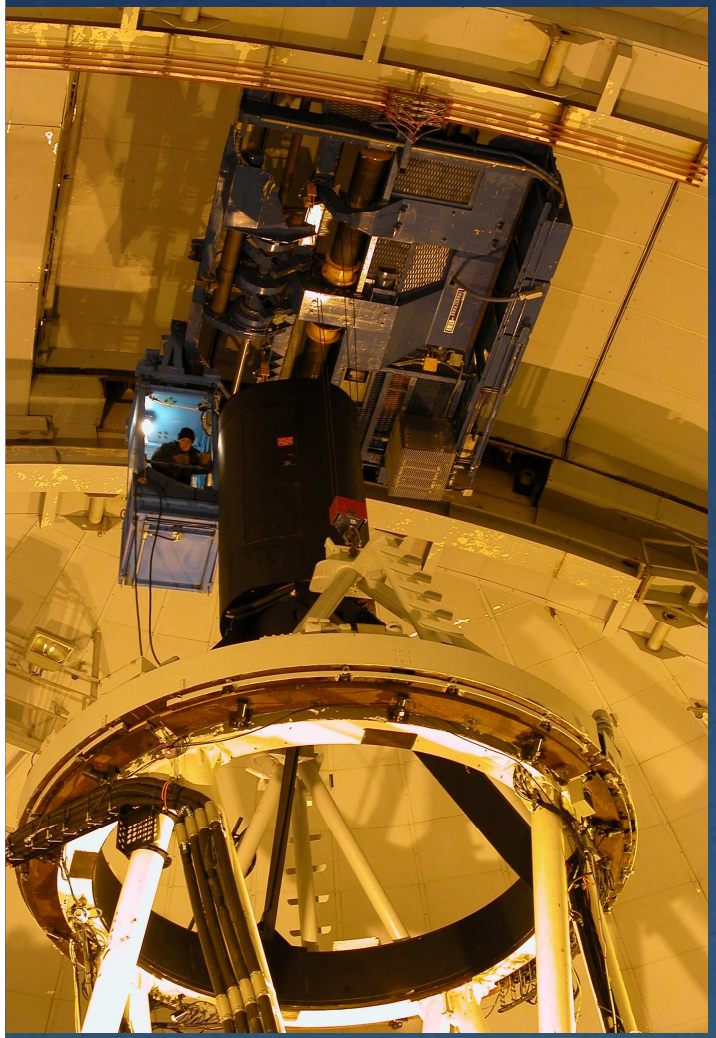
The Extended Chandra Deep Field-South



4 Black square: E-CDF-S
Blue polygon: CDF-S
Green: GEMS
Red square: HUDF
Orange rectangle: GOODS

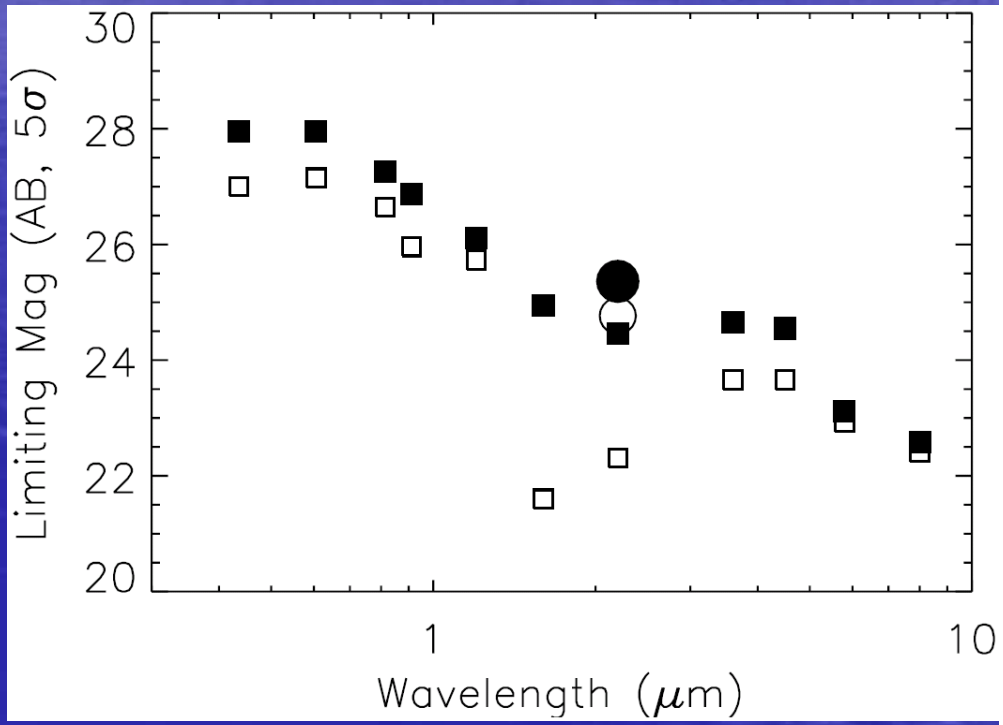
$30' \times 30'$ area

(Lehmer et al. 2005)



Deep WIRCam Images

- WIRCam (Wide-field InfraRed Camera)
- The deep CFHT Ks-band image -- limiting magnitude of 25.4 (AB, 5σ)
- The deep CFHT J-band image -- limiting magnitude is 25.1 (AB, 5σ)



Multi-wavelength Images

SURVEY	BAND	λ_0	Area (")	5 σ Depth(AB)	ref
MUSYC	U	3505 Å	975	26.5	Taylor et al. 2009
	U38	3655 Å	947	26	
	B	4605 Å	1012	26.9	
	V	5383 Å	1022	26.6	
	R	6520 Å	1017	26.3	
	I	8642 Å	977	24.8	
	Z'	9035 Å	996	24.0	
	J	12461 Å	906	23.1	
	H	16534 Å	560	23.1	
	K	21323 Å	906	22.4	
GOODS ISAAC	J	12461 Å	172.5 arcmin^2	25.0	Retzlaff et al. 2010
	H	16534 Å	159.6	24.5	
	Ks	21537 Å	173.1	24.4	
GEMS	F606W(V)	5907 Å	796 arcmin^2	28.25	Rix et al. 2004
	F850LP(Z)	8950 Å		27.10	
SIMPLE	Ch1	3.6 μm	1600 arcmin^2	23.86	Damen et al. 2011
	Ch2	4.5 μm		23.69	
	Ch3	5.8 μm		21.95	
	Ch4	8.0 μm		21.84	
FIDEL		24 μm	GOODS-S: 91	20.21	Magnelli et al. 2009
			ECDFS-O: 517	19.29	
		70 μm	GOODS-S: 91	15.60	
			ECDFS-O: 517	15.24	
BLAST		250 μm	wide: 10 deg^2	36mJy	Chapin et al. 2010
			deep: 0.9 deg^2	11mJy	
		350 μm	wide: 10 deg^2	31mJy	
			deep: 0.9 deg^2	9mJy	
		500 μm	wide: 10 deg^2	20mJy	
			deep: 0.9 deg^2	6mJy	
LESS		870 μm	30' × 30'	1.20mJy rms	WEIß et al. 2009
VLA 1.4 GHz		1.4GHz	34.1'× 34.1'	30 μJy rms	Miller et al. 2008

Medium-band Image Properties

Band (1)	FWHM (″) (2)	5σ depth (AB)[a] (3)	Zero Point (AB) (4)
IA427	1.01	25.01	25.10 ± 0.11
IA445	1.23	25.18	25.07 ± 0.08
IA464	1.79	24.38	25.30 ± 0.03
IA484	0.76	26.22	25.50 ± 0.05
IA505	0.94	25.29	25.34 ± 0.02
IA527	0.83	26.18	25.72 ± 0.03
IA550	1.13	25.45	25.88 ± 0.06
IA574	0.95	25.16	25.71 ± 0.02
IA598	0.63	26.05	26.02 ± 0.03
IA624	0.61	25.91	25.89 ± 0.05
IA651	0.60	26.14	26.15 ± 0.03
IA679	0.80	26.02	26.20 ± 0.03
IA709	1.60	24.52	26.02 ± 0.03
IA738	0.77	25.93	26.02 ± 0.02
IA767	0.70	24.92	26.04 ± 0.02
IA797	0.68	24.69	26.02 ± 0.02
IA827	1.69	23.60	25.92 ± 0.04
IA856	0.67	24.41	25.73 ± 0.01

Cardamone et al. 2010

How good is our K_s image?

	Depth (AB, 5σ)	Area(arcmic^2)
MUSIC	25.25	143.2
MUSYC	22.4	906
Kajisawa et al.(deep)	26.09	28
Kajisawa et al.(wide)	25.09	103
TENIS	25.4	900
Satini et al.	25.5	33

- Our depth = MUSYC $\times$ 16 =MUSIC
  = Kajisawa et al. (deep)$\times$ 0.53
- Our sample size = MUSIC $\times$ 6.3
  = Kajisawa et al.(wide) $\times$ 9

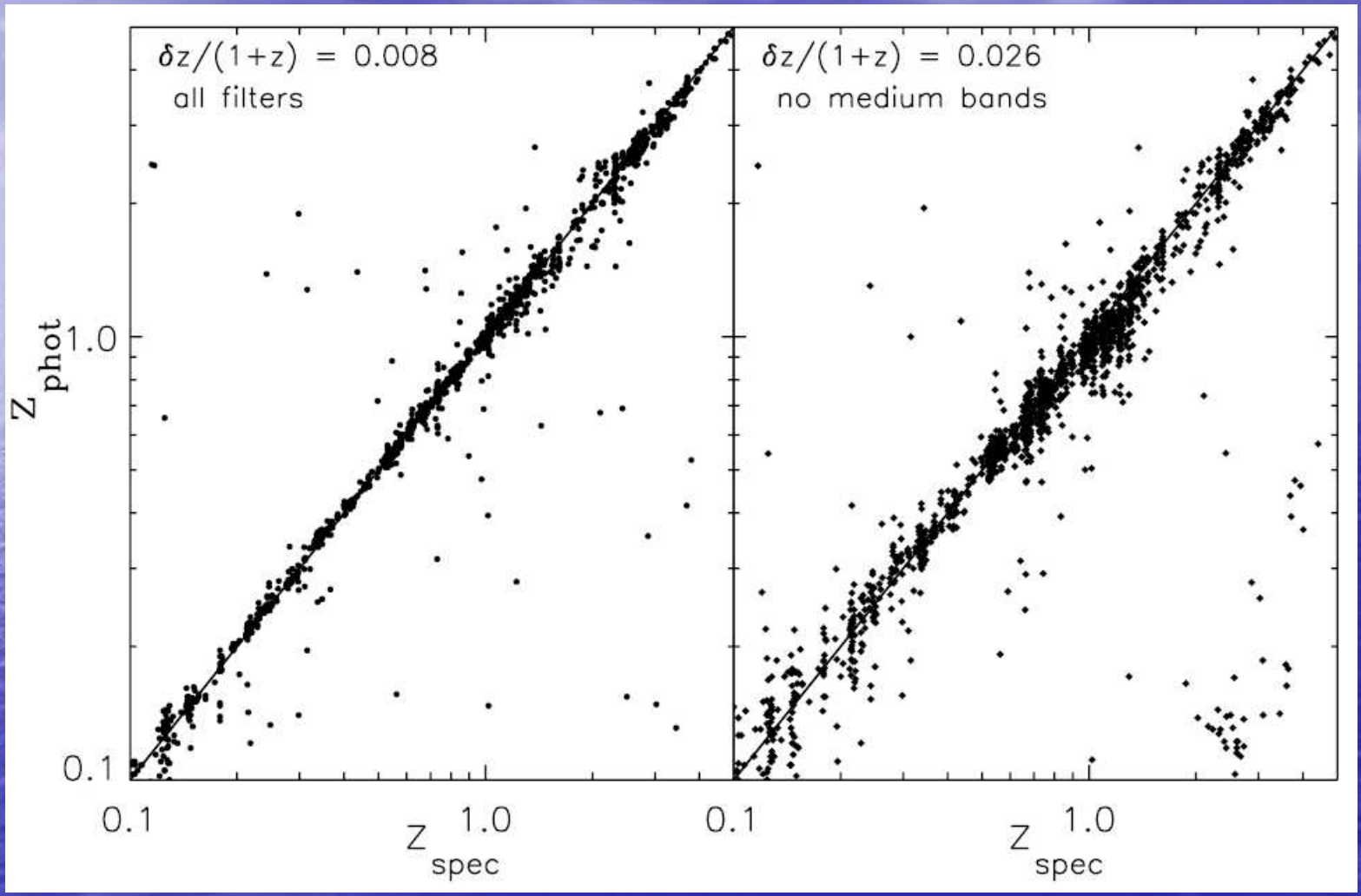
Available Spectroscopic Redshift in CDFS

Summary of the Spectroscopic Redshifts Available for MUSYC ECDFS Detections

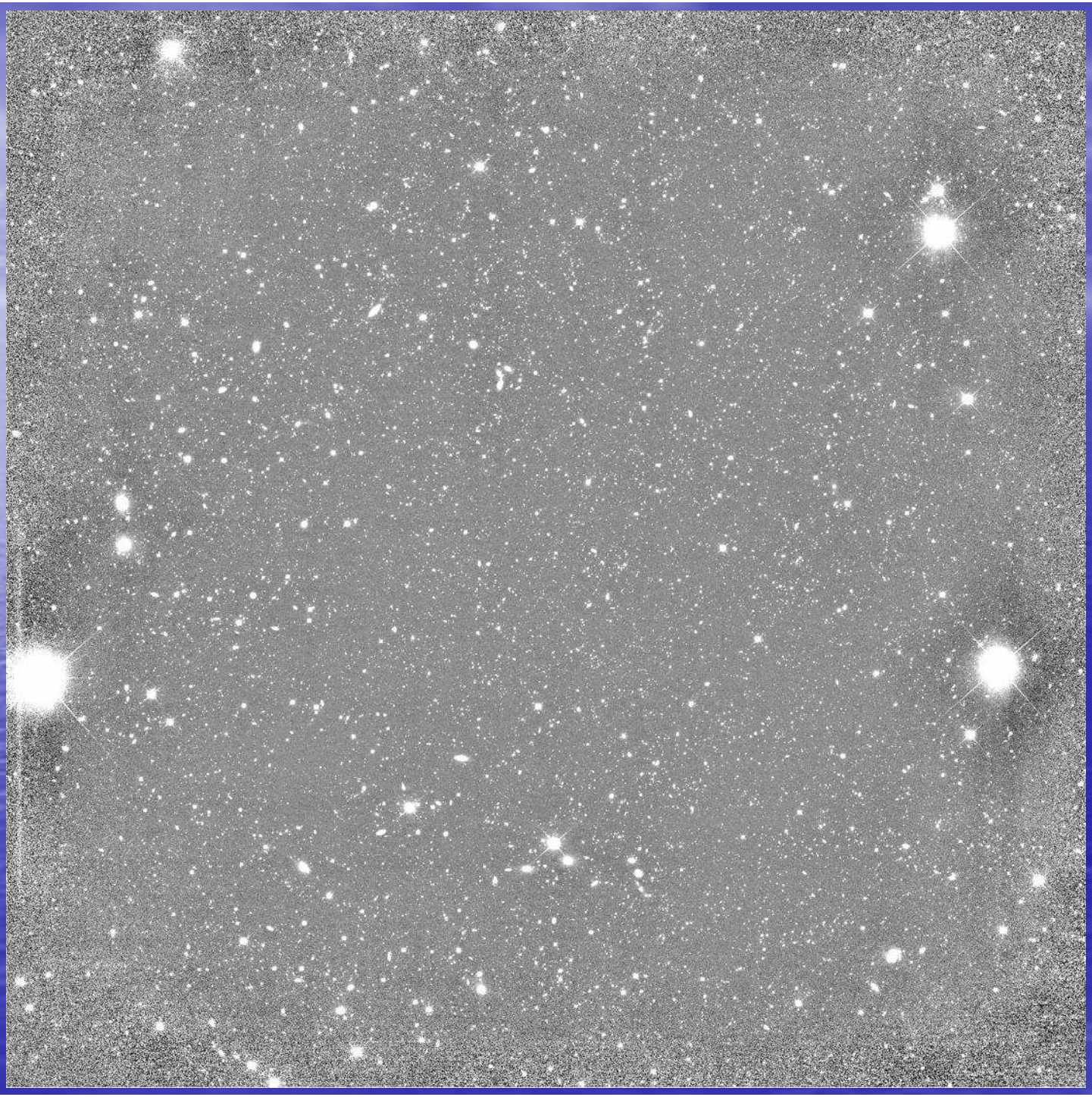
Reference(s) (1)	Source Code (2)	Internal Qual. Flag (3)	No. Galaxies (4)	No. Adopted (5)	Median $\Delta z/(1+z)$ (6)	NMAD $\Delta z/(1+z)$ (7)	Outlier Fraction (8)
Cimatti et al. (2002);	K20	1	267	232	−0.025	0.033	0.047
Mignoli et al. (2005)		0	14	2	−0.012	0.069	0.182
Szokoly et al. (2004)	X-ray	⩾2.0	114	114	−0.024	0.037	0.135
		<2.0	17	4	0.045	0.146	0.133
Le Fèvre et al. (2004)	VVDS	4	172	131	−0.030	0.027	0.027
		3	347	267	−0.030	0.032	0.035
		2	342	19	−0.022	0.058	0.080
		1	82	1	−0.003	0.127	0.017
		9	49	1	0.016	0.199	0.036
Vanzella et al. (2005, 2006, 2007)	GDS-F	A	306	226	−0.023	0.044	0.034
		B	77	14	−0.029	0.080	0.054
		C	52	4	0.025	0.106	0.079
Popesso et al. (2009)	GDS-V	A	289	197	−0.036	0.030	0.048
		B	59	3	−0.026	0.081	0.087
		C	48	1	−0.008	0.144	0.051
Ravikumar et al. (2007)	IMAGES	1	267	219	−0.032	0.030	0.067
		2	168	24	−0.025	0.046	0.056
		3	51	7	−0.012	0.095	0.000
Treister et al. (2009)	MUS-I	N/A	165	120	0.001	0.112	0.125
	MUS-V	N/A	34	33	0.011	0.295	0.000
S. Koposov et al. (2009, in preparation)	Kopsv	N/A	455	283	−0.034	0.025	0.043
Croom et al. (2001)	KX	N/A	17	5	−0.016	0.029	0.353
Strolger et al. (2004)	SNe	N/A	9	2	...	...	...
Van der Wel et al. (2004, 2005)	vdWel	N/A	28	26	−0.007	0.022	0.000
Daddi et al. (2005)	Daddi	N/A	5	5	...	...	...
Doherty et al. (2005)	LCIRS	1–3	14	10	0.003	0.050	0.071
Kriek et al. (2006)	Kriek	N/A	12	12	0.056	0.134	0.000
Total			2863	1966	−0.029	0.036	0.078

(Taylor 2009)

Comparison Comparison of photometric redshift vs. *z*_spec



Cardamone et al. 2010



Data analysis

- **SED Fitting (HYPERZ, EAzY code)**

  photometric SED is fitted by a set of template spectra through χ^2 minimization procedure

- **Stellar mass function**

  Schechter function form:

$$\phi(M) = \phi^* \cdot \log(10) \cdot \left[10^{(M-M^*)}\right]^{(1+\alpha)} \cdot \exp\left[-10^{(M-M^*)}\right]$$

  M* : characteristic mass at which the stellar mass function turns over

  α : slope of the faint end of the stellar mass function,

  ϕ^* : scale factor.


Thank You