

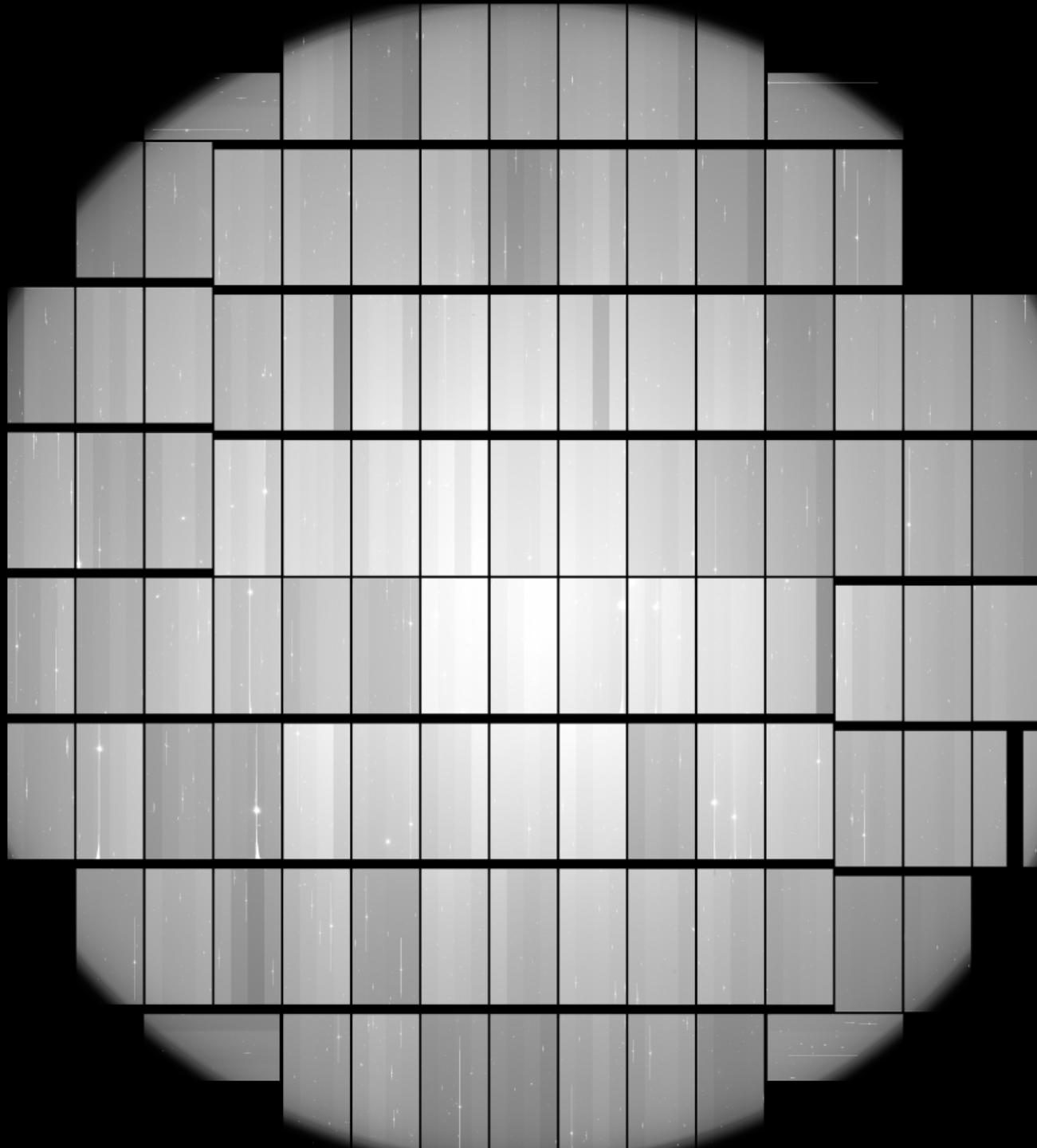
First Data Release of the Hyper Suprime-Cam
Subaru Strategic Program

Masayuki Tanaka
(National Astronomical Observatory of Japan)

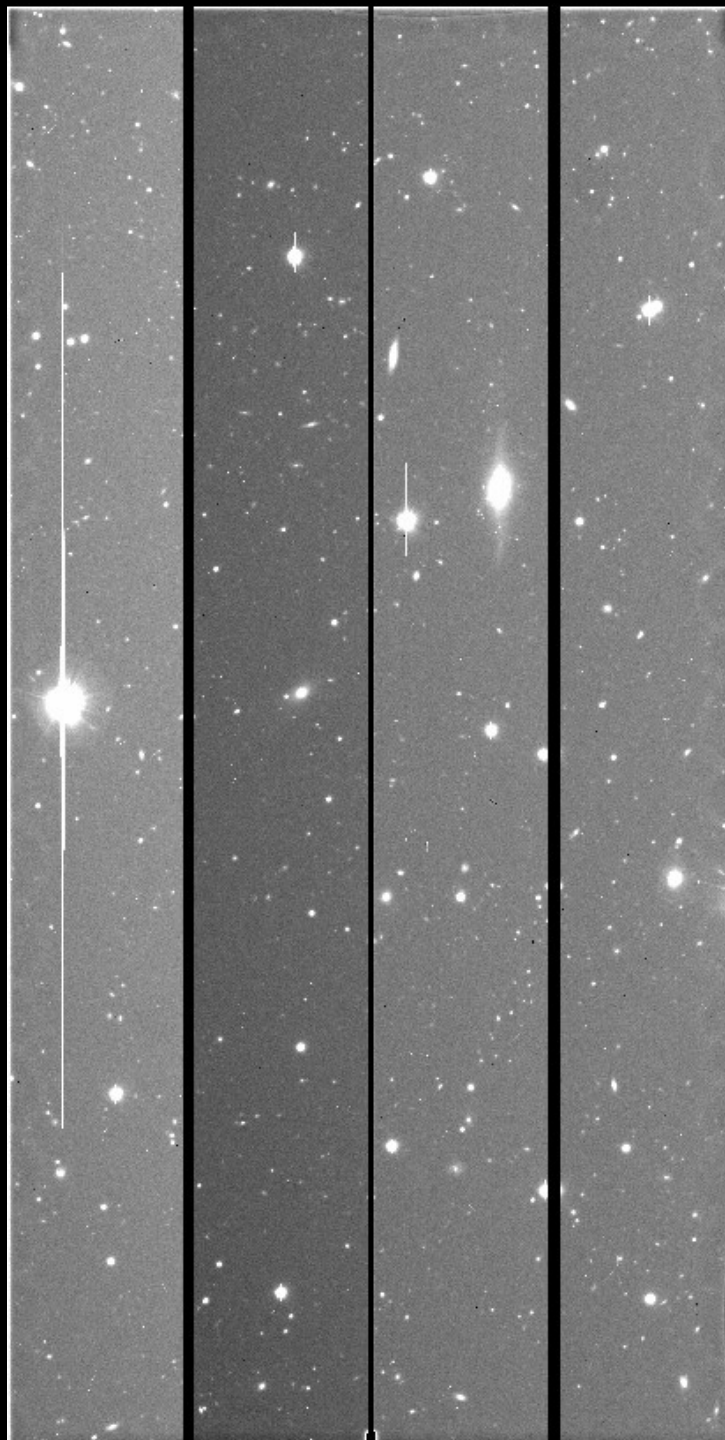
I will show no complicated equations in this talk.
You can relax!







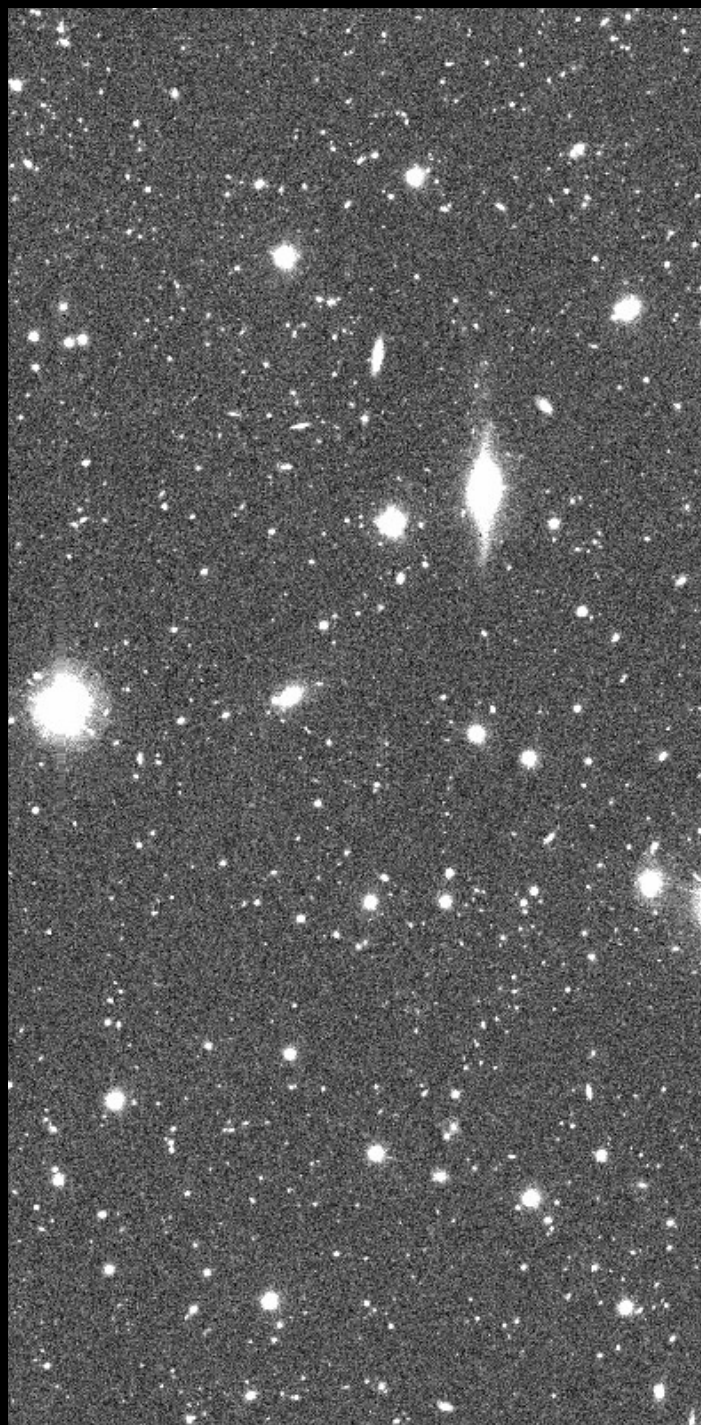
Raw



Raw



Processed



1- Bias subtraction

2- Flat fielding

3- Background sub.

4- Source detection

5- Flux calibration

6- Astrometric calib.

Raw



Processed



Stacked



7- Stacking

8- Object detection
and measurement

9- We have a catalog
for science!

Data Processing

hscPipe, a version of LSST stack, has been primarily developed by the software group at Princeton, Yasuda-san at IPMU, and NAOJ.

The code is getting shape:

- Internal : 1% PSF photometry, ~ 10 mas astrometry
- Against PS1: 1-2% PSF photometry, ~ 40 mas astrometry



Robert Lupton



Bob Armstrong



Jim Bosch



Paul Price



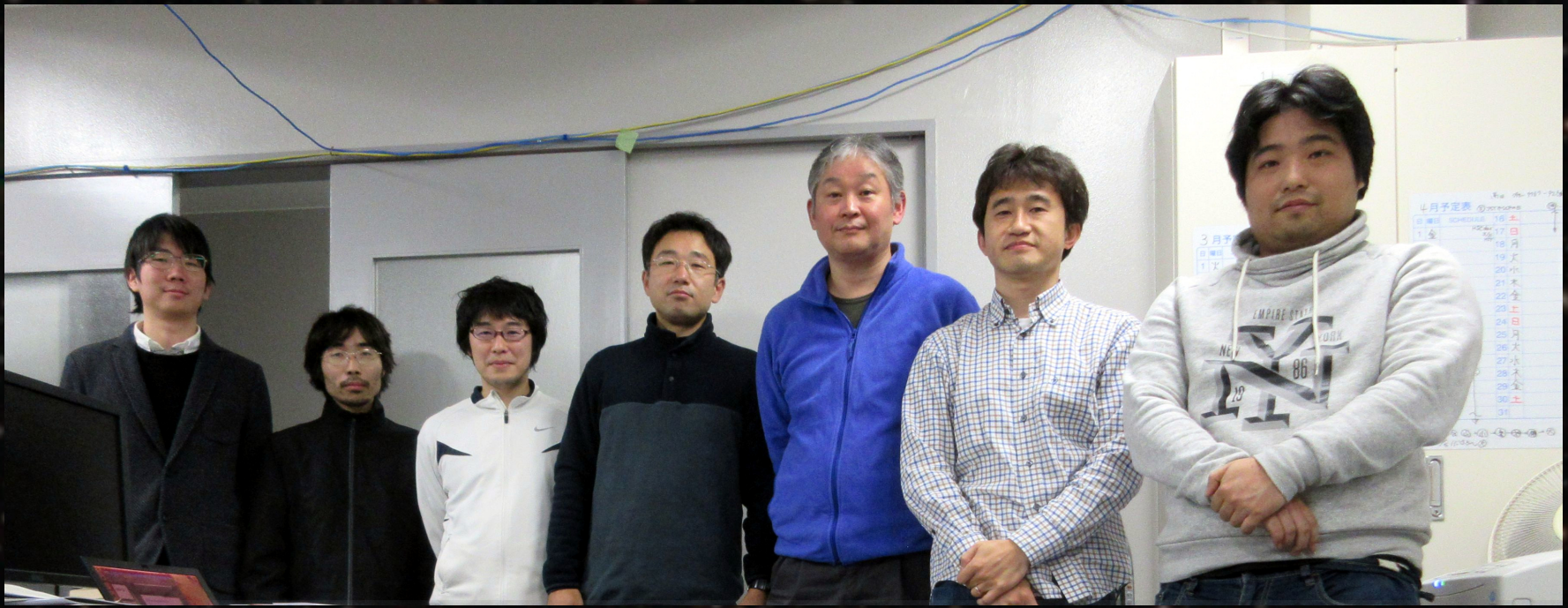
Naoki Yasuda

Data Processing

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The code is getting shape:

- Internal : 1% PSF photometry, ~ 10 mas astrometry
- Against PS1: 1-2% PSF photometry, ~ 40 mas astrometry





Group photo from the HSC collaboration meeting at IPMU in August

Subaru Strategic Program

International collaboration of **all Japan**, Princeton, and Taiwan.

Over 170 scientists are putting efforts in a huge observing program of 300 nights over 5-6 years. The survey started in March 2014 and it is about 30% done.

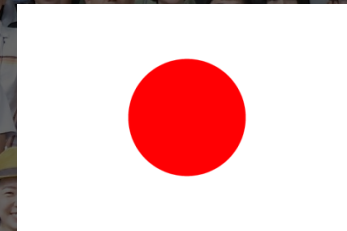
SSP proposal

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 team¹: 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. Greene⁽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⁽³⁾, N. Kashikawa⁽⁵⁾, N. Katayama⁽³⁾, T. Kawaguchi⁽¹⁹⁾, S. Kawanomoto⁽⁵⁾, I. Kayo⁽²⁰⁾, T. Kitayama⁽²⁰⁾, G. R. Knapp⁽⁶⁾, T. Kodama⁽⁵⁾, K. Kohn⁽²⁾, M. Koike⁽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⁽⁵⁾, 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⁽²³⁾, S. Okumura⁽²⁷⁾, Y. Okura⁽⁵⁾, Y. Ono⁽²⁾, M. Onodera⁽²⁸⁾, K. Ota⁽²³⁾, 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⁽²⁾, M. Shirasaki⁽²⁾, J. D. Silverman⁽³⁾, D. N. Spergel^{*(6)}, 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. Utsuni⁽⁵⁾, 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⁽⁵⁾, 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) Los Mochis (25) KIAA, China (26) Hacci (27) ISCA (28) ETH (29) Berkeley (30) CUAS (31) Hiroshima (32) HSC (33) HSC (34) HSC (35) HSC



corporation meeting at IPMU in August

Processing and Internal Data Releases

Release	Date	Layer	N filter	Area (deg ²)	Files (TBytes)	N object	Version hscPipe
S14A0	2014-09-04	UltraDeep	5	2	2.2	880,792	2.12.4a
		Wide	2	24	2.6	10,548,142	2.12.4a
S14A0b	2015-02-10	UltraDeep	5	4	6.4	2,183,707	2.12.4d
		Wide	5	94 (23)	18.6	63,954,672	3.4.1
S15A	2015-09-01	UltraDeep	6	4	7.2	2,973,579	3.8.5
		Deep	6	24	17.7	14,747,568	3.8.5
		Wide	5	203 (82)	40.7	64,073,662	3.8.5
S15B	2016-01-29	UltraDeep	7	4	8.6	3,225,285	4.0.1
		Deep	7	26	16.6	15,959,257	4.0.1
		Wide	5	413 (111)	145.2	157,423,778	4.0.1
S16A	2016-08-04	UltraDeep	7	4	7.5	3,208,918	4.0.2
		Deep	7	28	8.0	16,269,129	4.0.2
		Wide	5	456 (178)	245.0	183,391,488	4.0.2

The survey started in March 2014. We have made 5 internal data releases so far.

Hyper Suprime-Cam Subaru Strategic Program

Data Release 1

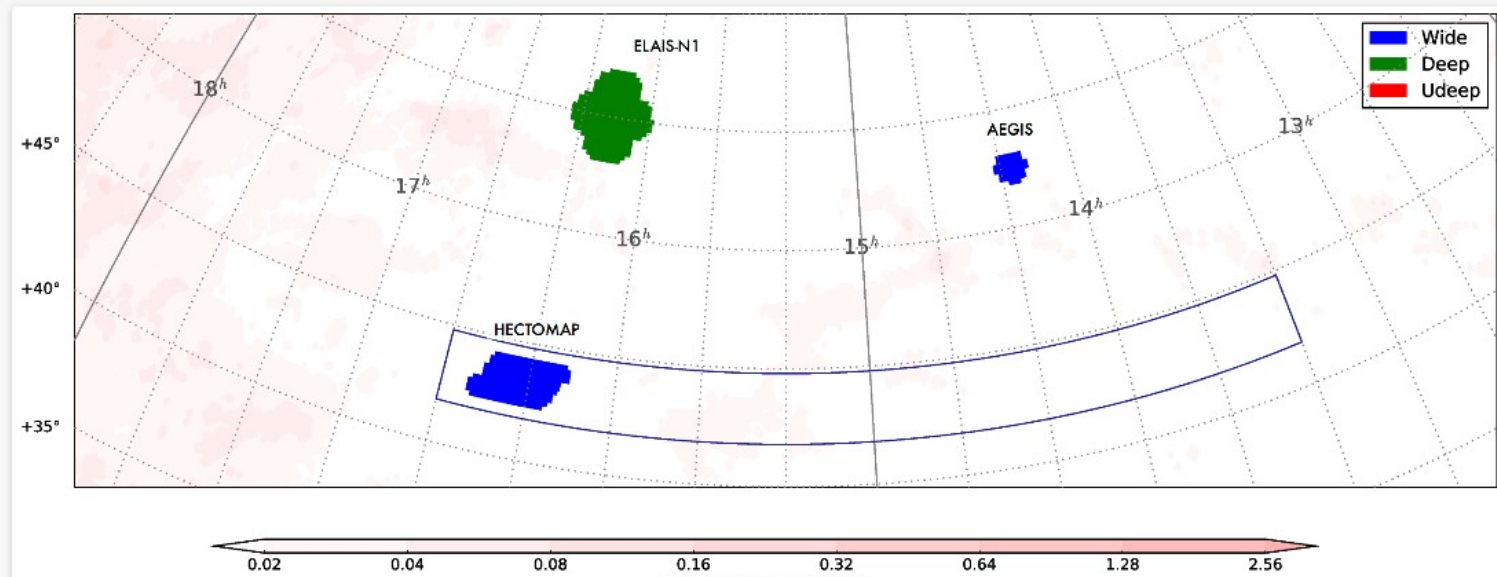
[Home](#) [Survey](#) [Processing](#) [Release Data](#) [Database](#) [Data Access](#) [FAQ](#)

We peer deep into the Universe to unveil the nature of dark matter and dark energy.

Public Data Release 1

Welcome to the [Hyper Suprime-Cam](#) Subaru Strategic Program Data Release Site!

The first public release of HSC-SSP occurred on 28 February 2017. The release includes over 100 square degrees of deep multi-color data served through dedicated databases and user interfaces. The figures below shows the area covered in this release and the table gives an overview of the data in the three survey layers. Refer to [our survey website](#) for details of the survey design.



Hyper Suprime-Cam Subaru Strategic Program

Data Release 1

[Home](#) [Survey](#) [Processing](#) [Release Data](#) [Database](#) [Data Access](#) [FAQ](#)

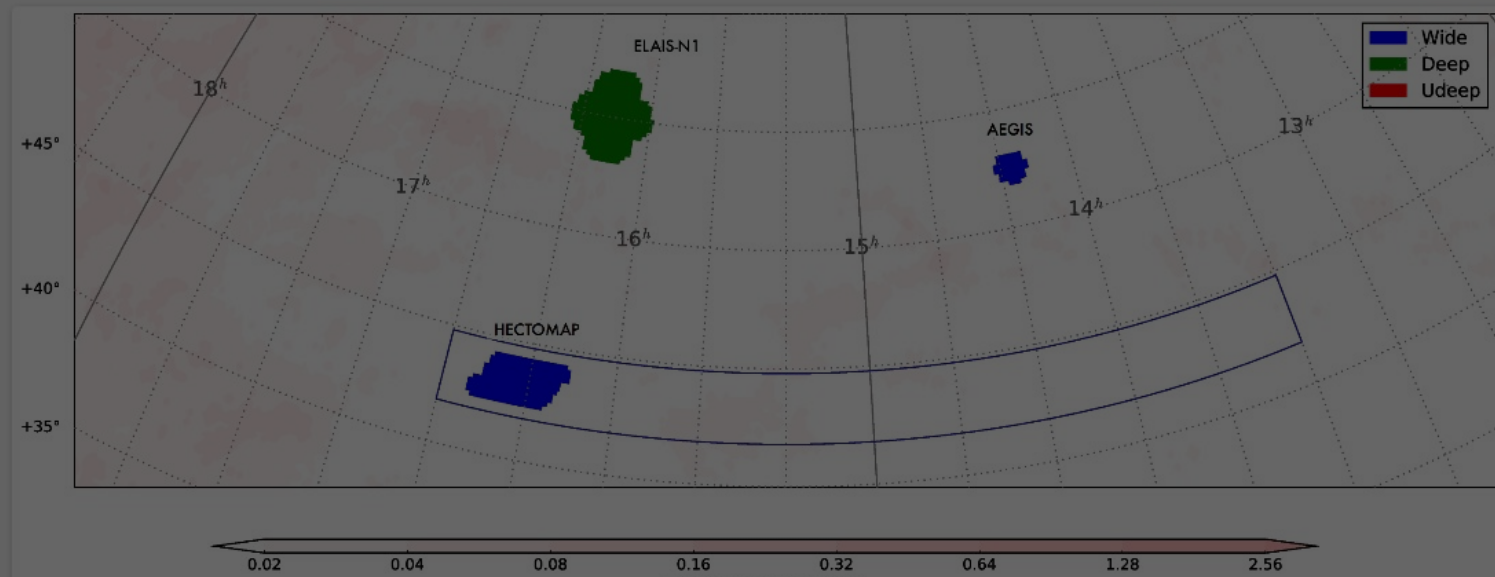
We peer deep into the Universe to unveil the nature of dark matter and dark energy.

This is a major milestone of the survey!

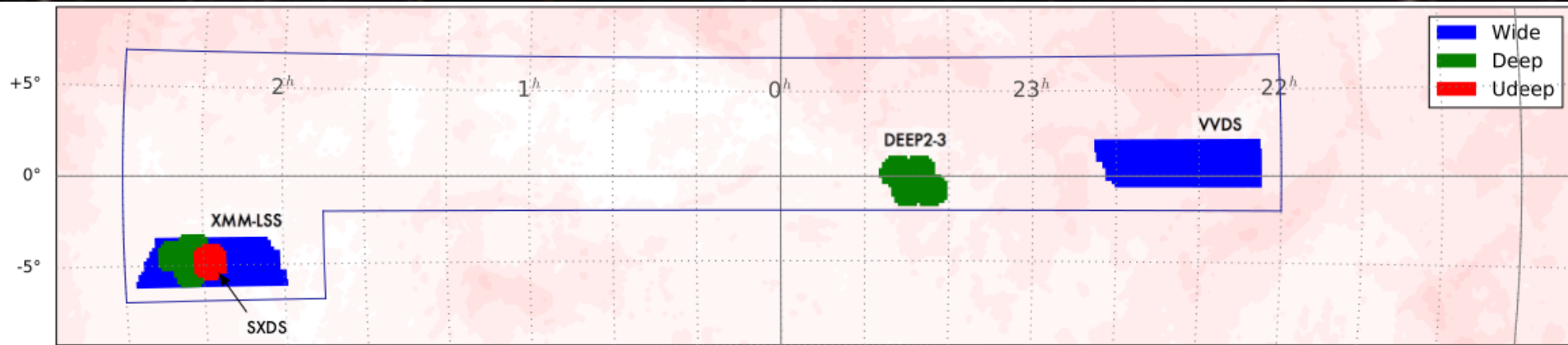
Public Data Release 1

We should all be proud of this!

Welcome to the [Hyper Suprime-Cam Subaru Strategic Program Data Release 1](#) page. The first public release of Hyper Suprime-Cam data on 29 February 2017. The release provides about 10 square degrees of multi-band-color data served through dedicated databases and user interfaces. The figures below shows the area covered in this release and the table gives an overview of the data in the three survey layers. Refer to [our survey website](#) for details of the survey design.



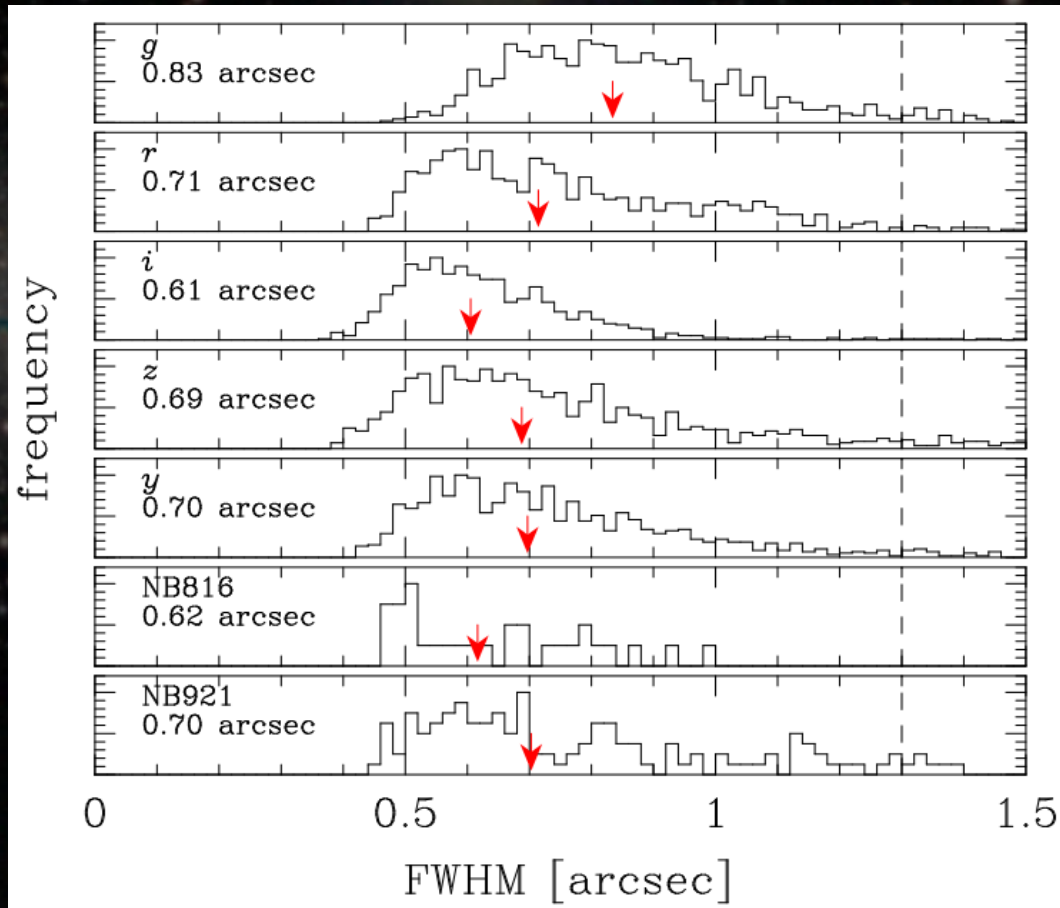
First Public Data Release



The release includes ~ 140 square degrees of deep, multi-color data. This is 1/10 of the total survey area. The figure shows one of the survey stripes.

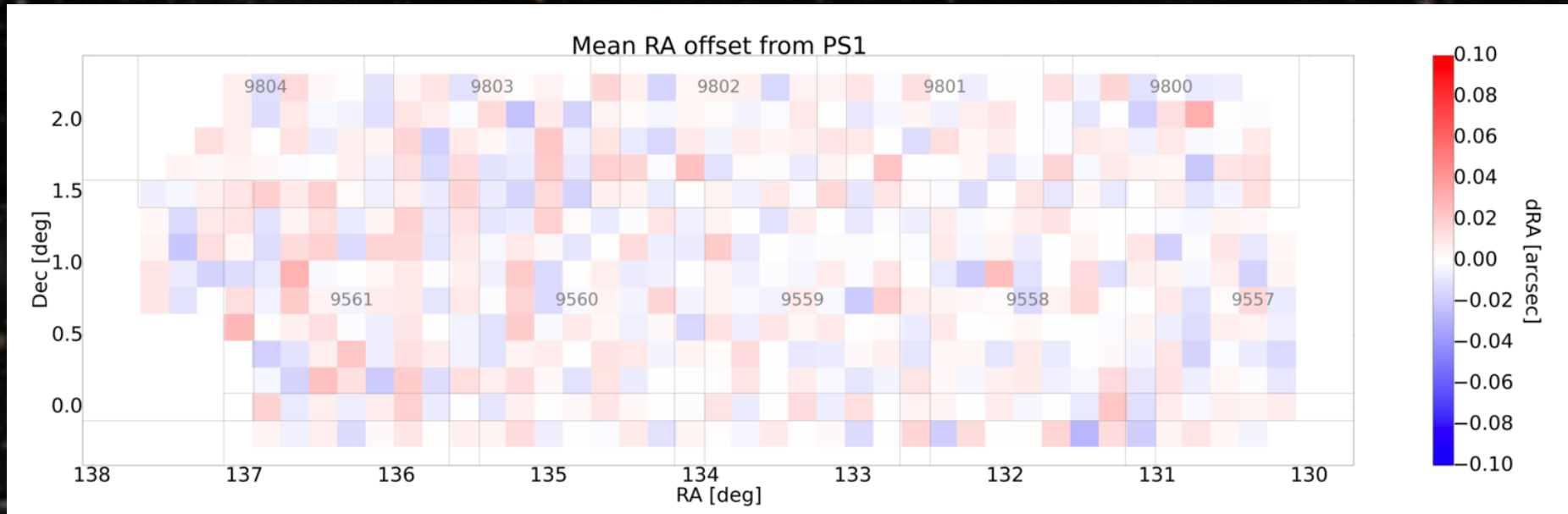
The release includes 7×10^7 objects. The total data volume is about 80Tbytes.

First Public Data Release



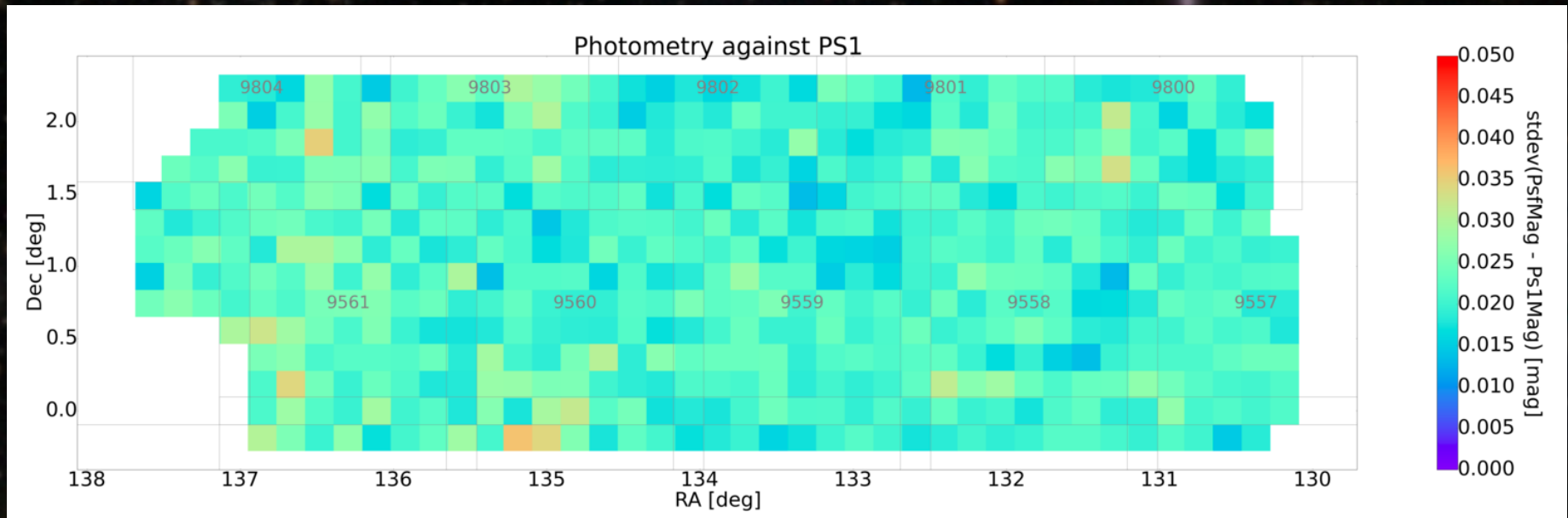
Excellent image quality – the median seeing in the i-band is 0.6 arcsec!

Data Quality – astrometry



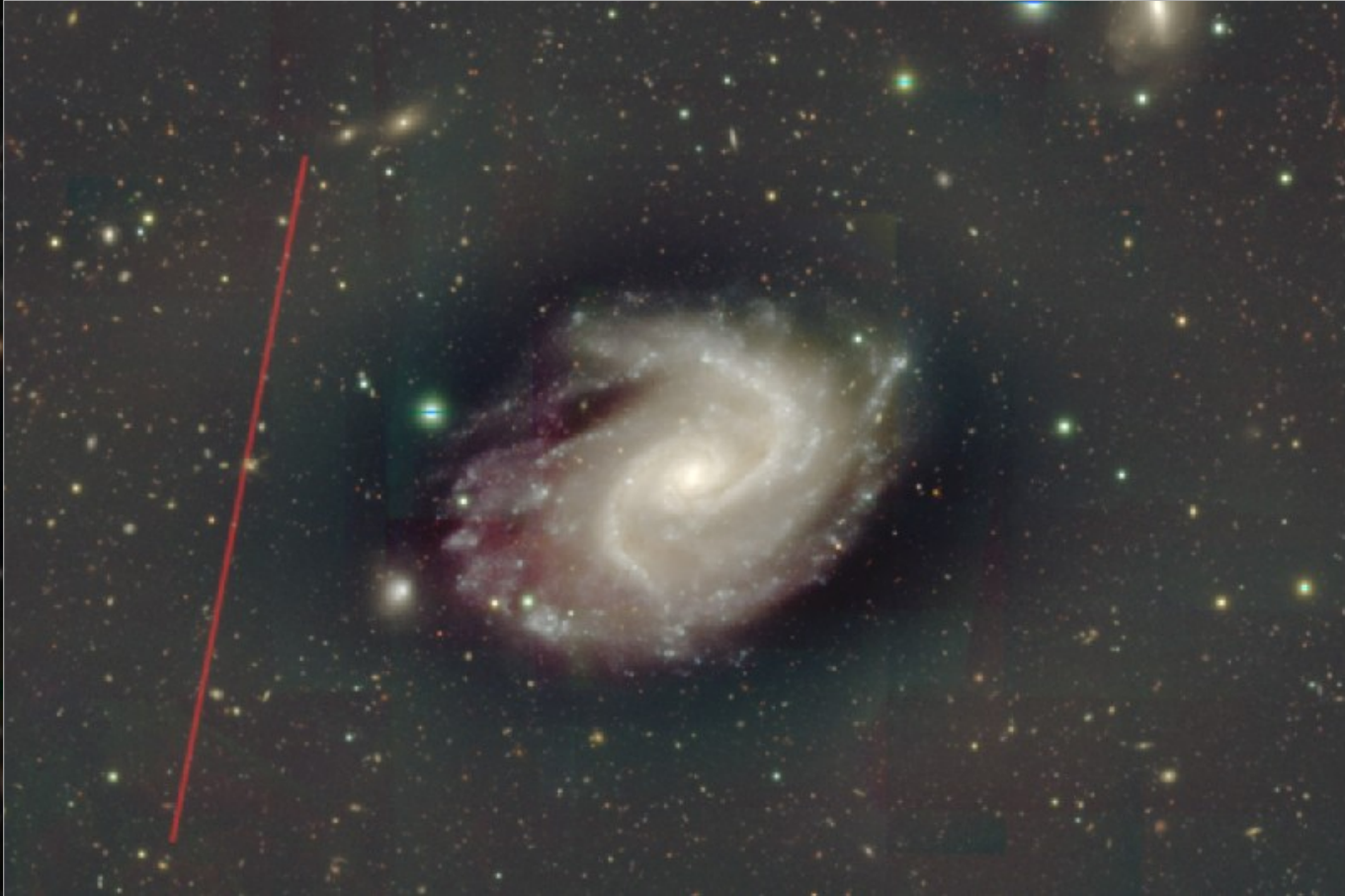
Our astrometry against an external data (PanSTARRS1) is about ~40 milli-arcsec. This is sufficient for most science cases.

Data Quality – photometry



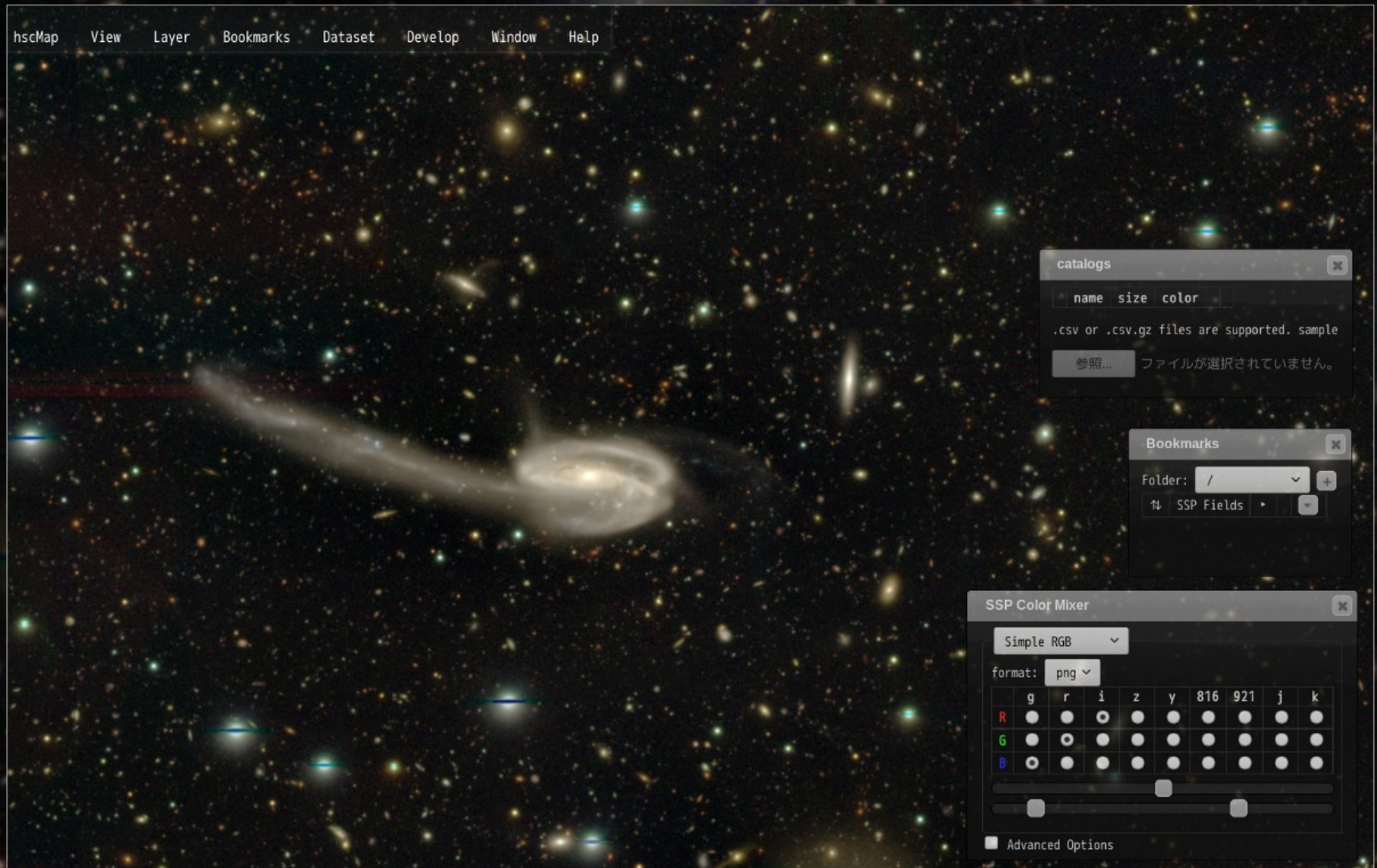
Our photometry against PanSTARRS1 is about ~ 0.02 mag rms.
Slightly worse than the 1% goal, but we are close.

Known problems



There are known problems in our data, but future improvements in the pipeline will hopefully mitigate them.

Dedicated Databases and User Interfaces



First Data Release of the Hyper Suprime-Cam Subaru Strategic Program

Hiroaki Aihara¹, Robert Armstrong², Steven Bickerton³, James Bosch², Jean Coupon⁴, Hisanori Furusawa⁵, Yusuke Hayashi⁵, Hiroyuki Ikeda⁵, Yukiko Kamata⁵, Hiroshi Karoji^{6,2}, Satoshi Kawanomoto⁵, Michitaro Koike⁵, Yutaka Komiyama^{5,7}, Dustin Lang^{8,9}, Robert H. Lupton², Sogo Mineo⁵, Hironao Miyatake^{10,11}, Satoshi Miyazaki^{5,7}, Tomoki Morokuma^{12,11}, Yoshiyuki Obuchi⁵, Yukie Oishi⁵, Yuki Okura^{13,14}, Paul A. Price², Tadafumi Takata^{5,7}, Manobu M. Tanaka¹⁵, Masayuki Tanaka^{5,*}, Yoko Tanaka¹⁶, Tomohisa Uchida¹⁵, Fumihiro Uraguchi⁵, Yousuke Utsumi¹⁷, Shiang-Yu Wang¹⁸, Yoshihiko Yamada⁵, Hitomi Yamanoi⁵, Naoki Yasuda¹¹, Nobuo Arimoto^{16,7}, Masashi Chiba¹⁹, Francois Finet¹⁶, Hiroki Fujimori²⁰, Seiji Fujimoto²¹, Junko Furusawa⁵, Tomotsugu Goto²², Andy Goulding², James E. Gunn², Yuichi Harikane^{21,23}, Takashi Hattori¹⁶, Masao Hayashi⁵, Krzysztof G. Helminiak²⁴, Ryo Higuchi²¹, Chiaki Hikage¹¹, Paul T.P. Ho^{18,25}, Bau-Ching Hsieh¹⁸, Kuiyun Huang²⁶, Song Huang^{27,11}, Masatoshi Imanishi^{5,7}, Ikuru Iwata^{16,7}, Anton T. Jaelani¹⁹, Hung-Yu Jian¹⁸, Nobunari Kashikawa^{5,7}, Nobuhiko Katayama¹¹, Takashi Kojima^{21,23}, Akira Konno²¹, Shintaro Koshida¹⁶, Alexie Leauthaud²⁷, C.-H. Lee¹⁶, Lihwai Lin¹⁸, Yen-Ting Lin¹⁸, Rachel Mandelbaum²⁸, Yoshiaki Matsuoaka^{5,29}, Elinor Medezinski², Shoken Miyama^{17,30}, Rieko Momose²², Anupreeta More¹¹, Surhud More¹¹, Shiro Mukae²¹, Ryoma Murata^{11,1}, Hitoshi Murayama^{11,31,32}, Tohru Nagao²⁹, Fumiaki Nakata¹⁶, Mana Niida³³, Hiroko Niikura^{1,11}, Atsushi J. Nishizawa³⁴, Masamune Oguri^{35,11,1}, Nobuhiro Okabe^{36,17}, Yoshiaki Ono²¹, Masato Onodera¹⁶, Masafusa Onoue^{5,7}, Masami Ouchi^{12,11}, Tae-Soo Pyo¹⁶, Takatoshi Shibuya²¹, Kazuhiro Shimasaku²³, Melanie Simet³⁷, Joshua Speagle^{38,11}, David N. Spergel^{2,39}, Michael A. Strauss², Yuma Sugahara^{21,23}, Naoshi Sugiyama^{40,11}, Yasushi Suto^{1,35}, Nao Suzuki¹¹, Philip J. Tait¹⁶, Masahiro Takada¹¹, Tsuyoshi Terai¹⁶, Yoshiaki Toba¹⁸, Edwin L. Turner^{2,11,1}, Hisakazu Uchiyama⁷, Keichi Umetsu¹⁸, Yuji Urata⁴¹, Tomonori Usuda^{5,7}, Sherry Yeh¹⁶, Suraphong Yuma⁴²,

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Data Release Paper with 110 authors!

The data release happened on the Feb 28th.
I posted the paper to arXiv on the 27th.

From arXiv:

Your article is scheduled to be
announced at Tue, 28 Feb 2017
01:00:00 GMT.

...but, the paper did not appear in the
listing on the 28th. Why?

Your submission was on hold
pending decision on
classification. It was released
and it is scheduled to be
announced in the next mailing
list.

Our paper was #1 in the listing!

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received from Mon 27 Feb 17 19:00:00 GMT to Tue 28 Feb 17 19:00:00 GMT

\\

arXiv:1702.08449

Date: Mon, 27 Feb 2017 07:47:42 GMT (5521kb)

Title: First Data Release of the Hyper Suprime-Cam Subaru Strategic Program

Authors: Hiroaki Aihara, Robert Armstrong, Steven Bickerton, James Bosch, Jean Coupon, Hisanori Furusawa, Yusuke Hayashi, Hiroyuki Ikeda, Yukiko Kamata, Hiroshi Karoji, Satoshi Kawanomoto, Michitaro Koike, Yutaka Komiyama, Robert H. Lupton, Sogo Mineo, Hironao Miyatake, Satoshi Miyazaki, Tomoki Morokuma, Yoshiyuki Obuchi, Yukie Oishi, Yuki Okura, Paul A. Price, Tadafumi Takata, Manabu M. Tanaka, Masayuki Tanaka, Yoko Tanaka, Tomohisa Uchida, Fumihiro Uruguchi, Yousuke Utsumi, Shiang-Yu Wang, Yoshihiko Yamada, Hitomi Yamanoi, Naoki Yasuda, Nobuo Arimoto, Masashi Chiba, Francois Finet, Hiroki Fujimori, Seiji Fujimoto, Junko Furusawa, Tomotsugu Goto, Andy Goulding, James E. Gunn, Yuichi Harikane, Takashi Hattori, Masao Hayashi, Krzysztof G. Helminiak, Ryo Higuchi, Chiaki Hikage, Paul T.P. Ho, Bau-Ching Hsieh, et al. (57 additional authors not shown)

Categories: astro-ph.IM astro-ph.EP astro-ph.GA astro-ph.HE astro-ph.SR

Comments: 33 pages, 19 figures. Draft paper to be submitted to PASJ special issue in a month. Data available at <https://hsc-release.mtk.nao.ac.jp/>
\\

The Hyper Suprime-Cam Subaru Strategic Program (HSC-SSP) is a three-layered imaging survey aimed at addressing some of the most outstanding questions in astronomy today, including the nature of dark matter and dark energy. The survey has been awarded 300 nights of observing time at the Subaru Telescope. The survey started in March 2014. This paper presents the first public data release of HSC-SSP. This release includes data taken in the first 1.7 years of observations (61.5 nights) and each of the Wide, Deep, and UltraDeep layers covers about 108, 26, and 4 square degrees down to depths of $i \sim 26.4$, ~ 26.5 , and ~ 27.2 mag, respectively (5 sigma for point sources). All the layers are observed in five broad-bands (grizy) and the Deep and UltraDeep layers are observed in narrow-bands as well. We achieve an impressive image quality of 0.6 arcsec in the i -band in the Wide layer. We show that we achieve 1-2 per cent PSF photometry (rms) both internally and externally (against Pan-STARRS1), and ~ 10 mas and ~ 40 mas internal and external astrometric accuracy, respectively.



Topics



Tweet



Print This Article

First Public Data Release by the Hyper Suprime-Cam Subaru Strategic Program

February 27, 2017

Figuring out the fate of the Universe is one step closer. The first massive dataset of a "cosmic census" is released using the largest digital camera on the Subaru Telescope. Beautiful images are available for public at large.

The first dataset from the Hyper Suprime-Cam Subaru Strategic Program (HSC-SSP) was released to the public on February 27th, 2017. HSC-SSP is a large survey being done using HSC, which is an optical imaging camera mounted at the prime focus of the Subaru Telescope. HSC has 104 scientific CCDs (for a total of 870 million pixels) and a 1.77 square-degree field of view.



Topics

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→ [2015](#)

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→ [2008](#)

→ [2007](#)

→ [2006](#)

→ [2005](#)

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→ [2000](#)



Topics

First Public D Strategic Pro

February 27, 20

Figuring out the faintest "cosmic census" is a beautiful images and the first dataset for was released to the done using HSC, with the Subaru Telescope and a 1.77 square



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国立天文台

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7000万個の銀河公開 すばる望遠鏡で撮影

毎日新聞 2017年2月28日 12時29分 (最終更新 2月28日 13時52分)

宇宙 > 宇宙 > 話題 > 速報 > サイエンス > 社会 >

[PR]



国立天文台は28日、米ハワイ島のすばる望遠鏡の高性能カメラで撮影した7000万個の銀河のデータ公開を始めた。宇宙最大の謎である暗黒物質や暗黒エネルギーの解明を目指した「宇宙地図」作りの一環で、ホームページで見ることができる。

公開したのは2014年から約2年間に観測した画像やデータ。一度に満月9個分の範囲を撮影できるカメラで、観測域をずらしな

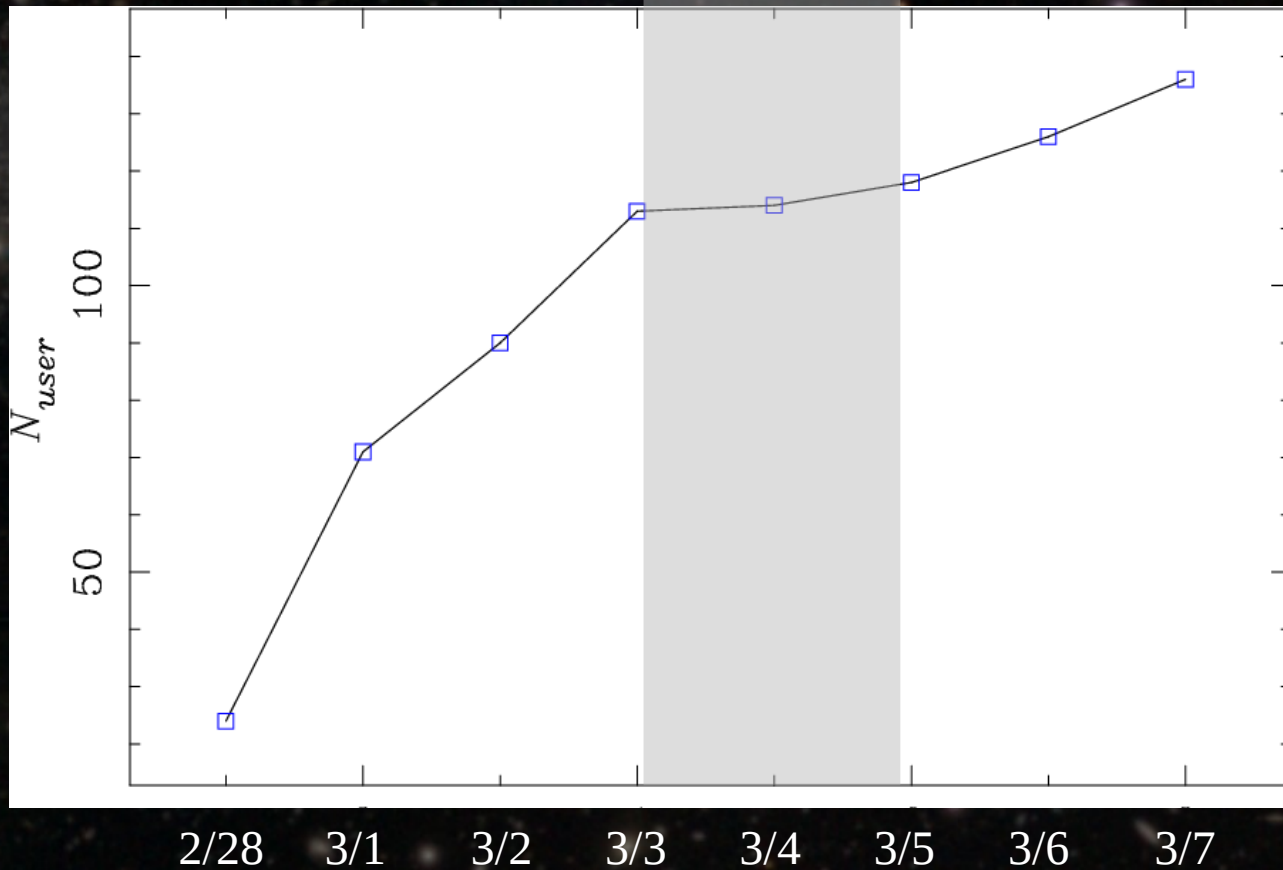
から撮影した画像を合成した。カバーはまだ全地球の300分の1程度で、観測を続け、4年後には30分の1程度となるデータの公開を目指すとしている。

公開画像からは、ろくぶんぎ座方向の数十億光年離れた宇宙に1000個以上の銀河が浮かぶ様子や、りゅう座方向の4億光年先にあるオタマジャクシの形をした銀河などが確認できた。データには、地球からの距離や明るさ、形なども含まれ、銀河の分布や形のゆがみを解析することで、暗黒物質や宇宙の起源の解明につながる成果が期待できるという。

➔ 2001

→ 2000

Database User Registration



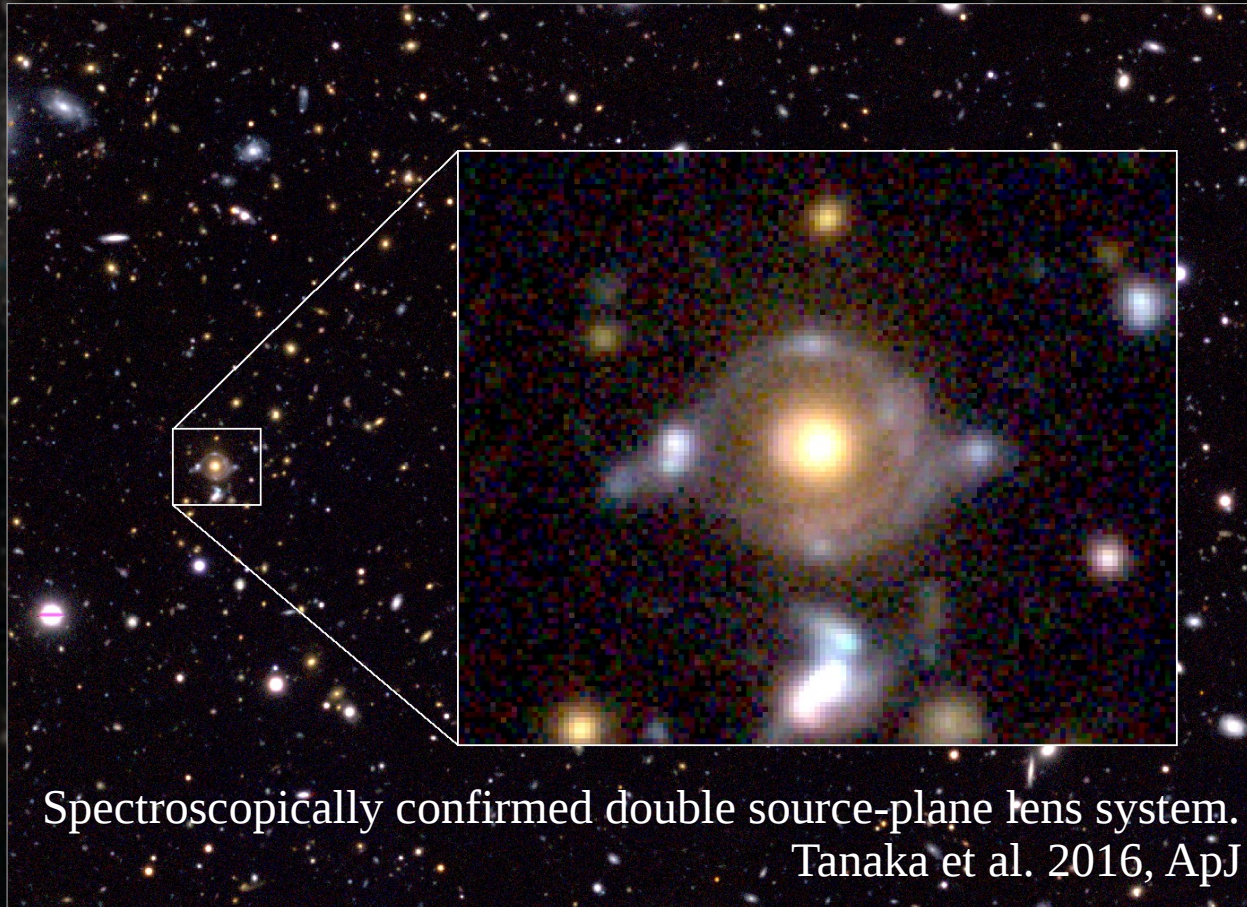
More than 100 registered users within 3 days. People started to use the HSC data.

HSC-SSP papers

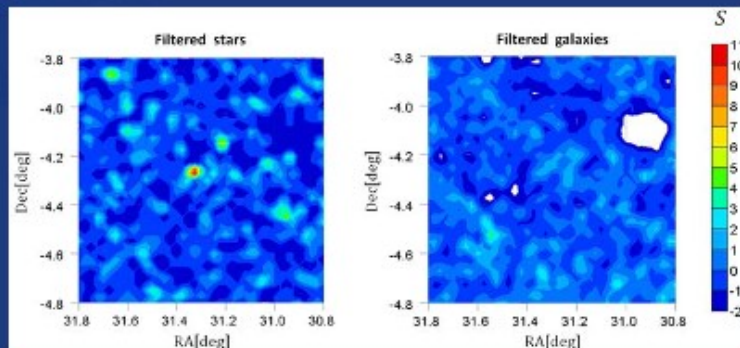
Science Publications in Refereed Journals:

1. **Toba et al. 2015, PASJ, 67, 86**, “Hyper-luminous dust-obscured galaxies discovered by the Hyper Suprime-Cam on Subaru and WISE”
2. **Harikane et al. 2016, ApJ, 821, 123** “Evolution of Stellar-to-Halo Mass Ratio at $z=0-7$ Identified by Clustering Analysis with the Hubble Legacy Imaging and Early Subaru/Hyper Suprime-Cam Survey Data”
3. **Matsuoka et al. 2016, ApJ, 828, 26** “Subaru high- z exploration of low-luminosity quasars (SHELLQs). I. Discovery of 15 quasars and bright galaxies at $5.7 < z < 6.9$ ”
4. **Chan et al. ApJ in press** “Galaxy-scale gravitational lens candidates from the Hyper Suprime-Cam imaging survey and the Galaxy And Mass Assembly spectroscopic survey”
5. **Tanaka et al 2016, ApJ, 826, L19** “A spectroscopically confirmed double source plane lens system in the Hyper Suprime-Cam Subaru Strategic Survey”
6. **Homma et al. 2016, ApJ, 832, 21** “A New Milky Way Satellite Discovered in the Subaru/Hyper Suprime-Cam Survey”
7. **More et al. 2016, MNRAS in press** “A new quadruple gravitational lens from the Hyper Suprime-Cam Survey: the dilemma of HSC~J115252+004733”
8. **Toba et al. 2017, ApJ, 835, 36**, “Clustering of infrared-bright dust-obscured galaxies revealed by the Hyper Suprime-Cam and WISE”
9. And a few more papers...

HSC-SSP papers



PASJ Publications of the Astronomical Society of Japan



HSC-SSP Special Issue 2017

We are preparing 40(?) papers for the PASJ special issue.

- Chiba-san reported on the discovery of new MW dwarf galaxies
- Oguri-san will give an overview of the lensing science.
- Nagao-san will describe the AGN science.

The special issue will cover other fields such as high- z galaxies.

It is finally the time to ‘harvest’ scientific results from the HSC data and write papers. Many exciting papers will come out.



Survey website and data release site:

<http://hsc.mtk.nao.ac.jp>

<https://hsc-release.mtk.nao.ac.jp>

Thank you for your attention!