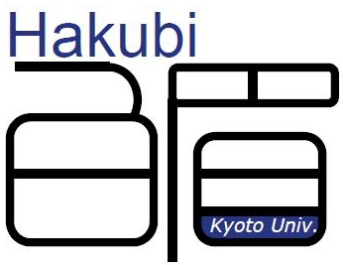
HSC Survey Design, Collaboration Policy, and AGN Sciences

Tohru Nagao
(The Hakubi Proj., Kyoto U.)



121218-20 HSC-AGN Meeting @Matsuyama, Japan

Our Brief History

1999: Subaru First Light
2003-04: Discussion on “Japanese astronomy in 2010’s”
- cosmology / galaxies / AGN / milkyway / stars / planetary sys.
- “wide and deep” new quasar survey was specifically discussed
- “Subaru Wide-Field AGN Survey” (SWANS) kicked off

2004-05: Applying 20 Subaru nights through “intensive program”
- 3 mag deeper than SDSS in g’r’i’z’ for 40 deg^2 with SCam
- z~4-5 low-luminosity quasars → QLF, CCF, environment, etc.
- failed

2006-11: JSPS “tokutei” grant for up-grating SCam → HSC
- main science driver of the HSC instrument team: cosmology (DE)
- Princeton and Taiwan joined
- discussion on “HSC legacy survey”, not only for cosmology
- various science groups (including SWANS) joined

2009-12: Discussion on the legacy survey design → HSC-SSP
- for applying 300 Subaru nights (in 5 years)
- proposal submitted at the end of Oct. 2012
- complementary document (HSC white paper) also prepared
- SWANS annual meetings (Matsuyama, Sendai, Kyoto, Matsuyama)

2012: HSC First Light

What's SSP (Subaru Strategic Program) ?

DEFINITION: Opportunities for fully utilizing the unique capability of new powerful instruments on the Subaru Telescope to carry out a long-term survey program, which cannot be done by individual/group programs

CONDITION: Maximum 300 nights for 5 years (max. 30 nights per semester), conducted in "All-Japan" style (plus international collaboators)

Call for SSP:
http://www.naoj.org/Science/SACM/Senryaku/senryakuwaku_koubo.html

More details of SSP:
http://www.naoj.org/Science/SACM/Senryaku/senryaku.html

Previous (on-going) SSP Projects

SEEDS
- -- 1st SSP, using Hi-CIAO (PI: Tamura-san @NAOJ)
- -- 120 nights, 2008-2012
- -- for exploring exoplanets & planetary disks through AO obs

FAST-SOUND
- -- 2nd SSP, using FMOS (PI: Totani-san @Kyoto→Tokyo)
- -- 40 nights, 2012-
- -- for cosmology through the redshift space distortion measurement

CAVEAT:

Original proposal of the FMOS-SSP was a larger survey including both galaxy studies and cosmology, but only the cosmology part of the original proposal was accepted
- -- The SSP review is REALLY serious and tough!!
- -- The review result is not clear at all even for our HSC-SSP case!!

from Takada-san's PPT

SSP Reviewing Process

Very complicated: ***4 steps!***

- Step 1: ← Now we are under this process
  - 3 referees (Japanese), selected by SAC, will review the SSP proposal. They select up to 2 proposals for the further reviewing processes
- Step 2:
  - The interim-accepted proposals are open to the community
  - The Subaru TAC selects referees (most of them are non-Japanese)
  - The SSP PI needs to form the survey team openly asking to the community to join, and also find someone from the Hawaii observatory as a co-PI
- Step 3:
  - The SSP proposal reviewed by the referees
  - The survey team and organization evaluated by the referees and SAC
  - Select the 1 SSP proposal (no proposal can be selected)
    - *The number of requested nights can be reduced if the scientific justification looks weak to the referees*
- Step 4:
  - Submit more detailed proposal, including the survey strategy as well as the descriptions on the organization and the operation scheme, to SAC
  - The SAC makes final decision
  - Ask the Subaru TAC for the time allocation

Our SSP Proposal

Submitted at the end of Oct.

PI: Miyazaki-san (ATC/NAOJ)
Co-PI: Iwata-san (Subaru/NAOJ)

166 members listed

Note: persons who are not listed in this proposal can also join in this project later, if the person belongs to one of Japanese, Princeton, or Taiwan community (cf. “collaboration policy”

Only 30 pages for applying 300 Subaru nights!
→ supplemental “white paper”

Wide-field imaging with Hyper Suprime-Cam: Cosmology and Galaxy Evolution

A Strategic Survey Proposal for the Subaru Telescope

PI: Satoshi Miyazaki (NAOJ)
Co-PI: Ikuru Iwata (NAOJ)

The HSC collaboration team[1]: S. Abe[(1)], H. Aihara*[(2),(3)], M. Akiyama[(4)], K. Aoki[(5)], N. Arimoto*[(5)], N. A. Bahcall[(6)], S. J. Bickerton[(3)], J. Bosch[(6)], K. Bundy†[(3)], C. W. Chen[(7)], M. Chiba†[(4)], T. Chiba[(8)], N. E. Chisari[(6)], J. Coupon[(7)], M. Doi[(2)], M. Enoki[(9)] S. Foucaud[(10)], M. Fukugita[(3)], H. Furusawa[(5)], T. Futamase[(4)], R. Goto[(2)], T. Goto[(11)], J. E. Gresne[(6)], J. E. Gunn†[(6)], T. Hamana[(5)], T. Hashimoto[(2)], M. Hayashi[(5)], Y. Higuchi[(2),(5)], C. Hikage[(12)], J. C. Hill[(6)], P. T. P. Ho*[(7)], B. C. Hsieh[(7)], K. Y. Huang†[(7)], H. Ikeda[(13)], M. Imanishi[(5)], N. Inada[(14)], A. K. Inoue[(15)], W.-H. Ip[(1)], T. Ito[(5)], K. Iwasawa[(16)], M. Iye[(5)], H. Y. Jian†[(17)], Y. Kakazu[(18)], H. Karoji[(5)], N. Kashikawa[(5)], N. Katayama[(3)], T. Kawaguchi[(19)], S. Kawanomoto[(5)], I. Kayo[(20)], T. Kitayama[(20)], C. R. Knapp[(6)], T. Kodama[(5)], K. Kohno[(2)], M. Kotka[(5)], E. Kokubo[(5)], M. Kokubo[(2)], Y. Komiyama[(5)], A. Konno[(2)], Y. Koyama[(5)], C. N. Lackner[(3)], D. Lang[(6)], A. Leauthaud†[(3)], M. J. Lehner[(7)], K.-Y. Lin[(7)], L. Lin[(7)], Y.-T. Lin†[(7)], C. P. Loomis[(6)], R. H. Lupton†[(6)], P. S. Lykawka[(21)], K. Maeda[(3)], R. Mandelbaum†[(22)], Y. Matsuda[(3)], K. Matsuoka†[(13),(23)], Y. Matsuoka[(12)], S. Mineo[(2)], T. Minezaki[(2)], H. Miyatake[(6)], R. Momose[(2)], A. More[(3)], S. More[(3)], T. J. Moriya[(3)], T. Morokuma†[(2)], H. Murayama*[(3)], K. Nagamine[(24)], T. Nagao†[(23)], S. Nagataki[(23)], Y. Naito[(2)], K. Nakajima[(2)], F. Nakata[(5)], H. Nakaya[(5)], T. Namikawa[(2)], C.-C. Ngeow[(1)], T. Nishimichi[(3)], H. Nishioka[(7)], A. J. Nishizawa†[(3)], K. Nomoto[(3)], M. Oguri†[(3)], A. Oka[(2)], N. Okabe[(7)], S. Okamoto[(25)], S. Okamura[(26)], J. Okumura[(22)], S. Okumura[(27)], Y. Okura[(5)], Y. Ono[(2)] M. Onodera[(28)], K. Ota[(22)], M. Ouchi†[(2)], S. Oyabu[(12)], P. A. Price[(6)], R. Quimby[(3)], C. E. Rusu[(2),(5)], S. Saito[(29)], T. Saito[(3)], Y. Saitou[(30)], M. Sato[(12)], T. Shibuya[(5)], K. Shimasaku†[(2)], A. Shimono[(3)], S. Shinogi[(3)], M. Shirasaki[(2)], J. D. Silverman[(3)], D. N. Spergel*[(6),(3)], M. A. Strauss†[(6)], H. Sugai[(3)], N. Sugiyama[(12),(3)], D. Suto[(2)], Y. Suto*[(2)], K. Tadaki[(2)], M. Takada†[(3)], R. Takahashi[(31)], S. Takahashi[(5)], T. Takata[(5)], T. T. Takeuchi[(12)], N. Tamura[(3)], M. Tanaka[(5)], M. Tanaka†[(3)], M. Tanaka[(4)], Y. Taniguchi[(13)], A. Taruya[(2)], T. Terai[(5)], Y. Terashima[(13)], N. Tominaga[(32)], J. Toshikawa[(30)], T. Totani[(23)], M. Tsai[(1)], E. L. Turner*[(6)], Y. Ueda[(23)], K. Umetsu[(7)], Y. Urata†[(1)], Y. Utsumi[(6)], B. Vulcani[(3)], K. Wada[(33)], S.-Y. Wang[(7)], W.-H. Wang[(7)], T. Yamada[(4)] Y. Yamada[(5)], K. Yamamoto[(34)], H. Yamanoi[(5)], C.-H. Yan[(7)], N. Yasuda†[(3)], A. Yonehara[(35)], F. Yoshida†[(3)], N. Yoshida[(2)], M. Yoshikawa[(36)], S. Yuma[(2)] (1) NCU, Taiwan (2) Tokyo (3) Kavli IPMU (4) Tohoku (5) NAOJ (6) Princeton (7) ASIAA (8) Nihon (9) Tokyo Keizai (10) NTNU, Taiwan (11) DARK, Copenhagen (12) Nagoya (13) Ehime (14) NNCT (15) Osaka Sangyo (16) Barcelona (17) NTU, Taiwan (18) Chicago (19) Tsukuba (20) Toho (21) Kinki (22) CMU (23) Kyoto (24) Las Vegas (25) KIAA, China (26) Hosei (27) JSGA (28) ETH (29) Berkeley (30) CUAS (31) Hirosaki (32) Konan (33) Kagoshima (34) Hiroshima (35) Kyoto Sangyo (36) JAXA

Executive Summary

We propose to carry out a three-layered, multi-band (*grizy* plus narrow-band filters) imaging survey with the Hyper Suprime-Cam (HSC) on the 8.2m Subaru Telescope. By combining data from the three layers (Wide: 1400 deg^2, $r \simeq 26$; Deep: 27 deg^2, $r \simeq 27$; Ultradeep: 3.5 deg^2, $r \simeq 28$), we will address some of the most pressing problems in modern cosmology and astrophysics: the origin of the acceleration of the Universe's expansion, the properties and evolution of galaxies from $z \simeq 7$ to today, and the nature of cosmic reionization. The survey is uniquely designed to enable all these science cases, with particular attention to controlling systematic errors, and the data will be analyzed with a state-of-the-art software pipeline. We will use the excellent-quality ($0.7''$ seeing), multi-broadband images of distant galaxies from the Wide layer to statistically reconstruct the dark matter distribution in the Universe up to $z \simeq 1.5$ via measurements of weak lensing (WL), coupled with photometric redshifts for every galaxy. The Deep layer goes one magnitude deeper, with repeated observations, allowing us to verify our PSF and galaxy shape measurements as a function of seeing, depth and galaxy properties. Measurements of cosmic shear and other HSC WL observables, in combination with geometrical constraints from lightcurves of ~ 120 Type Ia supernovae up to $z \simeq 1.4$ from the Ultradeep layer, will enable us to constrain the dark energy parameters to precisions of $\sigma(w_{\rm DE}) \simeq 0.04$ (constant dark energy equation of state) and the dark energy figure-of-merit FoM $= 1/[\sigma(w_{\rm pivot})\sigma(w_a)] \simeq 50$ (for $w(z)$ a two-parameter function of redshift), about a factor of 2 improvement over current constraints. Cross-correlating the HSC WL observables with data from the arcminute-resolution, high-sensitivity ACT CMB experiment, Planck, and the SDSS/BOSS spectroscopic galaxy survey will improve the FoM to 100. We will also perform a stringent test of gravity on cosmological distance scales by comparing dark matter clustering from HSC-WL observables with the redshift-space distortion effect measured in the BOSS galaxy clustering. In the field of galaxy evolution, the HSC survey will include over 20 million galaxies up to $z \simeq 1$ from the Wide layer, and a half-million galaxies over $1 \lesssim z \lesssim 2$ from the Deep and Ultradeep layers. These galaxy catalogs, of unprecedented sizes and cosmological volumes, will allow high-precision measurements of the properties of evolving galaxy populations and their relation to the WL-reconstructed dark matter distribution. With samples constructed from the Wide layer, we will measure absolute stellar growth rates over 2 orders of magnitude in stellar mass since $z \sim 1$, and establish evolutionary links between galaxy populations by tracking how the growth of some key sub-populations is related to the decline of others. A growth rate of 3% per Gyr will be measured with 10σ or greater precision across all mass bins probed. The Deep and Ultradeep layers will also include broad- and narrow-band imaging surveys of Lyman-break galaxies

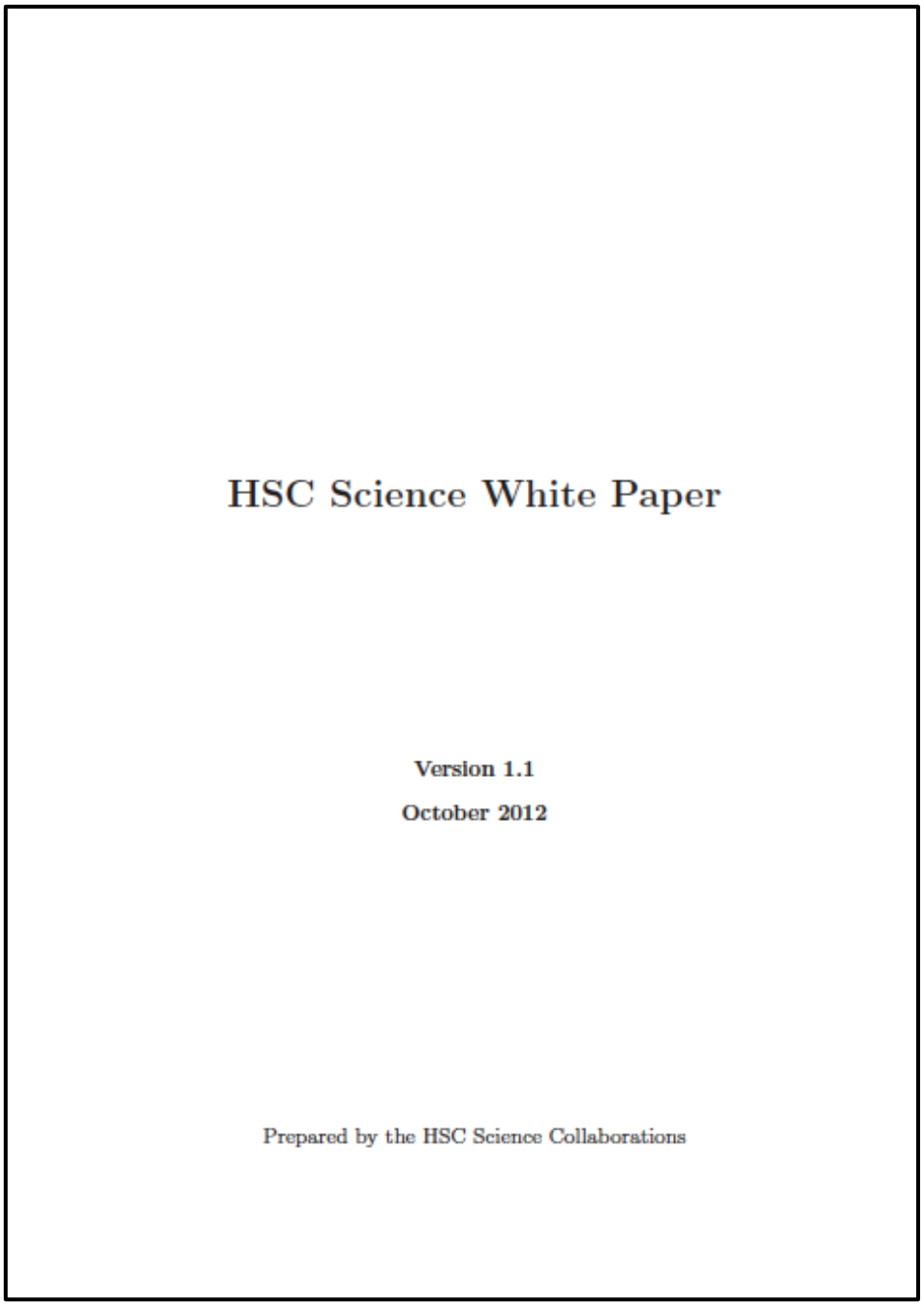
[1] Those people with the "*" superscript are the HSC Executive Board members. Those people with the "†" superscript are co-chairs of the HSC working groups (Weak Lensing, AGN, Galactic Structure, Solar System, Variables/Transients, Low-z Galaxies, High-z Galaxies, Clusters, Photometric Redshift, Photometric Calibration, Survey Strategy, Hardware, and Software & Data Distribution).

HSC White Paper

Released at the end of Oct.
504 pages in total

Science chapters:
- -- cosmology
- -- clusters of galaxies
- -- galaxy evolution at mid-z
- -- high-z galaxies
- -- AGNs (62 pages!)
- -- transients (SNe, GRBs, ...)
- -- solar systems
- -- MW and local group galaxies

ULR of this document is given in the SSP proposal, as a reference for the SSP referees


HSC Science White Paper

Version 1.1

October 2012

Prepared by the HSC Science Collaborations

HSC-SSP Survey Design

- Designing “All-Japan” survey
- In which various sciences should be achievable
- A large systematic survey that consists of 3 layers
- 300 nights in 5 years (equivalently ~210 clear photo. nights)
- Proposing to start the survey in S13B (2013.08 – 2014.01)

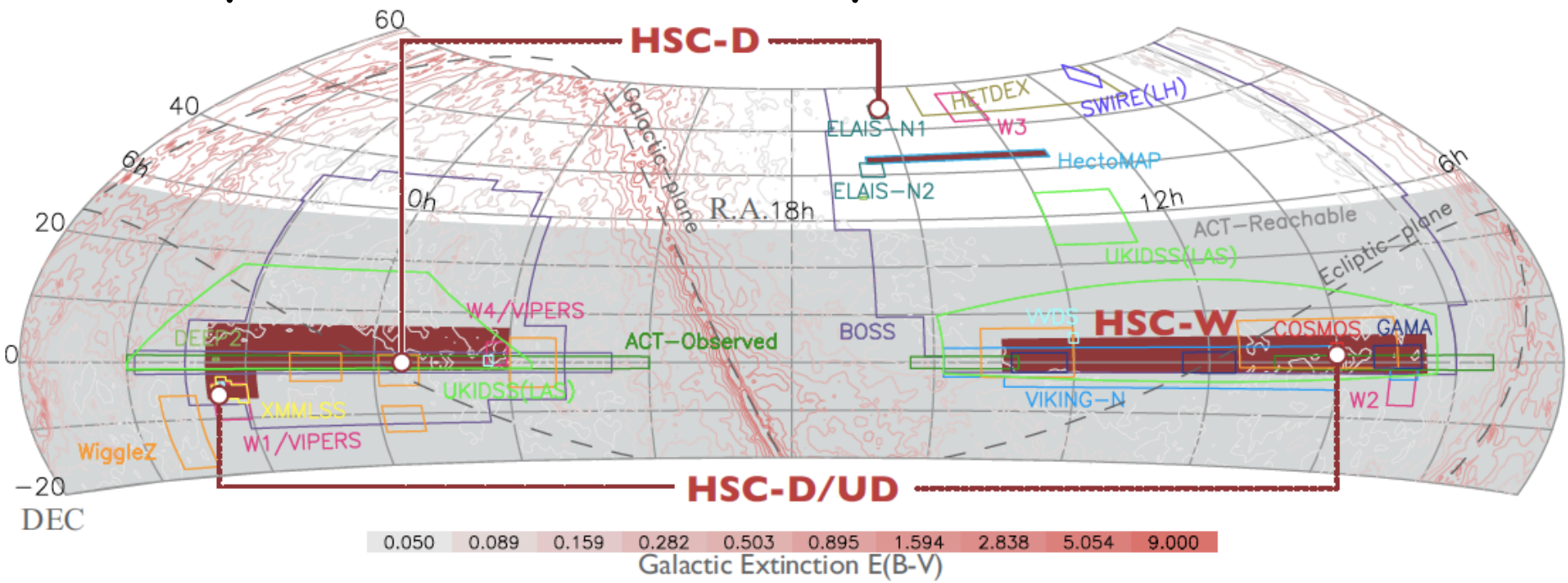
- HSC Wide-layer
  -- 1400 deg^2, grizy 5 bands (+UKIDSS/VIKING), i=25.9
  -- cosmology, clusters of galaxies, dropout AGNs, MW, ...

- HSC Deep-layer
  -- 28 deg^2, grizy + N387/816/921 + multi wav., i=26.8
  -- galaxy evolution, transient, variable AGNs, solar system, ...

- HSC Ultradeep-layer
  -- 3.5 deg^2, grizy + N816/921/101 + multi wav., i=27.4
  -- very high-z galaxies, reionization, high-z SNe, Ly blob, ...

from the SSP proposal

Survey Field (HSC Wide Layer)

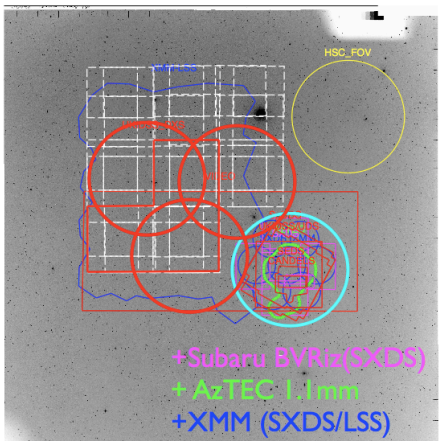


Fall Field (~640 deg^2): ACT, VIPERS, UKIDSS, WiggleZ, etc.
Spring Field (~680 deg^2): ACT, VIKING/KIDS, GAMA, Herschel, etc.
North Field (~55 deg^2): HectoMAP (r<21.3 spectra)

~1400 deg^2 in total

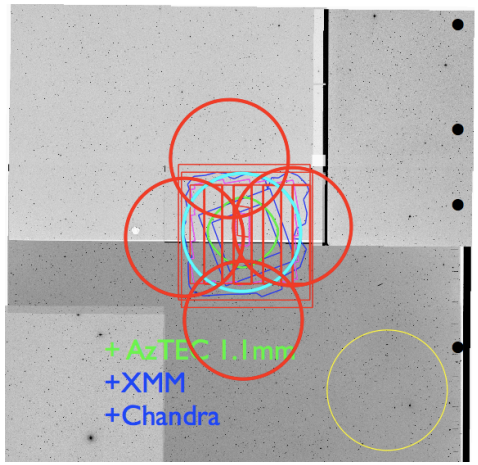
Survey Field (HSC Deep and Ultra-Deep Layers)

XMM-LSS/UDS field, other



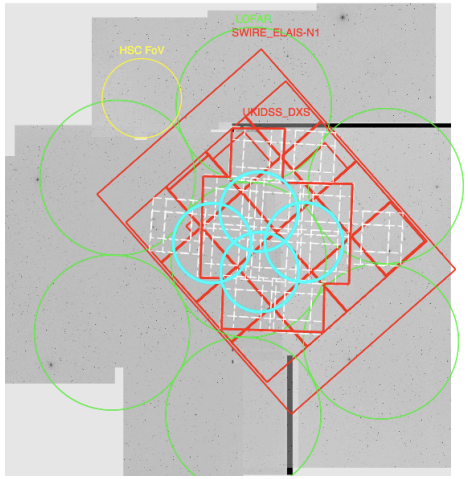
- UKIDSS/DXS
  - J+K (J_{AB}~23.4 K_{AB}~22.4)
- VISTA/VIDEO
  - ZYJHK (K_{AB}~23.5)
- UKIDSS/UDS
  - JHK (J_{AB}~24.0 K_{AB}~23.9)
- Spitzer/SpUDS, SEDS
  - IRAC+MIPS (3.6um~24.8AB)
- HST/CANDELS
  - F105W,F125W,F160W (F125W~27.3) (+ACS)

COSMOS/UltraVISTA field, other



- COSMOS NIR
  - WIRCAM,WFCAM, ... (K_{AB}~23)
- S-COSMOS
  - Spitzer/IRAC+MIPS
- UltraVISTA
  - J_{AB}~25.5 K_{AB}~24.5 (goal)
  - J_{AB}~23.5-24 K_{AB}~22.5-23 (current)
- CANDELS
  - F105W,F125W,F160W (F125W~27.3)

ELAIS-N1 field



- UKIDSS/DXS
  - J+K (J_{AB}~23.4 K_{AB}~22.4)
- LOFAR EoR
  - Redshifted 21cm line (e.g., 190MHz@z~6.5, 115MHz@z~11.5)
- SWIRE-ELAIS-N1
  - IRAC+MIPS (~3.7uJy@3.6um)

DEEP2-3 field

no map (sorry for this!)
famous “SSA22” included
spectroscopic dataset from DEEP2

Filters & Survey Depth

Recent change:
N387, N527, N718 dropped from UD

Layer	Filter	Exp.[a] (# of epochs)	Total[b] nights	Lim. mag.[c] (5σ, $2''$)	Moon[d] phase	Requirement(s)[e]
Wide	g, r	10 min (3)	53	26.5, 26.1	d	photo
Wide	i	20 min (6)	53	25.9	d	FWHM $\lesssim 0.7''$
Wide	z, y	20 min (6)	108	25.1, 24.4	g	photo
Deep	g, r	1.4 hrs (10)	7.3	27.5, 27.1	d	cadence
Deep	i	2.1 hrs (10)	5.4	26.8	d	FWHM $\lesssim 0.7''$, cadence
Deep	z	3.5 hrs (10)	9.1	26.3	g	cadence
Deep	y	2.1 hrs (10)	5.4	25.3	g	cadence
Deep	$N387$	1.4 hrs ($\simeq$10)	3.6	24.5	d	photo
Deep	$N816$	2.8 hrs ($\simeq$ 10)	7.2	25.8	g/d	photo
Deep	$N921$	4.2 hrs ($\simeq$ 10)	11	25.6	g/d	photo
UD	g, r	7 hrs (20)	4.8	28.1, 27.7	d	cadence
UD	i	14 hrs (20)	4.8	27.4	d	cadence
UD	z, y	18.9 hrs (20)	13	26.8, 26.3	g	cadence
UD	$N816$	10.5 hrs ($\simeq$ 10)	3.6	26.5	g/d	photo
UD	$N921$	14 hrs ($\simeq$ 10)	4.8	26.2	g/d	photo
UD	$N101$	17.5 hrs ($\simeq$ 10)	6.1	24.8	g/d	photo

Collaboration Policy

"Survey members": Registered faculties in Japanese, Princeton and Taiwanese institutes can use the HSC-SSP outcomes

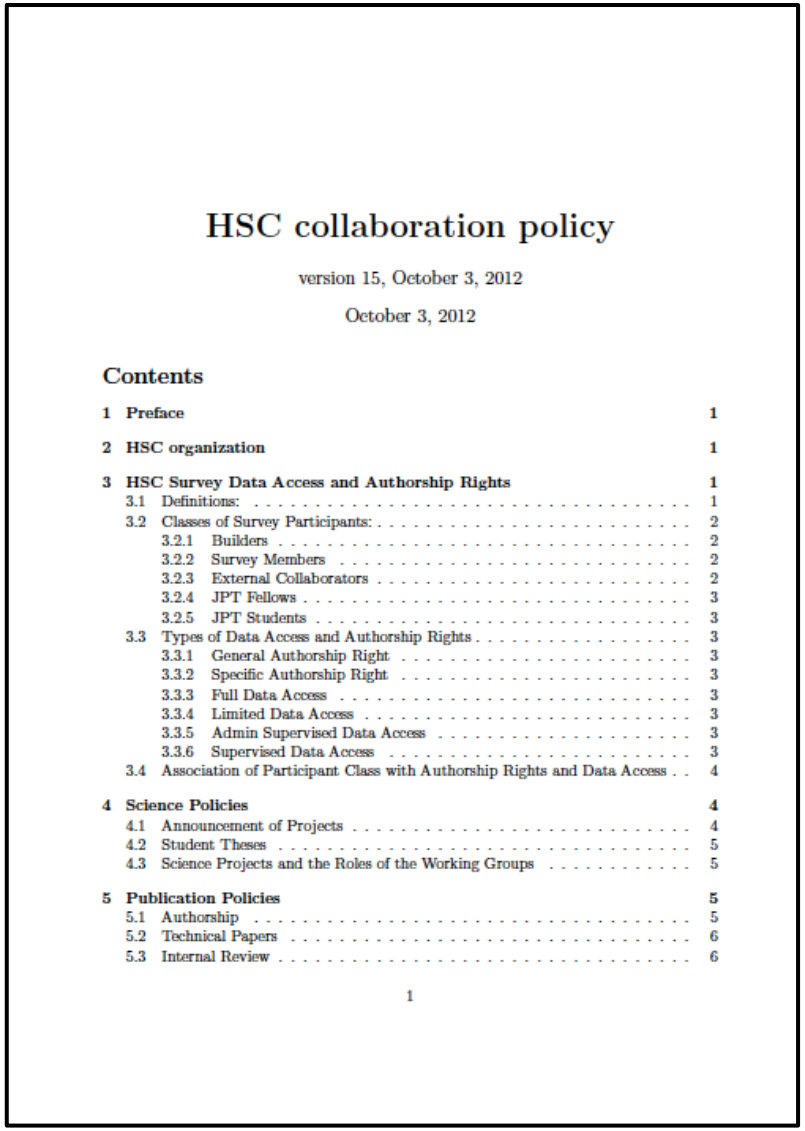
"JPT fellows/students": Fellows and students in Japanese, Princeton and Taiwanese institutes can use the HSC-SSP outcomes through survey members

(How about the case of Nagao??)

"External collaborators": Registered specific individuals, approved by the EB based on the necessity, who join in the specific science using the HSC-SSP data (cf. Peter Capak's SPLASH with Spitzer)

"Announcement of projects": Any projects based on the HSC-SSP data should be announced through the HSC web, describing the members, scope, timescale, and anticipated papers; then the HSC-SSP members would contact to the project PI

available at the HSC wiki



HSC collaboration policy

version 15, October 3, 2012

October 3, 2012

Contents

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Organization Structure

A Principal Investigator

Satoshi Miyazaki (NAOJ)

B Executive Board Members

Hiroaki Aihara (U.of Tokyo, Kavli IPMU)
Nobuo Arimoto (director of Subaru observatory, NAOJ)
Paul Ho (ASIAA)
Hitoshi Murayama (Kavli IPMU)
David Spergel (Princeton U.)
Yasushi Suto (U. of Tokyo)
Edwin Turner (Princeton U.)

Table 2: Science working groups

working group	chair	vice-chair
Galactic Evolution	Gunn	
AGN	Nagao	Strauss
Weak Lensing	Takada	Hamana
Galactic Structure	Chiba	
Solar System	Yoshida	
Variables/transients	Morokuma	Huang
Very high redshift	Ouchi	Shimasaku
Clusters	Lin	Oguri
Supernovae	Yasuda	Urata
Photometric Calibration	Gunn	Furusawa
Hardware	Miyazaki	
Software and Data Distribution	Lupton	Furusawa

C HSC Survey Committee

M. Chiba (Tohoku U.), J. Gunn (Princeton U.), M. Ouchi (Institute of Cosmic Ray Research, U. of Tokyo; chair of ultra-deep survey), K. Shimasaku (U. of Tokyo; chair of deep survey), M. Strauss (Princeton U.; chair of general survey design), M. Takada (Kavli IPMU; chair of wide survey), K. Umetsu (ASIAA). This committee is chaired by M. Takada, who has the responsibility and authority to make final decisions on survey design and management.

defined in the HSC collaboration policy document

AGN Sciences in the HSC-SSP Survey

- A lot of possibilities, of course!
  - -- color selection, variability selection, multi-wave selection, ...
  - -- QLF, ACF, CCF, ... (→ various talks in this meetings!)
  - -- based on 3 layers data (incl. cadence info, multi-wave info, ...)

- But MORE data are actually needed for AGN sciences
  - -- SPECTRA!
  - -- u-band, IR (→Seb's talk)
  - -- ALMA, JVLA
  - -- Xray, SPITZER, others (to be discussed)
  - -- how to get these data efficiently?

- Action items & discussion items in this Matsuyama meeting
  - -- sharing various science ideas, possibilities, opportunities
  - -- exploring various collaboration possibilities
  - -- discussing publication plans (specifically "1st-yr sciences" !!)
  - -- also follow-up proposal plans
  - -- starting date; any strong justification for starting in S13B?