木曽KWFCとすばるHSCでの超新星探査観測

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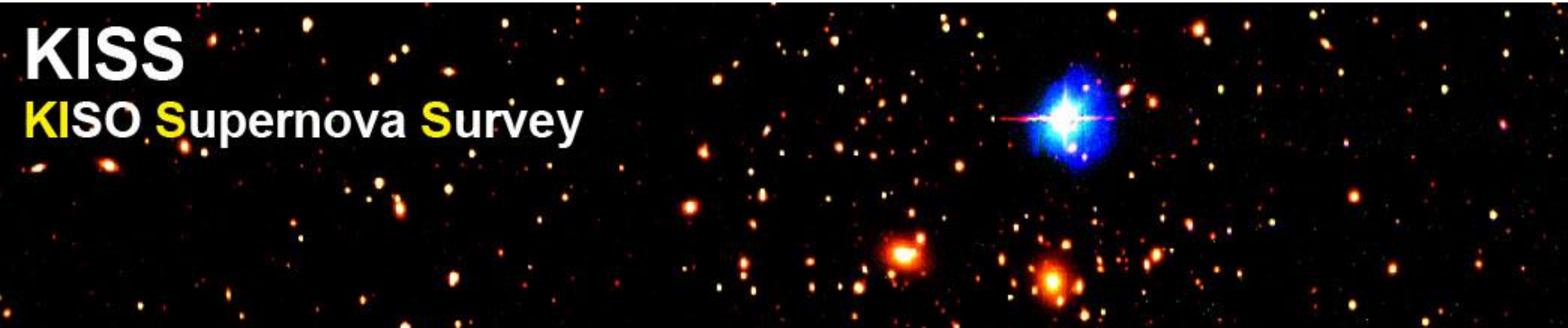
田中雅臣（国立天文台）
柴田拓実（甲南大学/JRA）
KISS/SHOOTの方々

目次

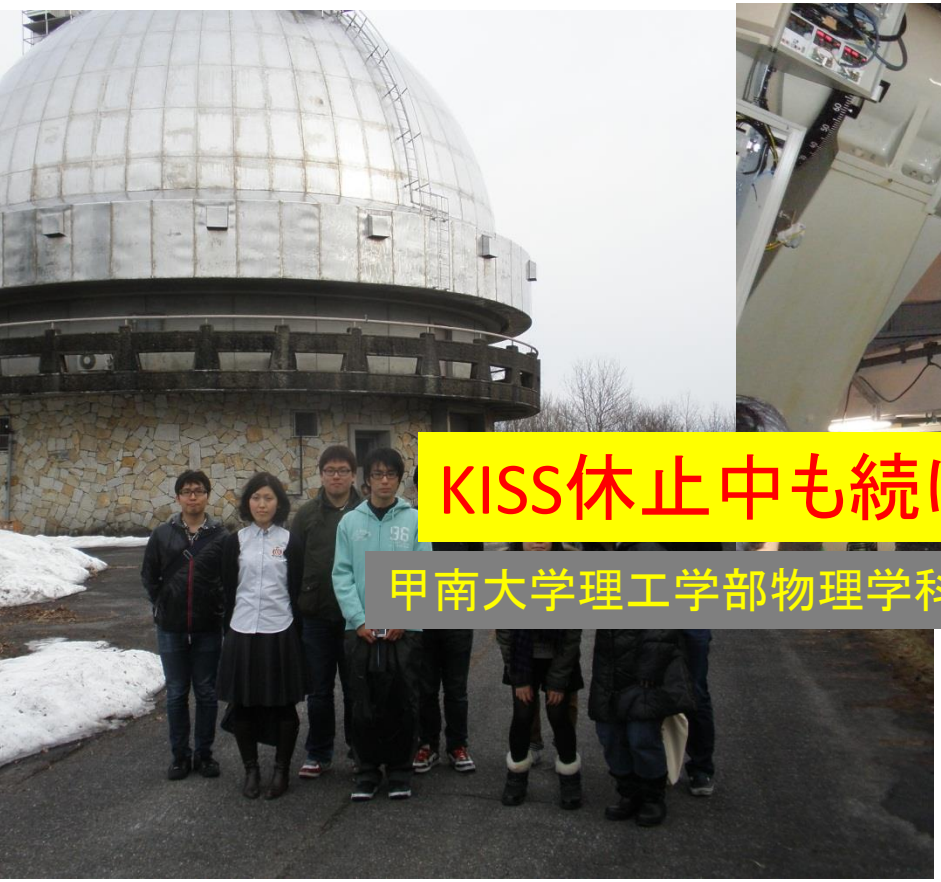
- Kiso Supernova Survey (KISS)
- Subaru HSC Survey Optimized for Optical Transients (SHOOT)

Kiso Supernova Survey (KISS)

- 諸隈さん講演
- 日本国内初の(ゼロから始める)超新星探査観測
- メンバー
  - 諸隈智貴(東大)、冨永望(甲南大)、田中雅臣(国立天文台)木曽関係者の皆様、東大・甲南大の学生、追観測メンバー、アマチュアの方々



KWFC大規模探査観測に向けた甲南大学観測実習
-平成2011-2014年度- 希望者のみ

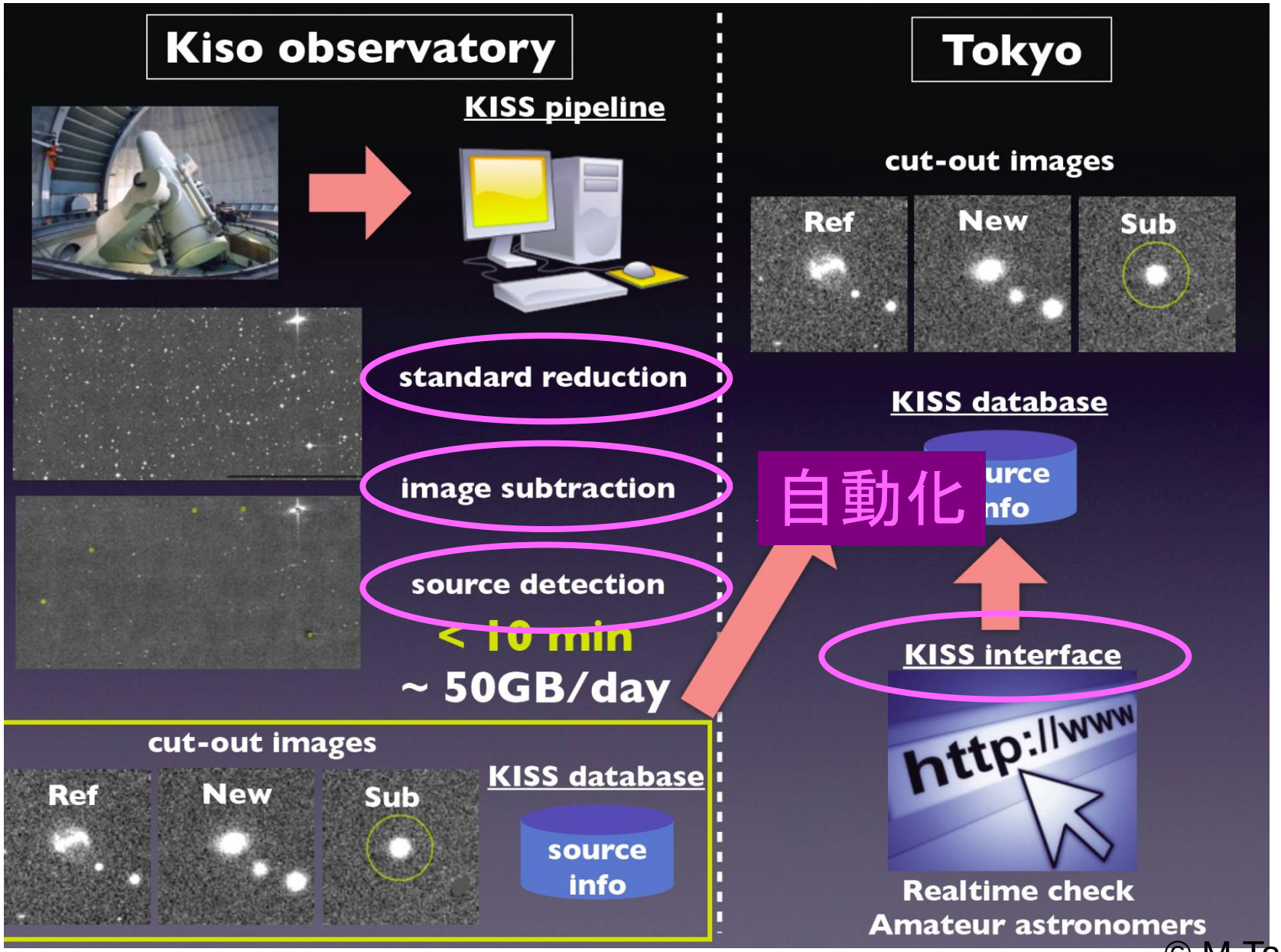


KISS休止中も続けさせてください。

甲南大学理工学部物理学科理論研究室の魅力のひとつ

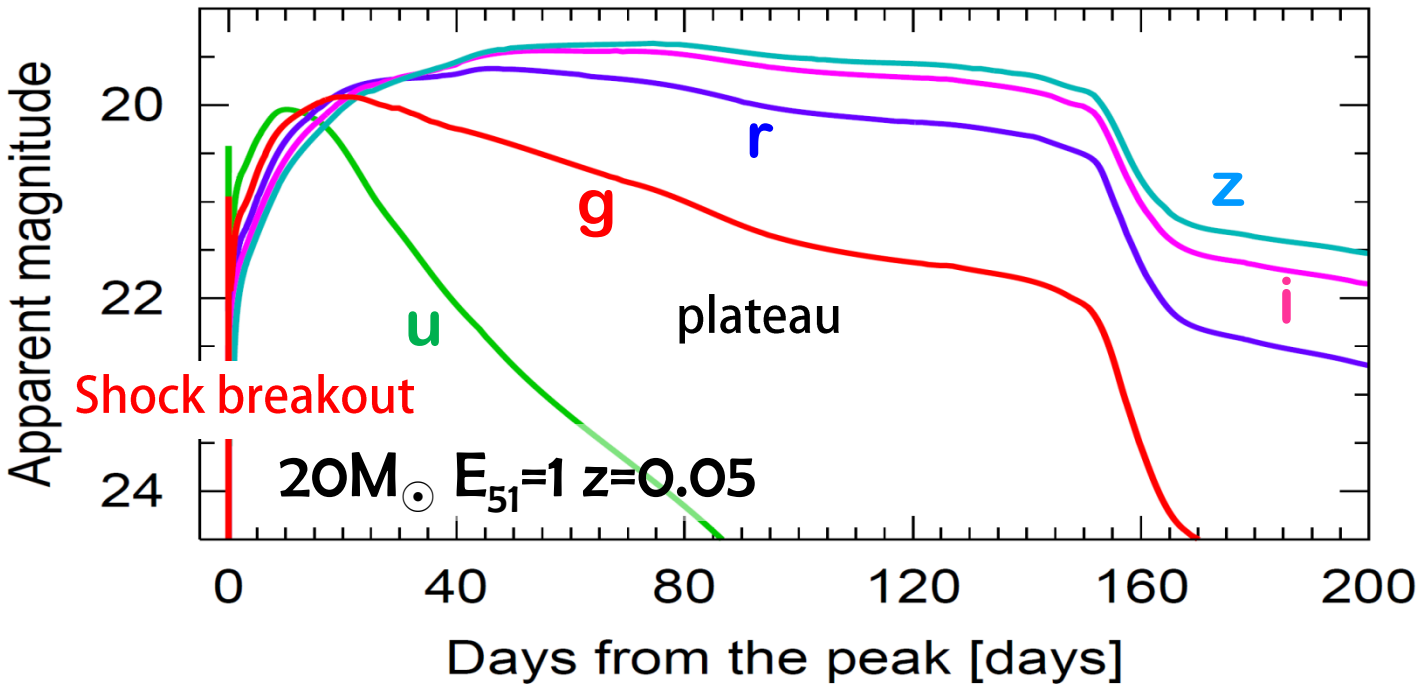
実習参加者:8割以上
卒業論文:2件
修士論文:1件

超新星探査観測



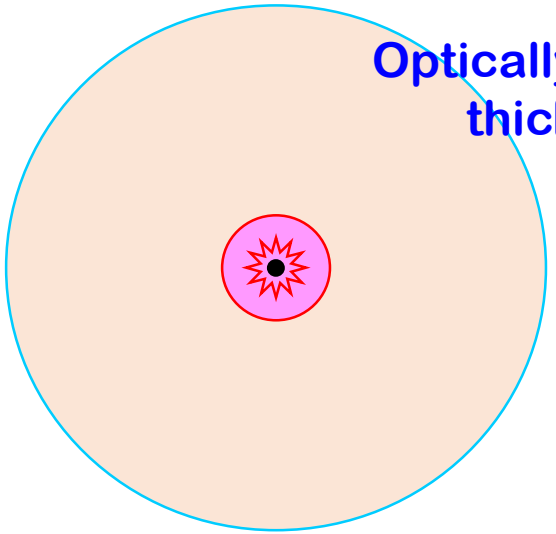
KISS primary science

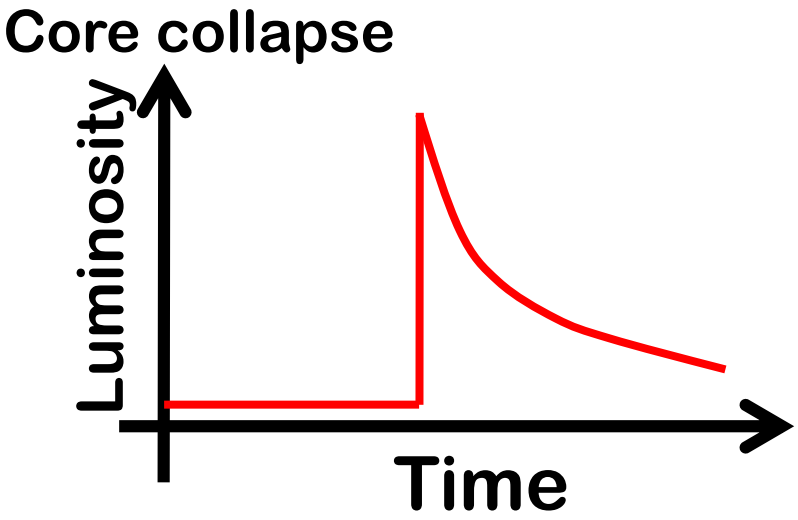
- 近傍のshock breakoutの検出
- $m_{plateau}$~20mag, m_{tail}~22mag
  - プラトー、スペクトルの追観測が可能
- Shock breakoutの物理の理解



NT+09;11

Shock breakout





Massive Star (>10$M_\odot$)

e$^-$-capture SNe (8-10$M_\odot$)

Core collapse

Shock formation

At the shock emergence, a stored energy is released as radiation.

Spectra are quasi-blackbody

$$T \sim R^{-3/4} E^{1/4}$$

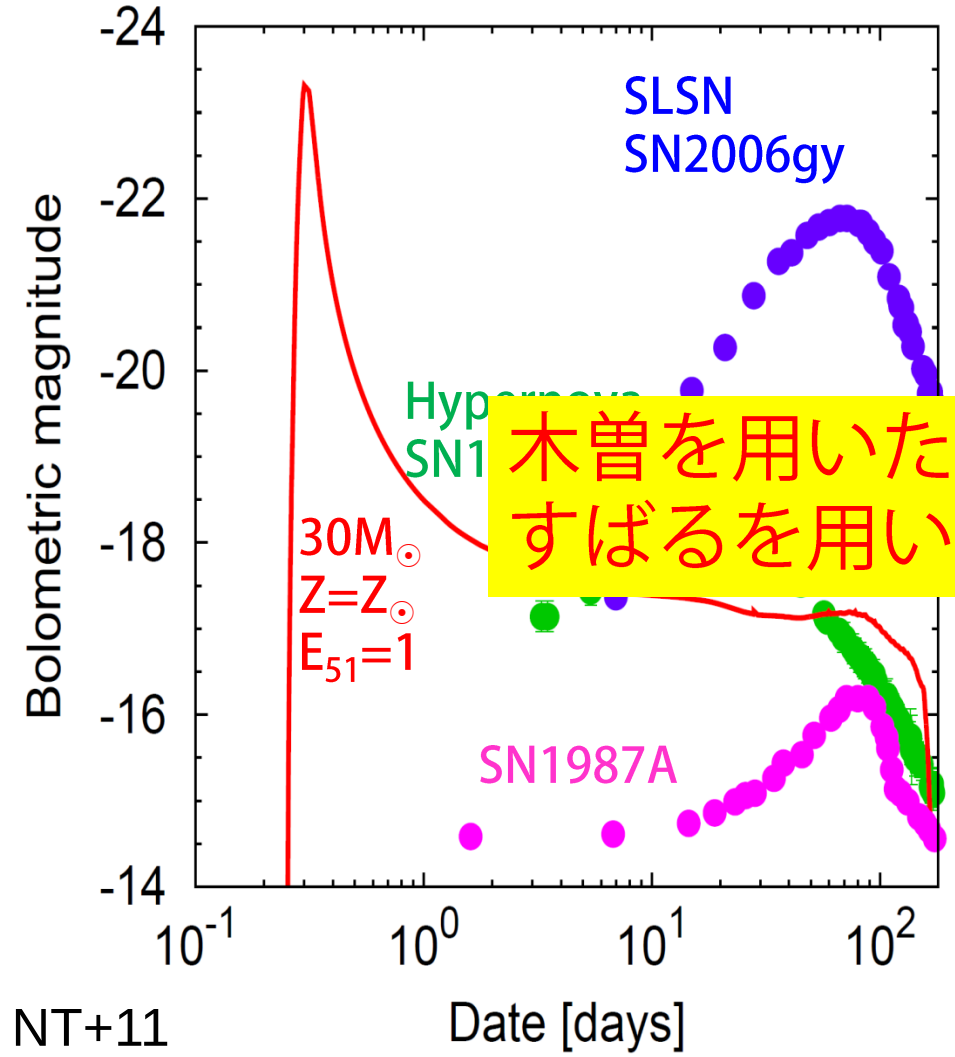
Typical properties

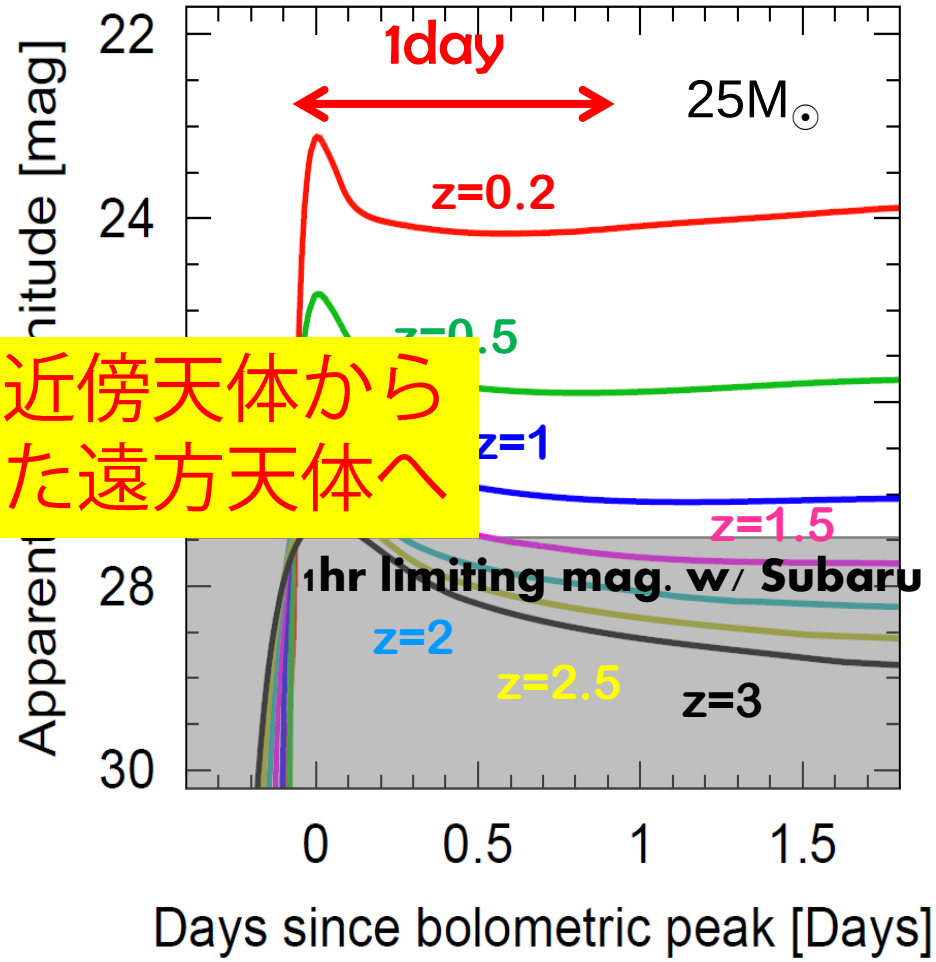
timescale: 1sec ~ 1day

peak wavelength: X-ray ~ UV

Why important?

- **Brighter than SLSN**
- **Detectable up to z~3**

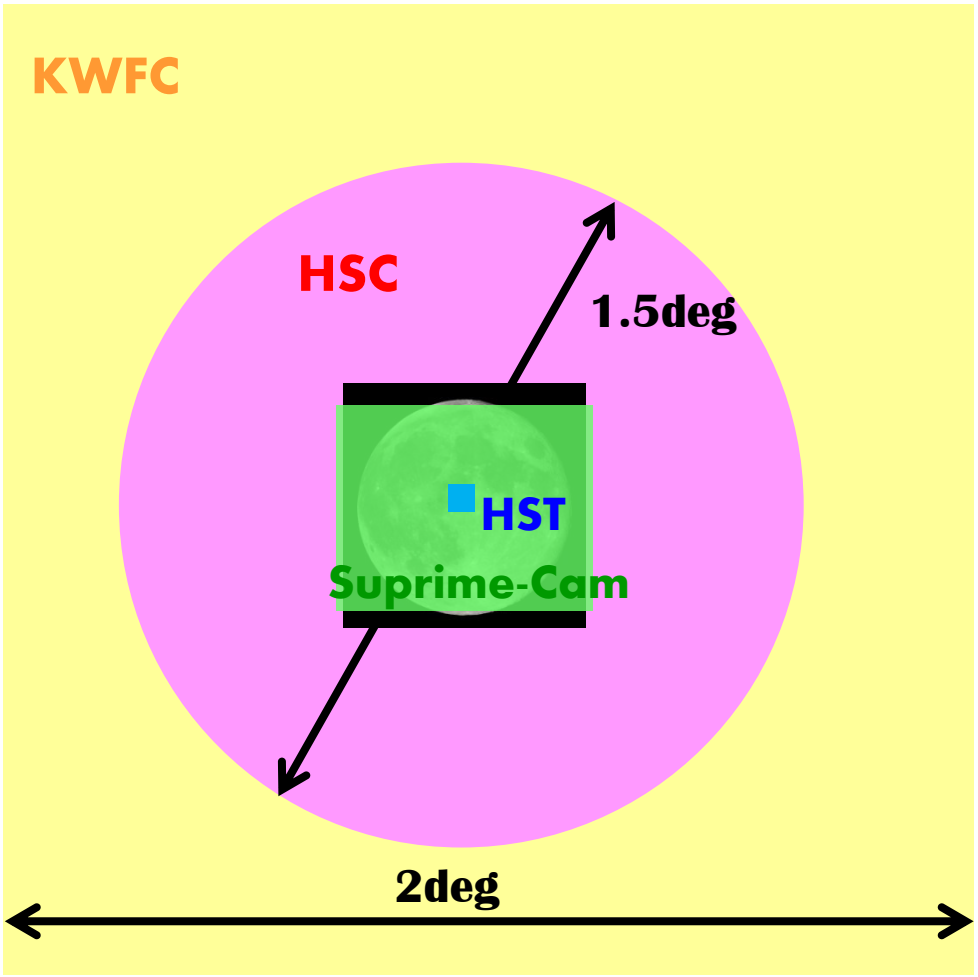


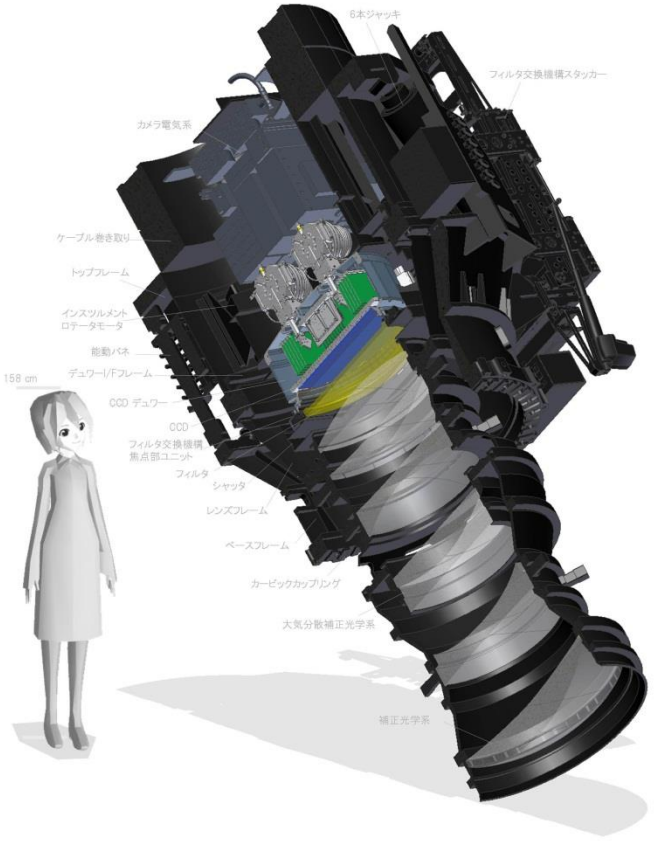


木曽を用いた近傍天体から
すばるを用いた遠方天体へ

NT+11

Hyper Suprime-Cam





Subaru Telescope/HSC

HSC Subaru strategic proposal (SSP)

- Primary science
  - Weak lensing
  - Galaxy evolution
  - SN Ia cosmology
- 300nights/5yrs
- 3 layers
  - Wide, Deep, Ultradeep

Transient science is free!!

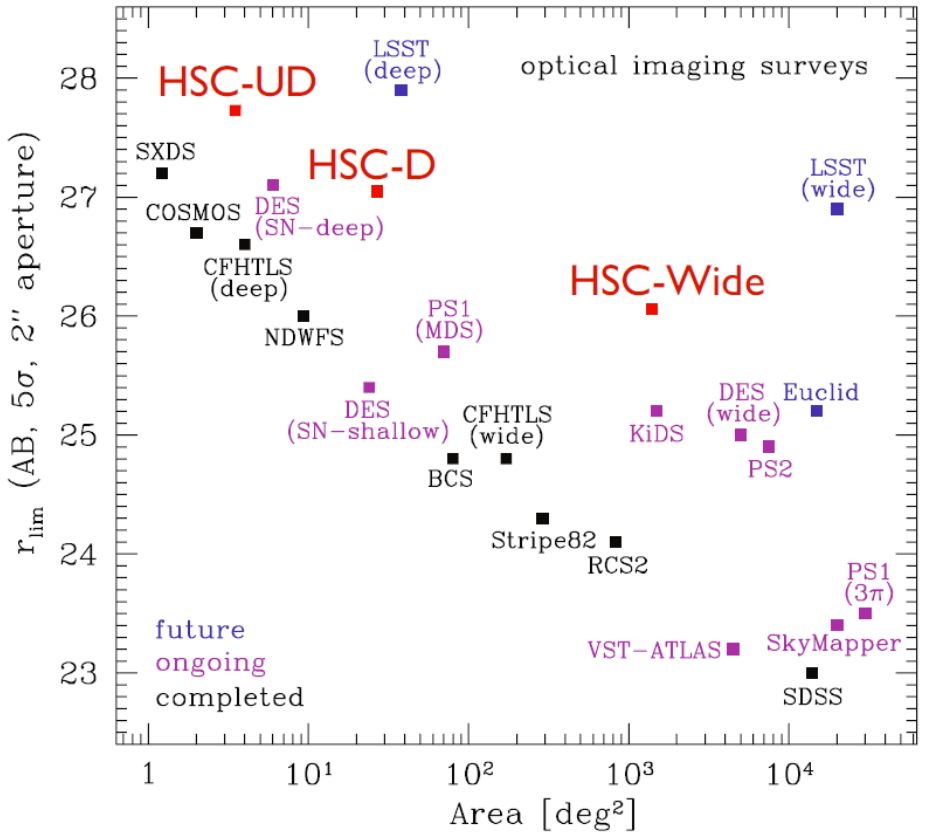
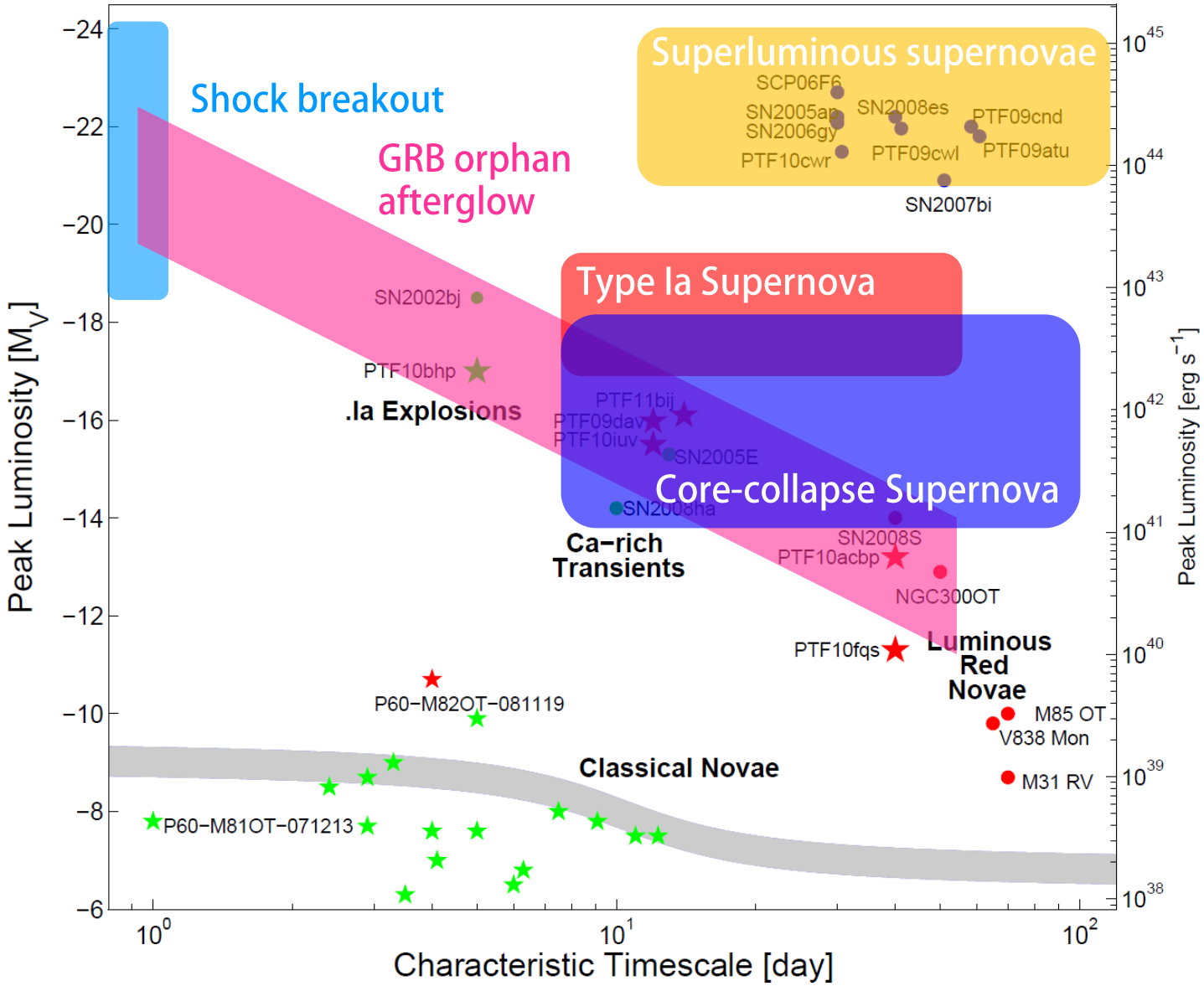


Table 1: **Summary of HSC-Wide, Deep and Ultradeep layers**

Layer	Area [deg^2]	# of HSC fields	Filters & Depth	Comoving volume [h^{-3}Gpc^3]	Key Science
Wide	1400	916	*grizy* ($r \simeq 26$)	$\sim 4.4\,(z < 2)$	WL cosmology, $z \sim 1$ gals, clusters
Deep	27	15	*grizy*+3NBs ($r \simeq 27$)	$\sim 0.5\,(1 < z < 5)$	$z \lesssim 2$ gals, reionization, WL calib.
Ultradeep	3.5	2	*grizy*+3NBs ($r \simeq 28$)	$\sim 0.07\,(2 < z < 7)$	$z \gtrsim 2$ gals, reionization, SNeIa

Transients with HSC-SSP

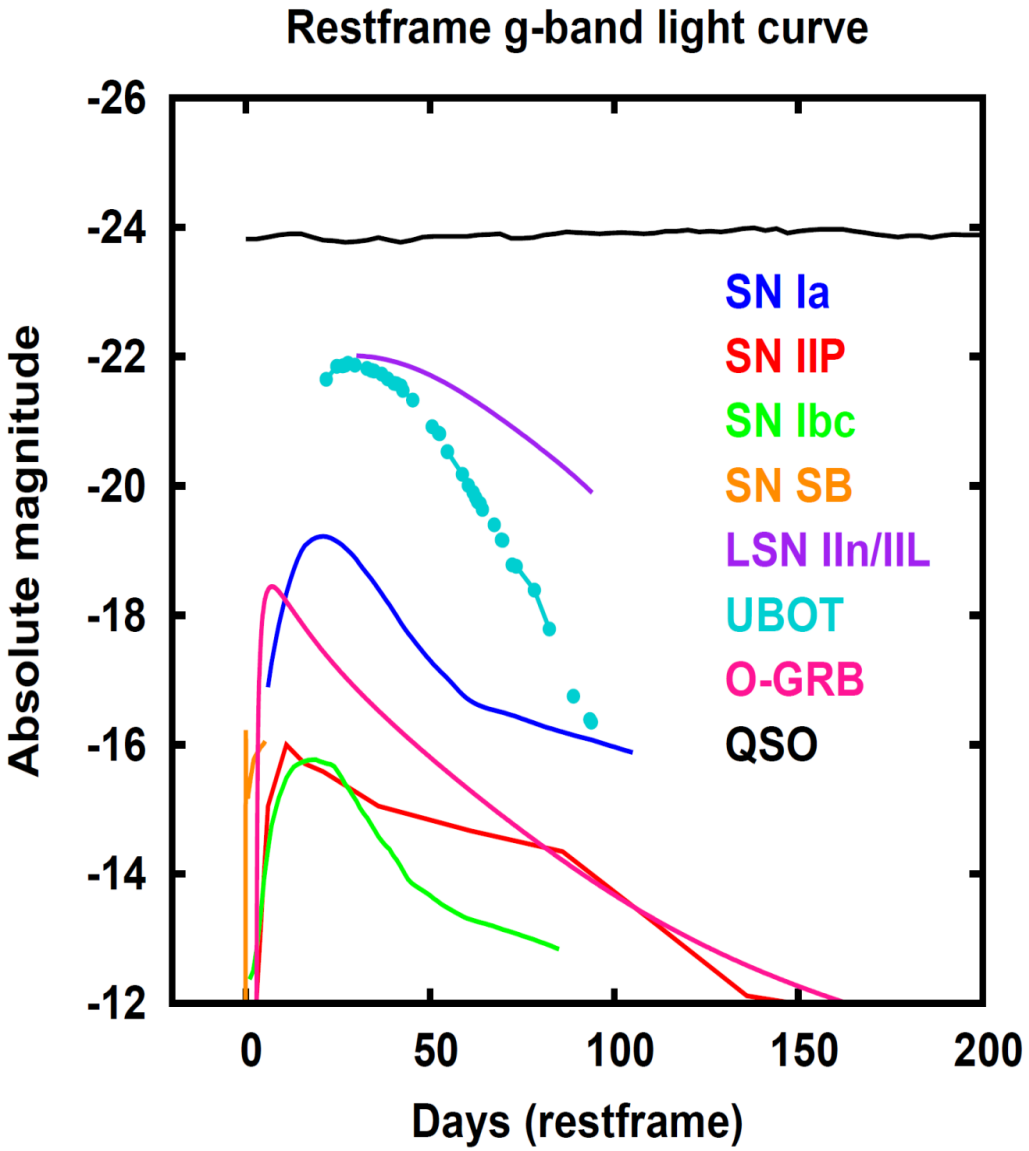
day ⟷ year

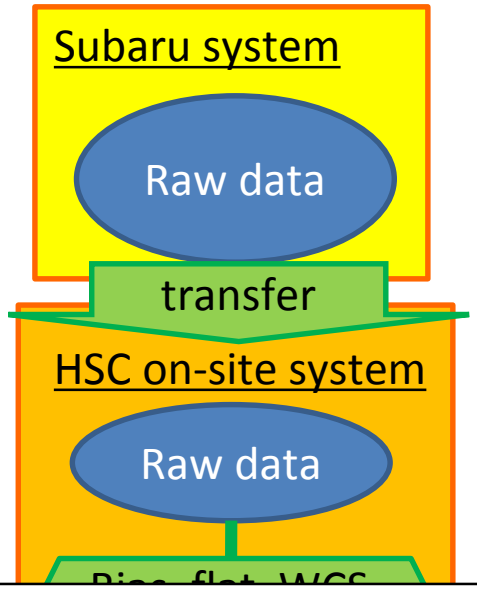


Kasliwal 11

Subaru HSC Survey Optimized for Optical Transients (SHOOT)

- Type Ia SN
- Core-Collapse SN
- Shock Breakout
- Type IIn/IIL LSN
- Type Ic LSN
- GRB Orphan Afterglow
- QSO

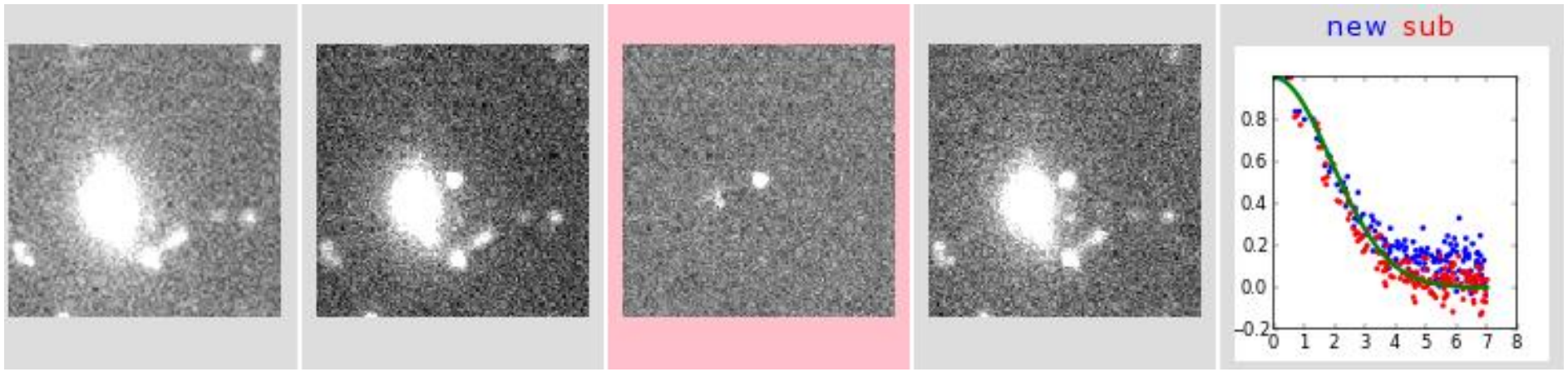


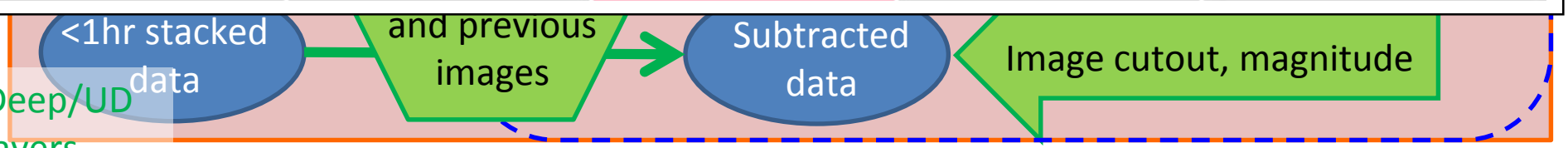


Preparation for HSC survey -real-time image subtraction system at Hilo-

We have developed a real-time data analysis system, in order to realize the immediate detection of transients (and the real-time follow-up obs. in future).

~30min after the exposures





Real-time detection and quick alert

First supernova candidates discovered with Subaru/Hyper Suprime-Cam

The Astronomer's Telegram

ATel #6291; *Nozomu Tominaga (Konan U./Kavli IPMU, U. Tokyo), Tomoki Morokuma (U. Tokyo), Masaomi Tanaka (NAOJ), Naoki Yasuda (Kavli IPMU, U. Tokyo), Hisanori Furusawa (NAOJ), Jian Jiang (U. Tokyo), Satoshi Miyazaki (NAOJ), Takashi J. Moriya (U. Bonn), Junichi Noumaru (NAOJ), Kiaina Schubert (NAOJ), and Tadafumi Takata (NAOJ)*
on 4 Jul 2014; 15:51 UT (Obs.: 02 and 03 Jul 2014)

ATel #6763; *+N. Okabe, T.Futamase* *on 27 Nov 2014; 18:03 UT* (Obs.: 26 and 27 Nov 2014)

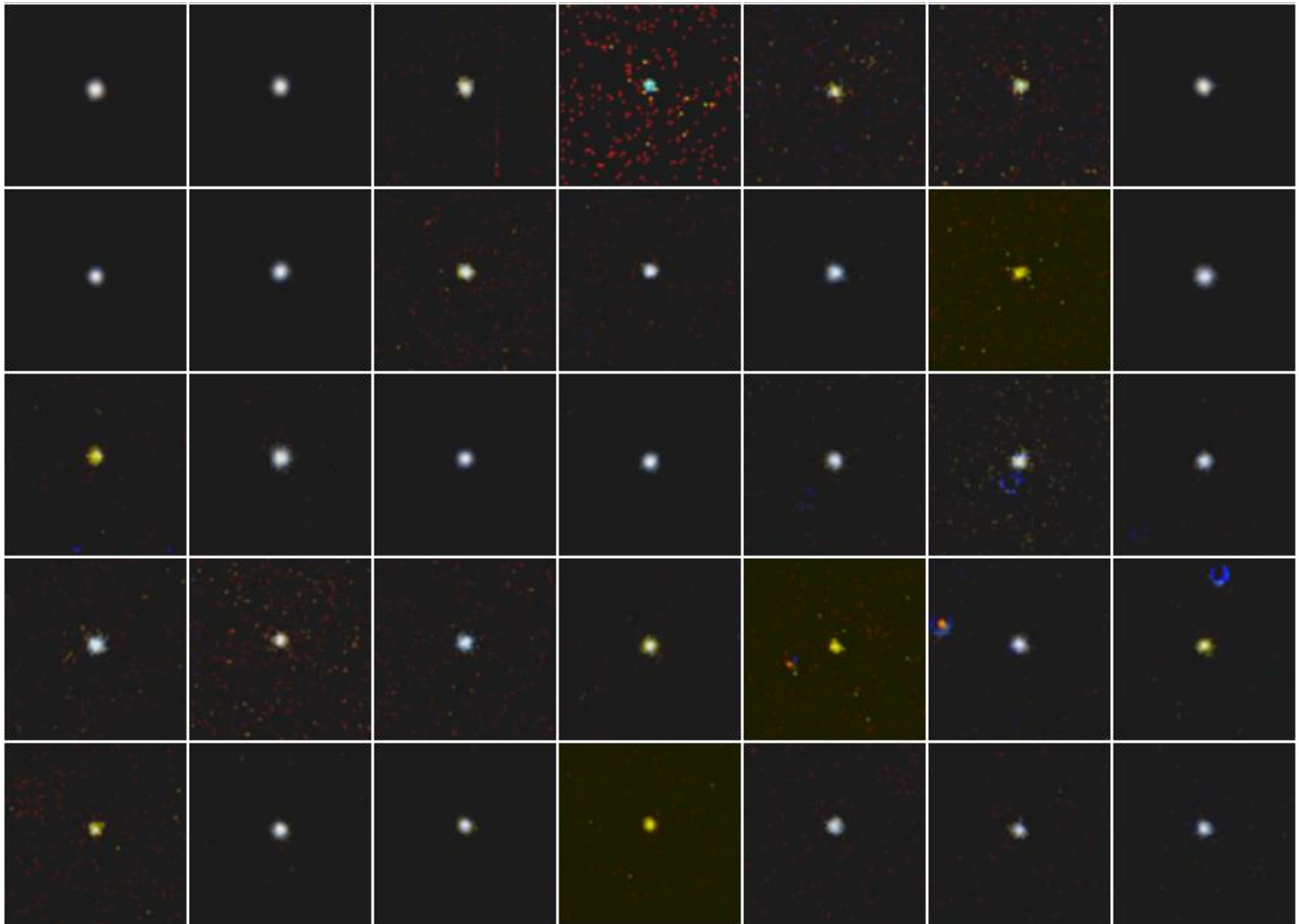
Fifty supernova candidates discovered with Subaru/Hyper Suprime-Cam

ATel #7565 ; *Nozomu Tominaga (Konan U./Kavli IPMU, U. Tokyo), Tomoki Morokuma (IoA, U. Tokyo/Kavli IPMU, U. Tokyo), Masaomi Tanaka (NAOJ/Kavli IPMU, U. Tokyo), Ji-an Jiang (U. Tokyo), Takahiro Kato (U. Tokyo), Yuki Taniguchi (U. Tokyo), Naoki Yasuda (Kavli IPMU, U. Tokyo), Hisanori Furusawa (NAOJ), Nobuhiro Okabe (Hiroshima Univ.), Toshifumi Futamase (Tohoku Univ.), Satoshi Miyazaki (NAOJ), Takashi J. Moriya (AIfA, U. Bonn), Junichi Noumaru (NAOJ), Kiaina Schubert (NAOJ), and Tadafumi Takata (NAOJ)*
on 26 May 2015; 15:23 UT (Obs.: 24 May 2015)

http://tpweb2.phys.konan-u.ac.jp/~tominaga/HSC-SN/

見つかった超新星

2012年7月 2013年7月 2014年7月



夢

すばるから木曽へのフィードバック

近傍 shock breakout 検出+追観測も必要

- 機械学習
  - ~100候補/露出 -> 0-1候補/露出
  - 自動即時追観測も可能に（MITSuMEなど）

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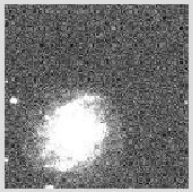
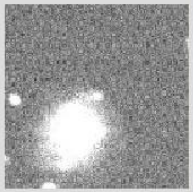
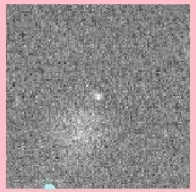
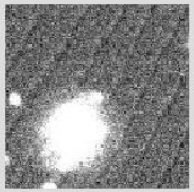
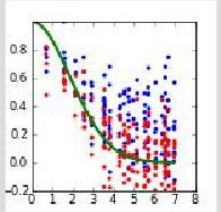
20	source ID 2656884 submit tominaga	KSFJ0324-0012 0099354_6 KISS15b					new sub 0.882 
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まとめ

- 木曽からすばるへ
  - 超新星探査観測の経験
  - システム開発
  - 遠方天体の検出に成功
- すばるから木曽へ
  - 近傍天体を使った詳細研究
  - 機械学習の導入
  - 自動追観測システム
  - Transient surveyor へ (KWFC, Tomo-e)
- 今後も木曽とすばるのふたつが必要