THE COSMIC EVOLUTION SURVEY (COSMOS): SUBARU OBSERVATIONS OF THE HST COSMOS FIELD

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ABSTRACT

We present deep optical imaging observations of 2 square degree area, covered by the Cosmic Evolution Survey (COSMOS), made by the prime-focus camera (Supreme-Cam) on the 8.2 m Subaru Telescope. Observations were done in six broadband $[B(4459.7 \AA), g'(4723.1 \AA), V(5483.8 \AA), i''(6213.0 \AA), i'(7640.8 \AA), z''(8855.0 \AA)]$ and one narrowband (NB816) filters. A total of $10^6$ galaxies were detected to $i'' \sim 26.5$ mag. These data, combined with observations at $u'$ and $K$-band are used to construct the photometric catalogs for the COSMOS, to measure their photometric redshifts, multiband spectral energy distributions, and stellar masses, and to identify high-redshift candidates. This catalog provides multi-wave band data for scientific analysis of the COSMOS survey.

Subject headings: galaxies: evolution — galaxies: interactions

1. INTRODUCTION

The Cosmic Evolution Survey (COSMOS) is a treasury program on the Hubble Space Telescope (HST), awarded a total of 640 HST orbits, carried out in two cycles (320 orbits in cycles 12 and 13 each; Scoville et al. 2007a; Koekemoer et al. 2007). COSMOS is a 2 square degree imaging survey of an equatorial field in $g_{\lambda14}$ band, using the Advanced Camera for Surveys (ACS). The HST ACS observations provide high-resolution imaging to map the morphology of galaxies as a function of environment and epoch covering from high redshift ($z \sim 6$) to the nearby ($z \sim 0$) universe. Since substantial large-scale structures (e.g., voids, filaments, groups, and clusters of galaxies) occur on scales up to 100 Mpc in the comoving frame, our 2 square degree COSMOS field can adequately map galaxy evolution over the full range of environments. It is also interesting to note that our survey volume at high redshift is similar to that of the Sloan Digital Sky Survey (York et al. 2000) at low redshift.

Our ACS survey depth, $i_{AB,lim} \sim 27$ AB, allows us to detect the order of $10^6$ sources in the COSMOS area. Therefore, the COSMOS project is fundamental to virtually all areas of galaxy evolution, identification of different classes of objects, evolution of large-scale structures as well as that of dark matter. In particular, the following interesting issues can be covered by our COSMOS project using statistically large samples: (1) the evolution of galaxies, clusters, large-scale structure, and cold dark matter on mass scales up to $>10^{14} M_{\odot}$ as a function of redshift, (2) the formation, assembly, and evolution of galaxies as a function of large-scale structure environment, morphology, and redshift, (3) the cosmic star formation history as a function of large-scale structure environment, morphology, and redshift, and (4) detailed study of the nature, morphology, and clustering properties of different populations of galaxies such as active galactic nuclei
Fig. 1.—Dithering pattern A.
(AGNs), extremely red objects, Ly$\alpha$ emitters (LAEs), Lyman break galaxies (LBGs), and star-forming galaxies, as well as their evolution with redshift.

However, to understand the whole evolution of galaxies, AGNs, and dark matter, it is absolutely necessary to obtain multiwavelength observations with high spatial resolution from X-ray to radio. In particular, we need optical multiband images of the COSMOS field, as we only take $i_{814}$ band data with ACS. Therefore, ground-based optical observations are also an essential part of the COSMOS project. Such data will be helpful in studying stellar contents of one million galaxies at various redshifts and in estimating photometric redshifts with reasonable accuracy. This could best be accomplished by using wide-area CCD detectors on 8 m class telescopes. In this respect, the Subaru prime-focus camera, Suprime-Cam (Miyazaki et al. 2002), on the Subaru Telescope (Kaifu et al. 2000; Iye et al. 2004), provides its superior imaging capability because of its very wide field of view (34′ × 27″).

During the period 2004 January to 2005 April, we obtained deep optical images of the COSMOS field with Suprime-Cam with the following seven filters: $B, g', r', i', z', and NB816$. We describe these observations in detail; see also Taniguchi et al. (2005). The last filter is the narrowband filter centered at 815 nm with a FWHM of 12 nm. The broadband data will be used to measure photometric redshifts and stellar mass (Mobasher et al. 2007), identify large-scale structures (Scoville et al. 2007a; Guzzo et al. 2007), estimate local densities (Capak et al. 2007b) and optically identify sources detected in X-ray (Hasinger et al. 2007), radio (Schinnerer et al. 2007), and infrared (Sanders et al. 2007) wavelengths. Combined with the narrowband (NB816) observations, these will be used to identify LAEs at $z = 5.7$ (Murayama et al. 2007), [O ii] emitters at $z = 1.2$ (Takahashi et al. 2007), and H$\alpha$ emitters at $z = 0.24$ (Shioya et al. 2007).

In the present paper we describe in detail the observational procedures, filters, sensitivities, and completeness of the COSMOS Subaru Suprime-Cam imaging (see also Taniguchi et al. 2005). Science investigations and their initial results are presented in the aforementioned papers. Throughout this paper, we use the AB magnitude system.

2. OBSERVATIONS

2.1. Observational Strategy

The COSMOS field covers an area of $1.4^\circ \times 1.4^\circ$, centered at R.A. (J2000.0) = $10^h 00^m 28.6^s$ and decl. (J2000.0) = $+02^\circ 12' 21.0''$. The Suprime-Cam consists of $102048 \times 4096$ CCD chips and provides a very wide field of view, $34' \times 27'$ in $10240 \times 8192$ pixels ($0''202$ pixel$^{-1}$). Despite the large field of view of the Suprime-Cam, we need a total of nine pointings to cover the whole COSMOS area. This requires special mapping (i.e., dithering) patterns to carry out the imaging observations. In order to obtain accurate astrometry, we also need to arrange the patterns to overlap. Furthermore, we need to take care of gaps ($3''-4''$ or $16''-17''$) between the CCD chips of the Suprime-Cam. In order to save observing time, we need an efficient mapping pattern with minimum pointings for covering the whole field of COSMOS with minimizing the shallower edges around the outside of the mosaic. On one hand, in order to achieve reliable astrometry covering the whole COSMOS field, it is also necessary to have a half-array shifted data set.

Taking these two points into account, we use the following two mapping patterns: pattern A and pattern C. Originally, we had another pattern B. However, we did not use this in our observations. From this historical reason, we refer our two mapping patterns as patterns A and C throughout this paper. Pattern A is a half-array shifted mapping method in which 12 pointings are necessary to map the whole COSMOS field; see Figure 1. The detailed dithering properties are given in Table 1. Pattern C is our most efficient mapping method in which only nine pointings are enough to map the whole field; see Figure 2. The detailed dithering properties are given in Table 2. Pattern A was used with a relatively short unit exposure time (e.g., a few to several minutes) because this pattern data were used to obtain

| ID   | ΔR.A.$^a$ | ΔDecl.$^b$ | P.A. (deg) |
|------|-----------|------------|------------|
| Pa01 | 45        | 31         | 0          |
| Pa02 | 19        | 32         | 0          |
| Pa03 | −7        | 33         | 0          |
| Pa04 | −33       | 31         | 0          |
| Pa05 | 46        | −1         | 0          |
| Pa06 | 20        | 0          | 0          |
| Pa07 | −6        | 1          | 0          |
| Pa08 | −32       | −7         | 0          |
| Pa09 | 45−33     | 0          | 0          |
| Pa10 | 19        | −32        | 0          |
| Pa11 | −7        | −31        | 0          |
| Pa12 | −33       | −33        | 0          |
| Pb01 | 32        | 33         | 0          |
| Pb02 | 6         | 31         | 0          |
| Pb03 | −20       | 32         | 0          |
| Pb04 | −46       | 33         | 0          |
| Pb05 | 33        | 1          | 0          |
| Pb06 | 7         | −1         | 0          |
| Pb07 | −19       | 0          | 0          |
| Pb08 | −45       | 1          | 0          |
| Pb09 | 32        | −31        | 0          |
| Pb10 | 6         | −33        | 0          |
| Pb11 | −20       | −32        | 0          |
| Pb12 | −46       | −31        | 0          |
| Pa13 | 31        | −45        | 90         |
| Pa02 | 32        | −19        | 90         |
| Pa03 | 33        | 7          | 90         |
| Pa04 | 31        | 33         | 90         |
| Pa05 | −1        | −46        | 90         |
| Pa06 | 0         | −20        | 90         |
| Pa07 | 1         | 6          | 90         |
| Pa08 | −1        | 32         | 90         |
| Pa09 | −33       | −45        | 90         |
| Pa10 | −32       | −19        | 90         |
| Pa11 | −31       | 7          | 90         |
| Pa12 | −33       | 33         | 90         |
| Pb01 | 33        | −32        | 90         |
| Pb02 | 31        | −6         | 90         |
| Pb03 | 32        | 20         | 90         |
| Pb04 | 33        | 46         | 90         |
| Pb05 | 1         | −33        | 90         |
| Pb06 | −1        | −7         | 90         |
| Pb07 | 0         | 19         | 90         |
| Pb08 | 1         | 45         | 90         |
| Pb09 | −31       | −32        | 90         |
| Pb10 | −33       | −6         | 90         |
| Pb11 | −32       | 20         | 90         |
| Pb12 | −31       | 46         | 90         |

$^a$ Offset in R.A. from the COSMOS center position in units of arcmin.  
$^b$ Offset in declination from the COSMOS center position in units of arcmin.
Fig. 2.—Dithering pattern C.
better astrometry and photometry in the whole COSMOS field (H. Aussel et al. 2007, in preparation; Capak et al. 2007a). On the other hand, pattern C was used with a longer unit integration time because this pattern was used to obtain deeper data efficiently.

2.2. Observational Programs and Runs

Our Suprime-Cam observations of the COSMOS field have been made during a period between 2004 January and 2005 March, consisting of three common-use observing programs. Four nights were allocated within the University of Hawaii observing time on the Subaru Telescope during a period between 2004 February and 2004 March; PI: N. Scoville. A summary of the observational programs is given in Table 3. It is noted that the two programs, S03B-239 and S04B-142, were allocated as an Open Use Intensive Program; such Intensive Programs provide the opportunity for researchers to proceed with large programs of advanced study that can only be achieved with the unique capability of Subaru Telescope and its instruments and needs an allocation of significant telescope time. Another Intensive Program (COSMOS-21) was also accepted in the semester S05B (S05B-013); note that “21” means 21 filters in the optical window. However, details of observations of S05B-013 will be given in a forthcoming paper.

Including the University of Hawaii time, 24.5 nights were allocated in total for our Suprime-Cam imaging of the COSMOS field. These observations were carried out in eight observing runs; see Table 4. During these runs, we obtained optical images of the COSMOS field with the Johnson broadband filters, $B$, $V$, $r$, and $i$, the SDSS broadband filters, $g', r', i'$, and $z'$, and a narrowband filter, NB816. The filter response curves including the CCD sensitivity and the atmospheric transmission are shown in Figure 3.

3. DATA REDUCTION AND SOURCE DETECTION

3.1. Data Reduction

All the individual CCD data were reduced using IMCAT by the standard process; bias subtraction, flat-fielding, combining the frames, astrometry, and photometry. Here we note that the night sky subtraction needs two steps to account for fringing and scattered light. The scattered light also makes it difficult to carry out accurate flat fielding. However, our careful experiments show that

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**TABLE 2**

| ID   | $\Delta$R.A. | $\Delta$Decl. | P.A. (deg) |
|------|---------------|----------------|------------|
| A1   | -3.5          | 26.5           | 0          |
| A2   | -30.5         | 27.5           | 0          |
| A3   | 30.0          | 0.5            | 0          |
| A4   | 3.0           | -0.5           | 0          |
| A5   | -3.5          | -27.5          | 0          |
| A6   | -30.5         | -26.5          | 0          |
| A7   | 26.0          | 30.0           | 90         |
| A8   | -27.0         | 3.0            | 0          |
| A9   | 27.0          | -30.0          | 90         |
| B1   | 26.5          | 3.5            | 90         |
| B2   | 27.5          | 30.5           | 90         |
| B3   | 0.5           | -30.0          | 90         |
| B4   | -0.5          | -3.0           | 90         |
| B5   | -27.5         | 3.5            | 90         |
| B6   | -26.5         | 30.5           | 0          |
| B7   | 30.0          | -26.0          | 0          |
| B8   | 3.0           | 27.0           | 0          |
| B9   | -30.0         | -27.0          | 0          |
| C1   | 3.5           | -26.5          | 0          |
| C2   | 30.5          | 27.5           | 0          |
| C3   | -30.0         | -0.5           | 0          |
| C4   | -3.0          | 0.5            | 0          |
| C5   | 3.5           | 27.5           | 0          |
| C6   | 30.5          | 26.5           | 0          |
| C7   | -26.0         | -30.0          | 90         |
| C8   | 27.0          | -3.0           | 90         |
| C9   | -27.0         | 30.0           | 90         |
| D1   | -26.5         | -3.5           | 90         |
| D2   | -27.5         | -30.5          | 90         |
| D3   | -0.5          | 30.0           | 90         |
| D4   | 0.5           | 3.0            | 90         |
| D5   | 27.5          | -3.5           | 90         |
| D6   | 26.5          | -30.5          | 90         |
| D7   | -30.0         | 26.0           | 0          |
| D8   | -3.0          | -27.0          | 0          |
| D9   | 30.0          | 27.0           | 0          |

* Offset in R.A. from the COSMOS center position in units of arcmin.

**TABLE 3**

| Semester | ID No. | PI     | Program Title       | Nights |
|----------|--------|--------|---------------------|--------|
| S03B     | 239    | Y. Taniguchi | COSMOS-Broad &* | 10     |
| S04A     | 080    | Y. Taniguchi | COSMOS-Narrow &b | 2.5    |
| S04B     | 142    | Y. Taniguchi | COSMOS-21 &c     | 8      |
| S04B     | UH-17A | N. Scoville | COSMOS-21 &c     | 4      |

* Suprime-Cam Imaging of the HST COSMOS 2-Degree ACS Survey Deep Field (Intensive Program).

**TABLE 4**

| ID No.   | Period       | Nights | Available Nights | Bands |
|----------|--------------|--------|------------------|-------|
| S03B     | 2004 Jan 16-21 | 6      | 5                | $B$, $r'$, $i'$, $z'$ |
| S03B     | 2004 Feb 15-18 | 4      | 2                | $V$, $i'$ |
| S04A-080 | 2004 Apr 15-19 | 2.5    | 1                | NB816 |
| S04B-142 | 2005 Jan 8-13  | 3      | 0                | No obs. |
| UH-17A   | 2005 Feb 3    | 1      | 0                | No obs. |
| S04B-142 | 2005 Feb 9-13  | 5      | 2                | $g'$, $V$, NB816 |
| UH-17A   | 2005 Mar 10-12 | 3      | 1                | NB816 |
| S04B-142 | 2005 Apr 4-8  | 4      | 3                | $g'$, NB816 |

a First half-night was used in every night.
b Compensation nights because of the poor weather in S04B-142 January and February runs.

25 Our SDSS broadband filters are designated as $g'$, $r'$, $i'$, and $z'$ in Capak et al. (2007a) to distinguish from the original SDSS filters. Also, our $B$ and $V$ filters are designated as $B_{J}$ and $V_{J}$ in Capak et al. (2007a), where $J$ means Johnson and Cousins filter system used in Landolt (1992).

26 IMCAT is distributed by Nick Kaiser at http://www.ifa.hawaii.edu/~kaiser/imcat.
the central 26' area of the field of view is stable at flat to 1% although the scattered light pattern shows variations as large as a few percent outside the central 26' area. Details of these reduction procedure are described in Capak et al. (2007a) and H. Aussel et al. (2007, in preparation). The point-spread function (PSF) sizes of final images are summarized in Table 5. Note that the PSF size of the images used for generating the official catalog was matched to that for the image with worst seeing (1.6').

In Figure 4, we show the composite color image of the whole COSMOS field made from $B$, $r'$, and $z'$ data. The reduced images were divided into tiles with a dimension of $10' \times 10'$ as shown in Figure 5. Note that the center position of the COSMOS field is located in tile 65. The region colored in light blue covered by 81 ($9' \times 9'$) tiles is the COSMOS HST ACS field.

We estimate the limiting magnitudes by using the 81 tiles. For each tile, we performed aperture photometry for 10,000 random points (810,000 points in total) on the PSF-matched image ($1B_6$) with 2" diameter and 3" diameter. Then we evaluated the limiting magnitudes from the standard deviation for the distribution of the random photometry. The results are summarized in Table 5.

As shown in Table 5, the 3 $\sigma$ limiting magnitudes are deeper than 27 mag (2" aperture) in $B$, $g'$, $V$, and $r'$. However, in $z'$ band, the limiting magnitude reaches to 25.7 mag. Difference of the limiting magnitudes among the 81 tiles is less than 0.25 mag in each band (Figs. 6–12).

Note that another type of limiting magnitudes can be estimated by using background-limited numbers. These results are also shown in Figures 13–19 provided by Capak et al. (2007a; see their Table 4).

3.2. Source Detection and Completeness

In Figures 20 and 21 we show the number counts of detected objects against the magnitude measured with 2" aperture and

### Table 5: Summary of the Optical Imaging Data for COSMOS

| Band   | $\lambda_c$ (Å) | $\Delta \lambda$ (Å) | Total TDT (min) | $m_{lim}^{d}$ (mag) | $m_{lim}^{e}$ (mag) | FWHM (PSF) (arcsec) |
|--------|-----------------|----------------------|-----------------|---------------------|---------------------|---------------------|
| B      | 4459.7          | 897                  | 70.3            | 27.8                | 27.2                | 0.95                |
| $g'$   | 4479.6          | 1265                 | 86.0            | 27.2                | 26.6                | 1.58                |
| $V$    | 5483.8          | 946                  | 50.3            | 27.1                | 26.5                | 1.33                |
| $r'$   | 6295.1          | 1382                 | 36.0            | 27.2                | 26.6                | 1.05                |
| $i'$   | 7640.8          | 1497                 | 40.3            | 26.8                | 26.1                | 0.95                |
| $z'$   | 9036.9          | 856                  | 63.5            | 25.9                | 25.3                | 1.15                |
| NB816  | 8151.0          | 117                  | 187.7           | 26.1                | 25.7                | 1.51                |

- $\lambda_c$: Central wavelength.
- $\Delta \lambda$: Filter bandwidth.
- Total TDT: The total target dedicated time.
- $m_{lim}$: The 3 $\sigma$ limiting magnitude in the AB system within 2" diameter aperture.
- FWHM (PSF): The PSF size of the final images. Note that the PSF size of each filter band is finally matched into 1.6" in the official photometric catalog.
Fig. 4.—Color image of the COSMOS field made from $B$, $r'$, and $z'$ data. The image size is $1.5' \times 1.5'$. 
Fig. 5.—Sub-tiles of the reduced images. Each tile has a $10' \times 10'$ dimension. The region with light green color is the COSMOS 2 square degree field covered by our *HST ACS* observations. The field center position is located at tile 65.
Fig. 6.—Variation of 3 $\sigma$ limiting magnitudes in the $B$ band among the 81 tiles covering the COSMOS HST ACS region (as shown by the region with light green color in Fig. 5). The image size is $1.5'' \times 1.5''$. The left panel shows the case for $2''$ diameter aperture, and the right panel is for $3''$ diameter aperture.

Fig. 7.—Same as Fig. 6 for the $g'$ band.
Fig. 8.—Same as Fig. 6 for the $V$ band.

Fig. 9.—Same as Fig. 6 for the $r'$ band.
Fig. 10.—Same as Fig. 6 for the $i$ band.

Fig. 11.—Same as Fig. 6 for the $z'$ band.
Fig. 12.—Same as Fig. 6 for the NB816 band.

Fig. 13.—Map of 3σ limiting magnitude for 3′′ diameter aperture in the B band estimated by Capak et al. (2007a). The image size is 2′ × 2′.

Fig. 14.—Same as Fig. 13 for the g′ band.
Fig. 15.—Same as Fig. 13 for the $V$ band.

Fig. 16.—Same as Fig. 13 for the $r'$ band.

Fig. 17.—Same as Fig. 13 for the $i'$ band.

Fig. 18.—Same as Fig. 13 for the $z'$ band.
aperture for each band, respectively. In this analysis, we use SExtractor version 2.3.2 (Bertin & Arnouts 1996) with the detection criteria of 5 pixel connection above the $2\sigma$ significance and measured aperture magnitude for the detected objects. The SExtractor parameter setup file used in our analysis is given in Table 6. Apparently, the source detection comes to be incomplete at a shallower magnitude than the limiting magnitude. This may be interpreted as a result of flux lost from extended sources. Note that breaks or drops of the number counts in the bright part are due to saturated objects.

In order to estimate detection completeness, we have performed a simulation using the IRAF ARDH DATA. We assume that galaxies have two types of light distributions obeying the exponential law and the de Vaucouleurs $r^{1/4}$ law. For each type of galaxies, we generated 200 model galaxies for each total magnitude interval (0.2 mag) in nine tiles (026, 029, 032, 062, 065, 068, 098, 101, and 104 in Fig. 5). Their sky positions, half-light radii ($0.3\pm0.75$), ellipticities ($0.3\pm1.0$), and position angles ($0^\circ\pm360^\circ$) are randomly determined. Then these model galaxies are put into the CCD data together with Poisson noises. After smoothing model-galaxy
### TABLE 6
SEXTRACTOR PARAMETERS

| Parameter                  | Setting                        | Comment                                      |
|----------------------------|--------------------------------|----------------------------------------------|
| PARAMETERS_NAME            | cosmos-subaru.param            | Fields to be included in output catalog      |
| FILTER_NAME                | gauss_2.5_5x5.conv             | Filter for detection image                   |
| STARNNW_NAME               | default.nnw                    | Neural-Network.Weight table filename         |
| CATALOG_NAME               | STDOUT                          | Output to pipe instead of file               |
| CATALOG_TYPE               | ASCII                           | Output type                                  |
| DETECT._TYPE               | CCD                             | Detector type                                |
| DETECT_MINAREA             | 5                               | Minimum number of pixels above threshold     |
| DETECT_THRESH              | 2                               | Detection Threshold in $\sigma$              |
| ANALYSIS_THRESH            | 2                               | Limit for isophotal analysis $\sigma$       |
| FILTER                      | Y                               | Use filtering                                |
| DEBLEND_NTHRESH            | 64                              | Number of deblending sub-thresholds          |
| DEBLEND_MINCONT            | 0.0                             | Minimum contrast parameter for deblending    |
| CLEAN                      | Y                               | Clean spurious detections                    |
| CLEAN_PARAM                | 1                               | Cleaning efficiency                          |
| MASK_TYPE                  | CORRECT                         | Correct flux for blended objects             |
| PHOT_APERATURES            | 13.3, 20                       | MAG_APER aperture diameter(s) in pixels      |
| PHOT_AUTOPARAMS            | 2.5, 3.5                       | MAG_AUTO parameters: $<\text{Kron\_fact}>,<\text{min\_radius}>$ |
| PHOT_FLUXFRAC              | 0.2, 0.5, 0.8                   | Define $n$-light radii                       |
| PHOT_AUTOAPERS             | 20.0, 20.0                     | MAG_AUTO minimum apertures: estimation, photometry |
| SATUR_LEVEL                | 300,000                        | Level of saturation                          |
| MAGZEROPOINT               | 31.4                            | Magnitude zero-point                         |
| GAIN                       | 1                               | Gain is 1 for absolute rms map               |
| PIXEL_SCALE                | 0                               | Size of pixel in arcsec                     |
| SEEING_FWHM                | 1.5                             | Stellar FWHM in arcsec                      |
| BACK_SIZE                  | 256                             | Background mesh in pixels                    |
| BACK_FILTERSIZE            | 5                               | Background filter                            |
| BACKPHOTO_TYPE             | GLOBAL                         | Photometry background subtraction type       |
| BACKPHOTO_THICK            | 8                               | Thickness of the background LOCAL annulus     |
| WEIGHT_GAIN                | N                               | Gain does not vary with changes in rms noise |
| WEIGHT_TYPE                | MAP_RMS                         | Set weight image type                        |
| MEMORY_PIXSTACK            | 1,000,000                      | Number of pixels in stack                    |
| MEMORY_BUFSIZE             | 4096                            | Number of lines in buffer                    |
| MEMORY_OBJSTACK            | 60,000                          | Size of the buffer containing objects        |
| VERBOSE_TYPE               | QUIET                           | ...                                          |

Fig. 22.—Detection completeness estimated by simulation in the $B$ band as a function of input total magnitude of model galaxies. The left panel shows the case for model galaxies with the light profiles of the exponential law, and the right panel shows the case for those with the de Vaucouleurs law profile.
Fig. 23.—Same as Fig. 22 but for the $g'$ band.

Fig. 24.—Same as Fig. 22 but for the $V$ band.

Fig. 25.—Same as Fig. 22 but for the $r'$ band.
Fig. 26.—Same as Fig. 22 but for the $i'$ band.

Fig. 27.—Same as Fig. 22 but for the $z'$ band.

Fig. 28.—Same as Fig. 22 but for the NB816 band.
TABLE 7
RESULTS OF ANALYSIS FOR THE DETECTION COMPLETENESS

| Band    | Exponential Law\(^a\) | de Vaucouleurs Law\(^b\) |
|---------|------------------------|--------------------------|
|         | 95% (mag) | 90% (mag) | 50% (mag) | 95% (mag) | 90% (mag) | 50% (mag) |
| B       | 24.1      | 24.7      | 25.5      | 24.1      | 24.7      | 25.3      |
| g'      | 23.9      | 24.3      | 24.9      | 23.7      | 24.3      | 24.7      |
| V       | 23.5      | 24.1      | 24.7      | 23.3      | 24.1      | 24.7      |
| r'      | 23.5      | 24.1      | 24.7      | 23.3      | 24.1      | 24.7      |
| i'      | 22.5      | 23.5      | 24.3      | 22.7      | 23.3      | 24.1      |
| z'      | 22.1      | 22.9      | 23.3      | 22.1      | 22.7      | 23.1      |
| NB816   | 22.1      | 23.1      | 23.7      | 22.1      | 22.9      | 23.5      |

\(^a\) Magnitude at which the detection completeness is greater than 95%, 90%, and 50% for the model galaxies with the exponential light profile.

\(^b\) Magnitude at which the detection completeness is greater than 95%, 90%, and 50% for the model galaxies with the de Vaucouleurs law light profile.

In order to compare the input total magnitude of the model galaxies used in the completeness analysis with magnitudes obtained by aperture photometry, we measured the aperture magnitudes of them by SExtractor. Figures 29–32 show the relation between the aperture magnitude (2\(\arcsec\) diameter and 3\(\arcsec\) diameter) and the input total magnitude of model galaxies with the profiles of the exponential law and the de Vaucouleurs law. The measured aperture magnitudes are always offset toward fainter against the input total magnitudes. These offsets are smaller for 3\(\arcsec\) aperture magnitudes.

3.3. Concluding Remarks

We present deep optical imaging observations made with the Suprime-Cam on the Subaru Telescope. Our observations cover the seven filter bands from B to z'. These imaging data allow us
to investigate photometric properties of \(~1\) million galaxies found in the COSMOS field together with the high-resolution ACS $I_{814}$ imaging data. The major COSMOS data sets including the Subaru images and catalogs are publicly available (following calibration and validation) through the Web site for IPAC/IRSA.\(^{27}\)

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\(^{27}\) See http://irsa.ipac.caltech.edu/data/COSMOS.

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