HSCを用いた超新星爆発研究

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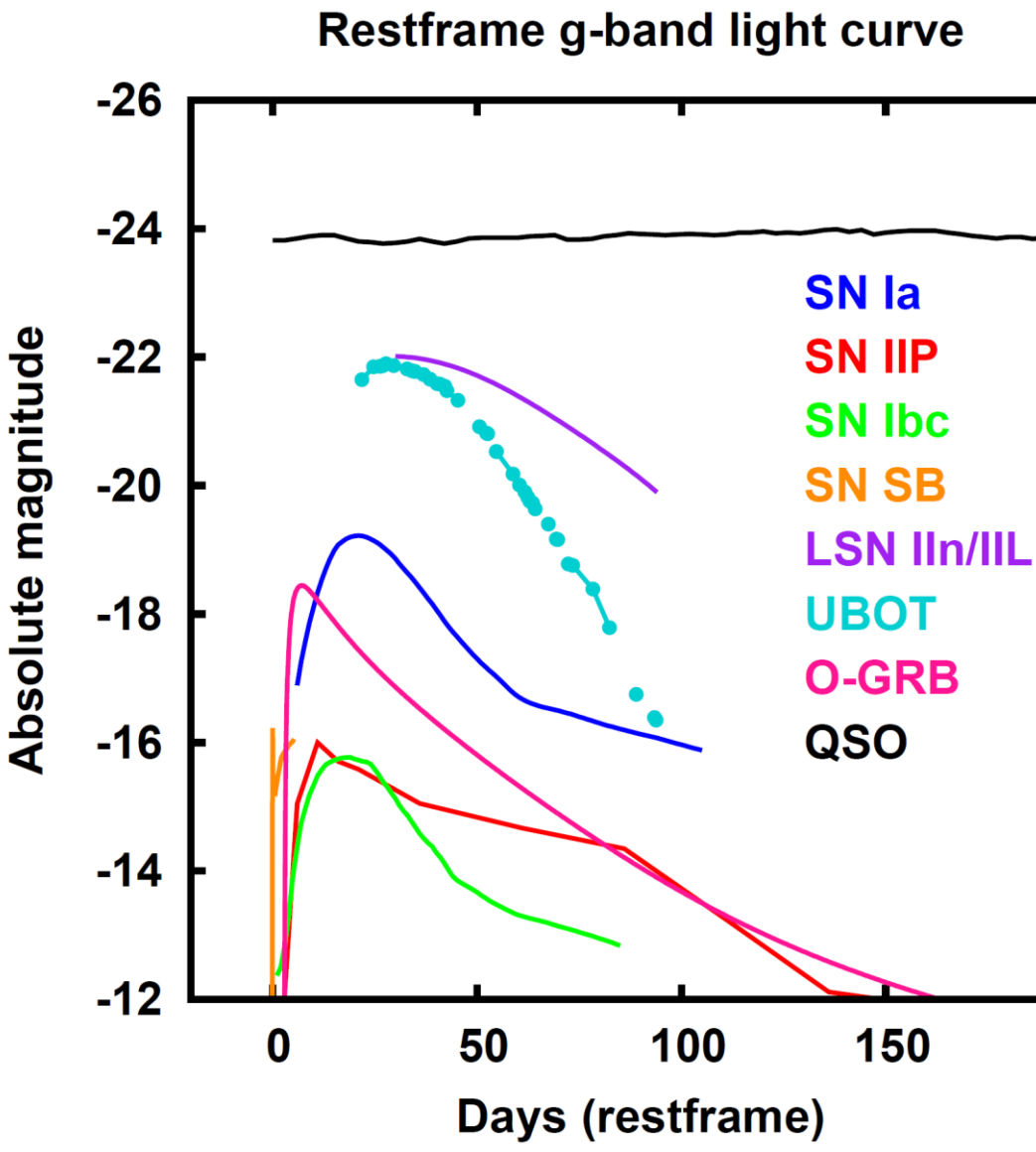
on behalf of
HSC-transient team

Contents

- Objectives
- Cadence requirements
- Strategy
- Science cases

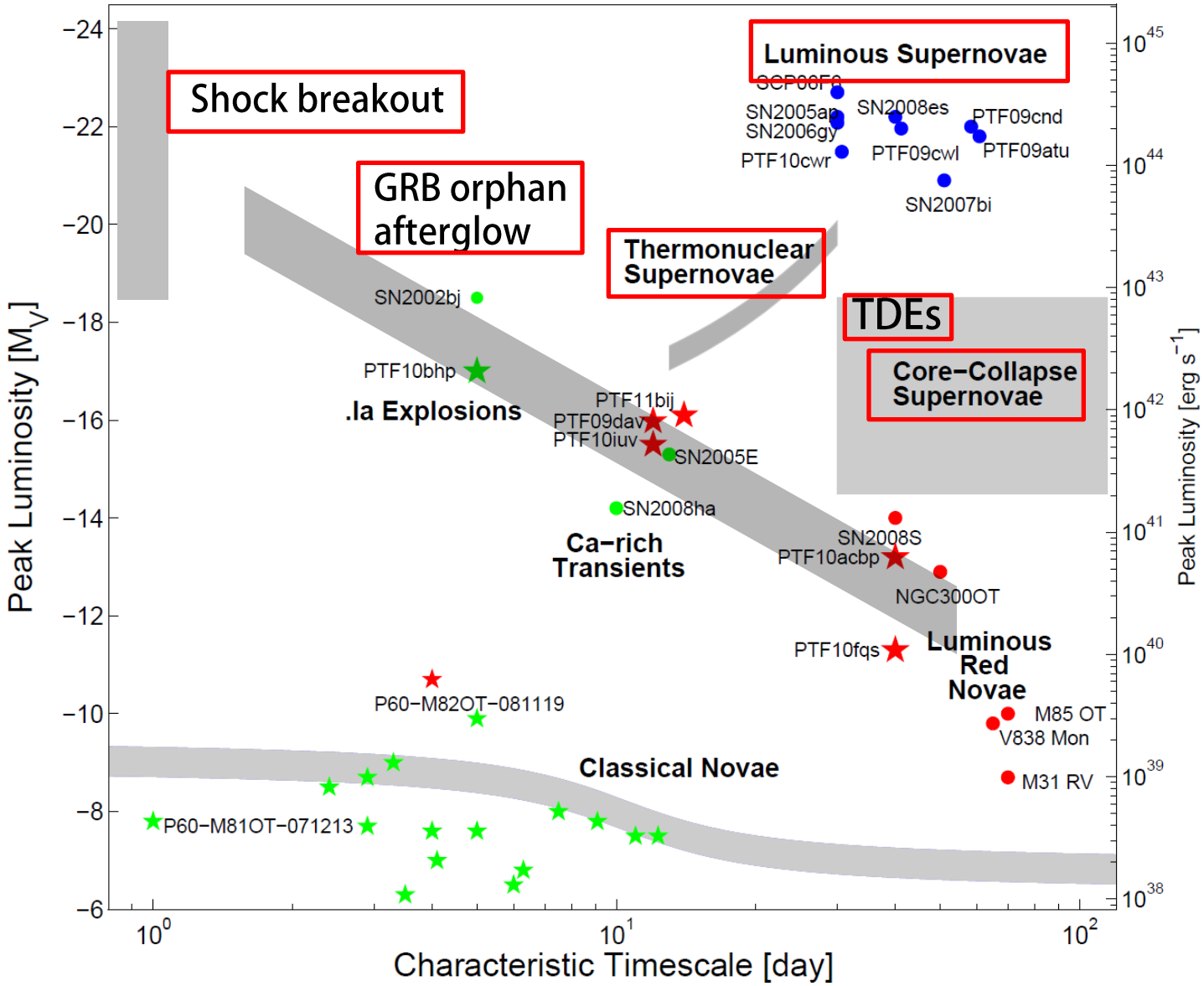
Objectives

- Type Ia SN
- Core-Collapse SN
- Shock Breakout
- Type IIn/IIL LSN
- Ultra-Bright Optical Transient
- GRB Orphan Afterglow
- QSO
- Tidal disruption event (TDE)



Time scales

day ⟷ year



Kasliwal 11

Cadence requirements

- τ~day → in a night and/or in a month
  - SN shock breakout
  - solar system, [weak lensing (i): >10-30min]
- τ~month → in a month and in 2-4 months
  - SN Ia, core-collapse SN, GRB orphan afterglow
  - AGN
- τ~1-several year(s) → in 5 years
  - Super Luminous SN
  - AGN

Survey strategy

led by Nishizawa-san, Yasuda-san, Tominaga

- Dynamic scheduling is compatible with transient studies to balance completeness and maintain cadence in the multi bands.
- Satisfactions of cadence requirements have small disadvantage in completeness and dead time. (preliminary)
  - Wide: daily/monthly schedule for WL, shock breakout, SS, AGN
  - Deep/UD: 1 intensive year for SNe Ia, CCSNe & continuous obs. over 5 years for SLSNe

Transient finding

- Catalog finding
  - make a photometric catalog for a reference image
  - compare it with a new catalog to find objects with flux variation
- Image subtraction
  - find variable objects in bright galaxies
  - a powerful tool commonly used for SNe and low-luminosity AGN

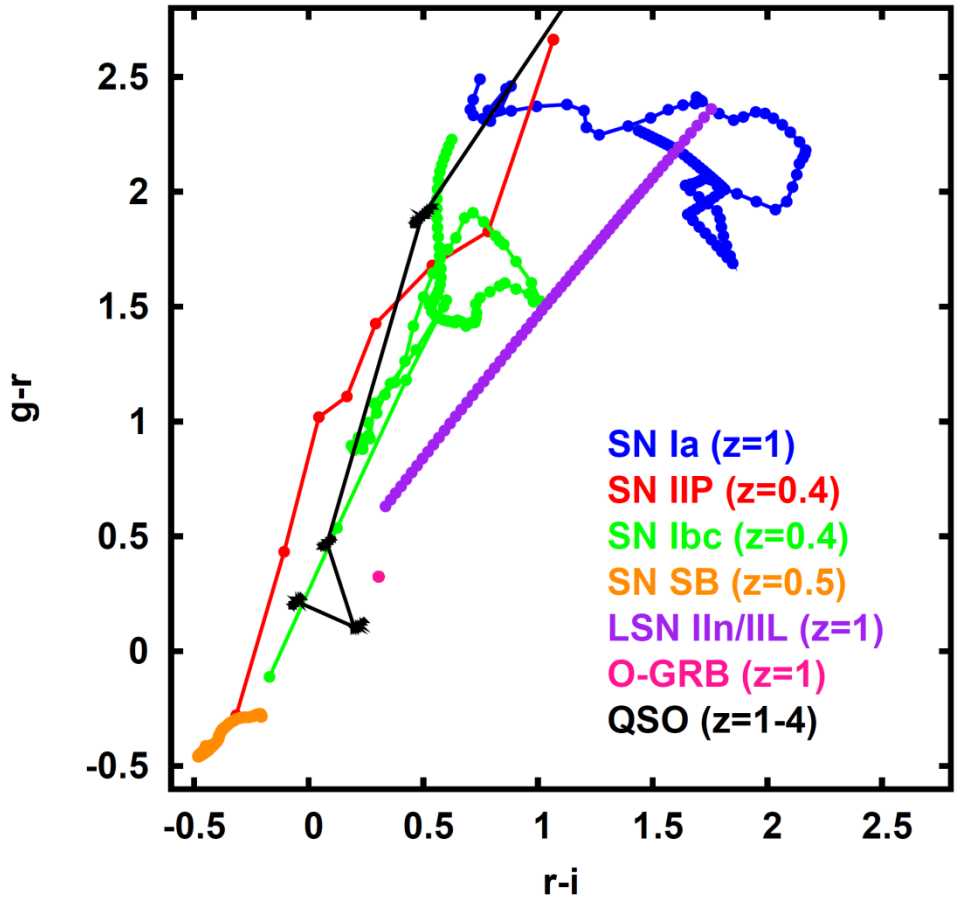
Transient classification

led by Tanaka-san, Urata-san

- Color (evolution) & multicolor light curves
- Photometric/spectroscopic redshift

In Taiwan, we are testing

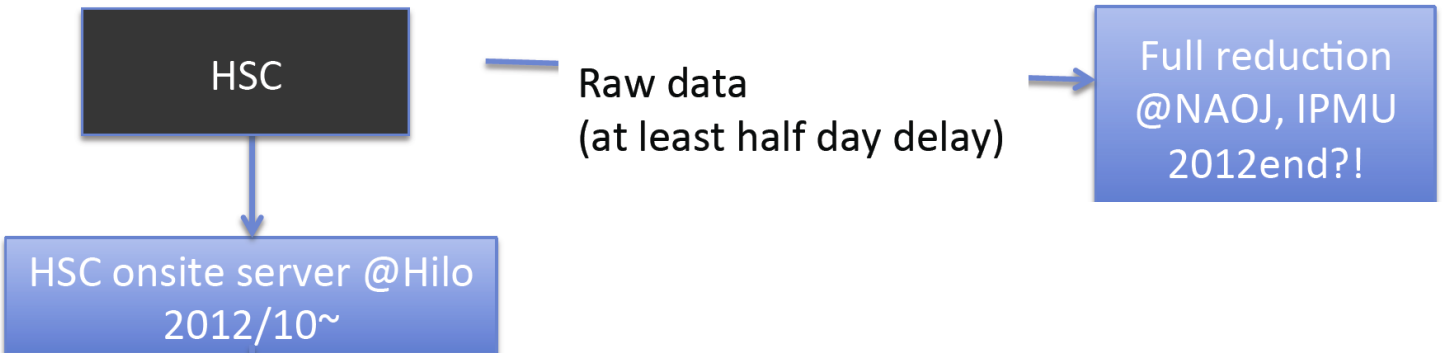
- support vector machine
- pattern mining



Preliminary

Transient server

led by Tominaga, Yasuda-san, Urata-san, Morokuma-san



Aug 2012

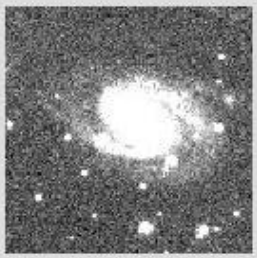
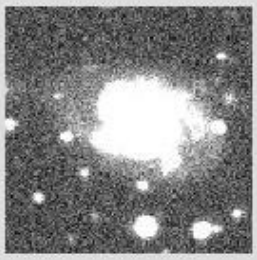
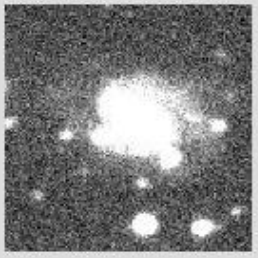
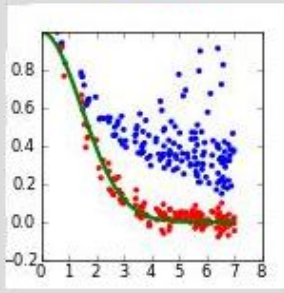
Web interface

led by Tanaka-san

KISS
KISO Supernova Survey

Tomoki Morokuma (PI)
Nozomu Tominaga
Masaomi Tanaka

SN2012ee

			Template image	Current image	Subtracted image	Previous image	Radial profile
32	source ID 639410 submit	KSFJ2044-0542 0016295_3					new sub 
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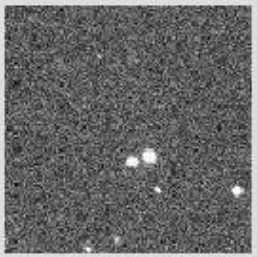
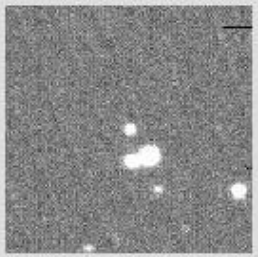
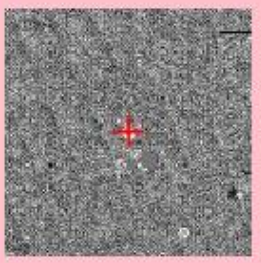
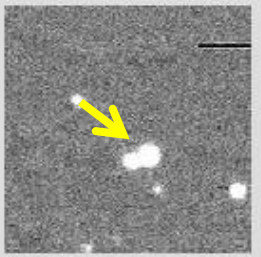
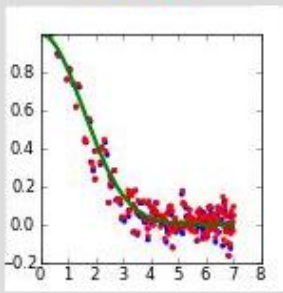
A list of SN candidates is available at ~10-20min after the exposure.

Minor planet (93951) 2000 WT179

37	source ID 639783 submit	KSFJ2215+1311 0016305_5					new sub 
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Follow-up observation

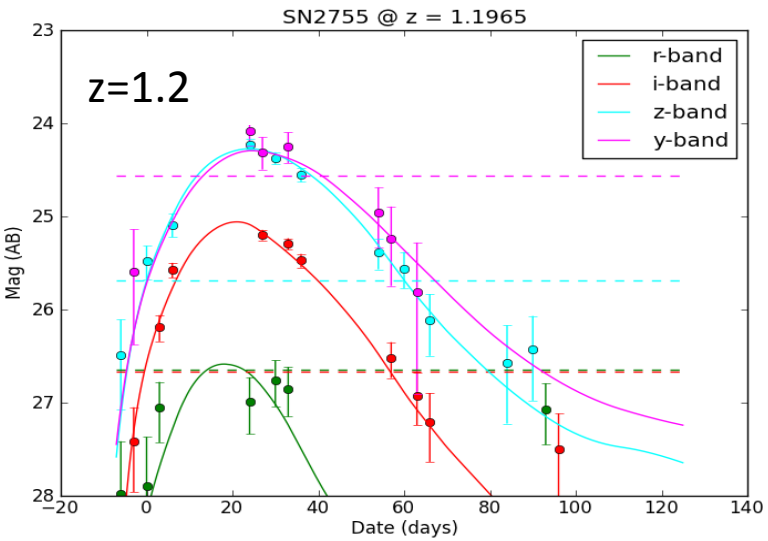
- Photometry
  - continuous observation to obtain light curves
  - NIR light curves for SNe Ia at z>1
  - backup observation of HSC-deep/UD fields when the seeing or weather condition is bad
- Spectroscopy (8m-class telescopes needed)
  - within 1 night (SN shock breakout)
  - within 2 weeks (SNe Ia, CCSNe)
  - in the next semester (SLSNe)

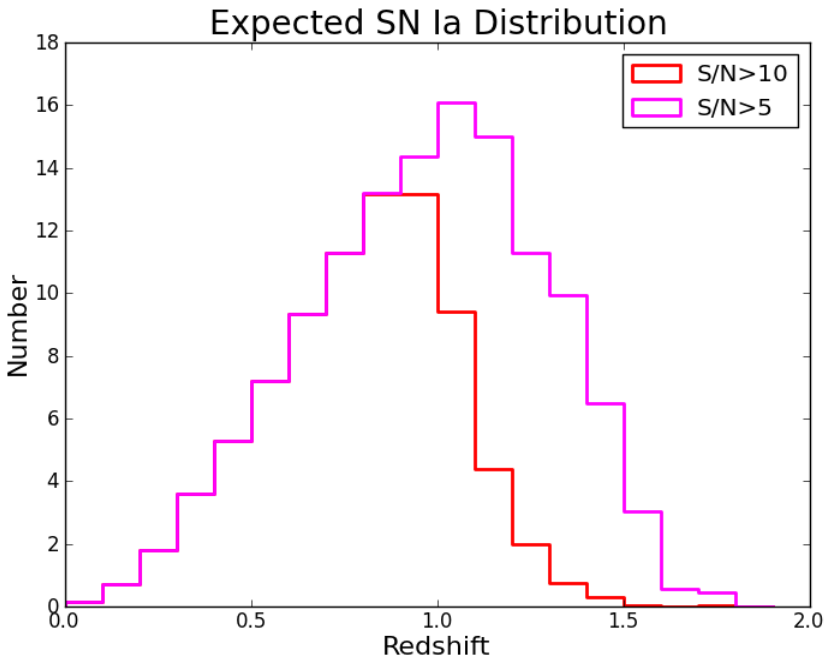
Openuse, alert, and collaborations

Science cases

Type Ia SNe

(deep)/UD





- SDSS: 0.05 < z < 0.4
- SNLS: 0.3 < z < 1.0
- HST: z > 1.0
- DES: 0.3 < z < 1.0
  - ~5000 SN Ia

SN Ia @ z > 1 is still small number.

HSC-UD survey

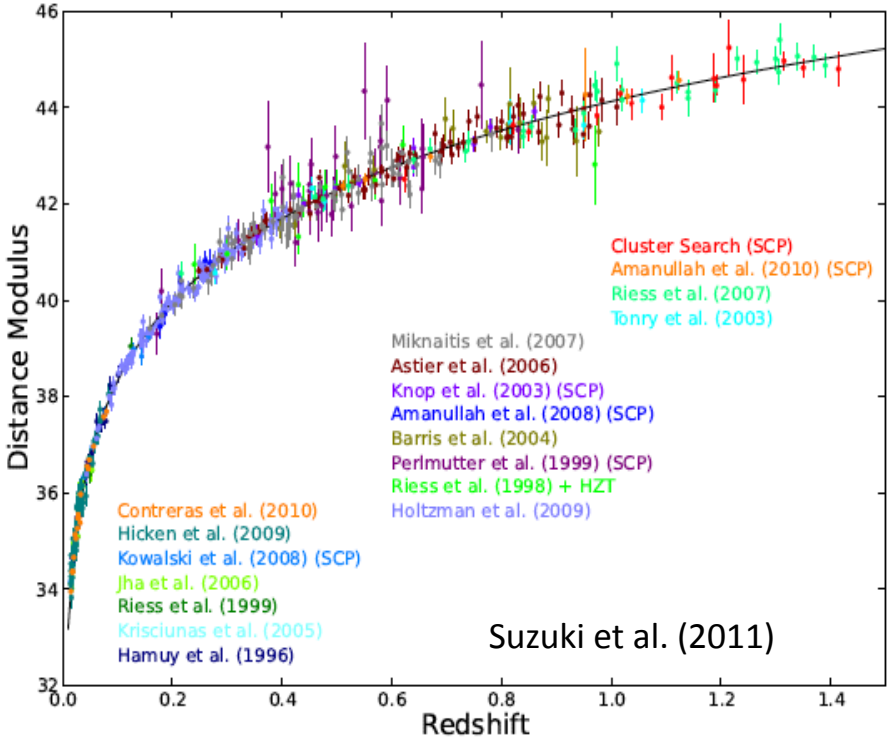
~130 SN (~60 at z > 1) for S/N>5

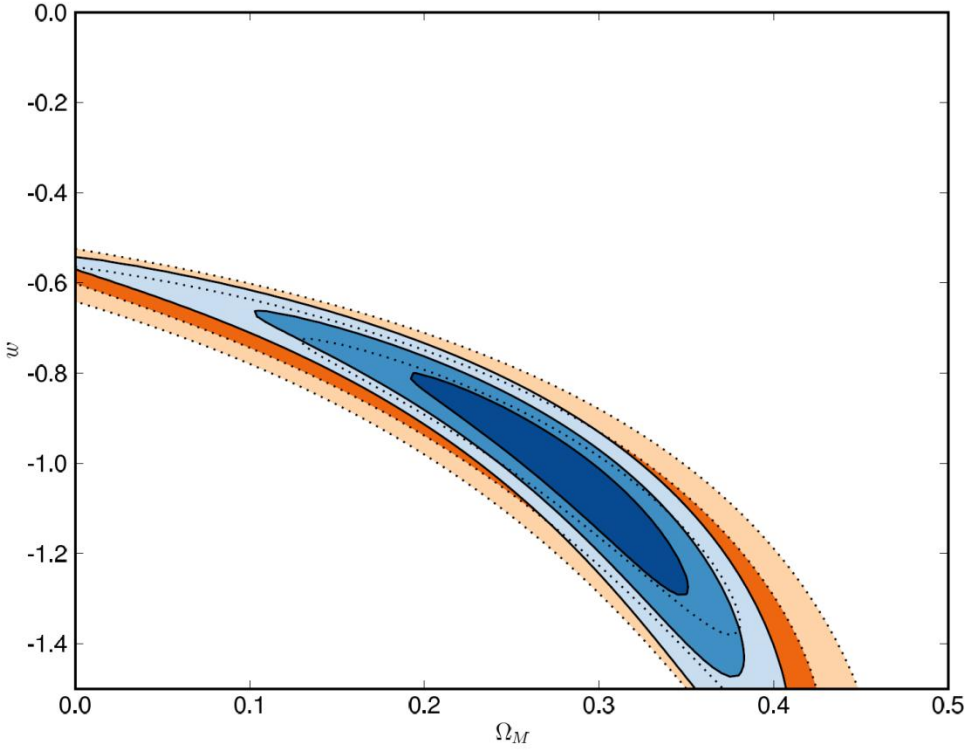
~80 SN (~20 at z > 1) for S/N>10

(3 bands detection)

Type Ia SNe -cosmology-

led by Yasuda-san



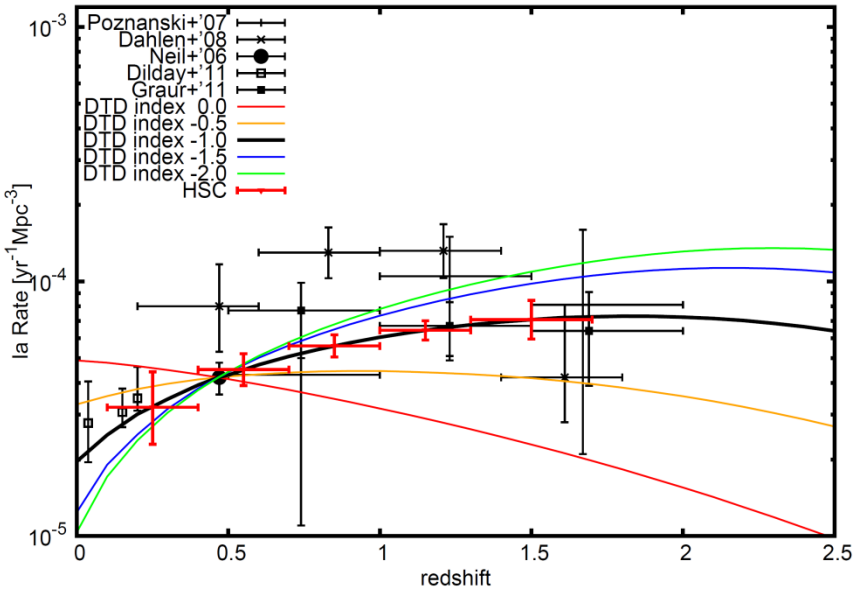


If we can use all S/N>5 sample in addition to UNION2 sample, error on Ω_M and w will be decreased by a factor of 2.

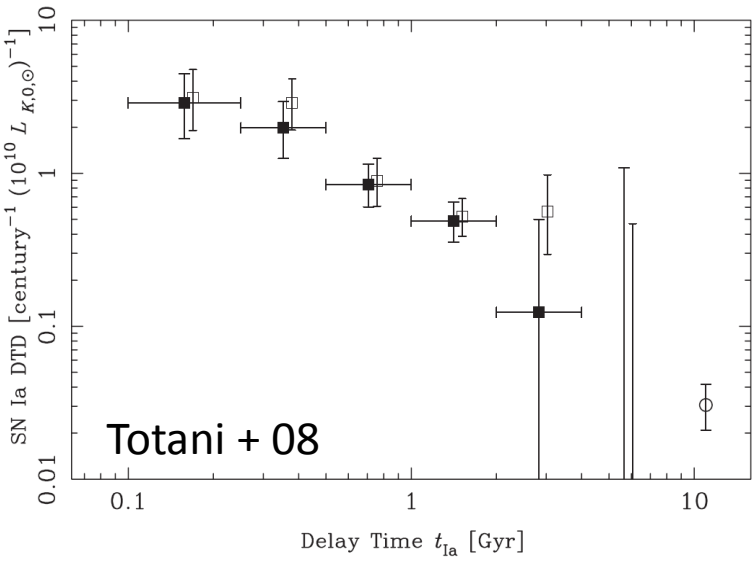
Type Ia SNe -rate-

led by Okumura-san

- SN Ia rate density
  - Most accurate SN Ia rate upto z~1.5
  - constrain delay time distribution



- Delay time distribution
  - delay time between star formation and SNe Ia
  - constrain progenitor system

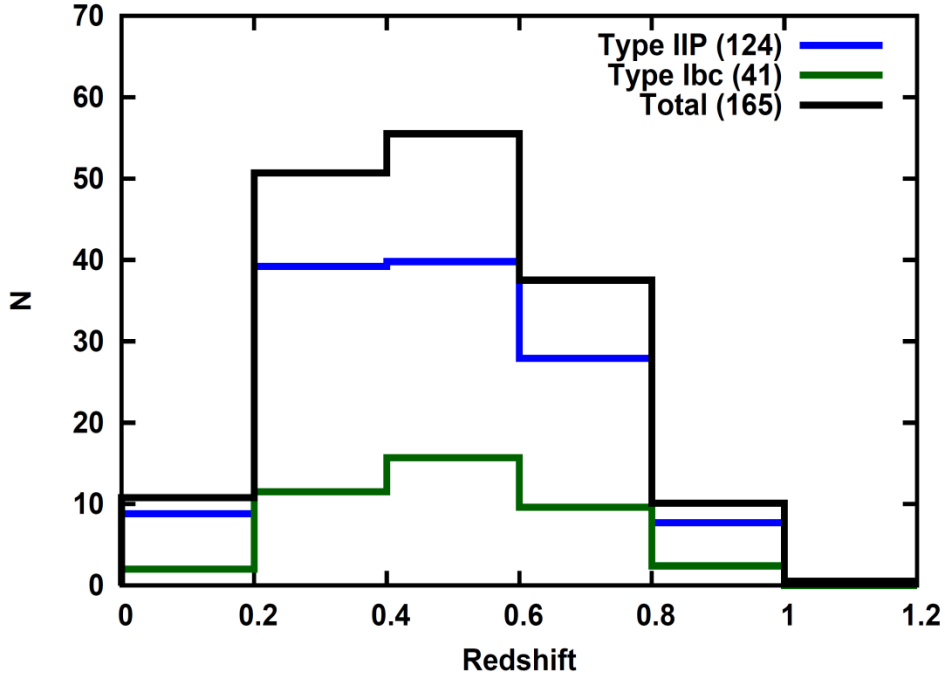


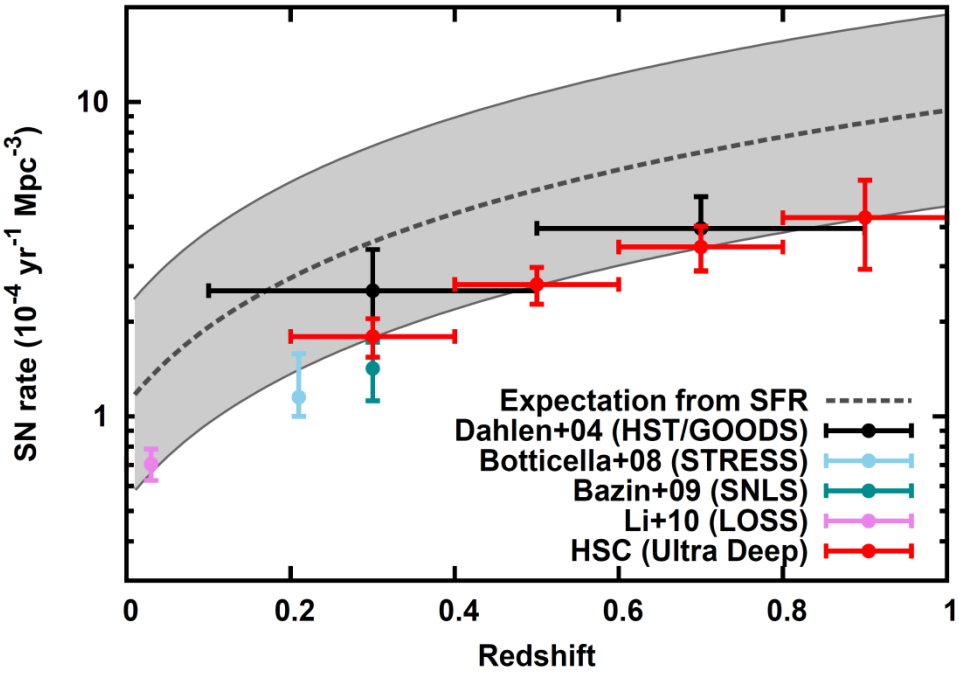
Core-collapse SNe

(deep)/UD

led by Tanaka-san

- Available for free with SNe Ia cadence





Survey	Tel.	Redshift	# of SNe
SNLS	CFHT	~0.3	120
GOODS	HST	0.1-1.3	45
HSC-UD	Subaru	0.2-1.0	~165

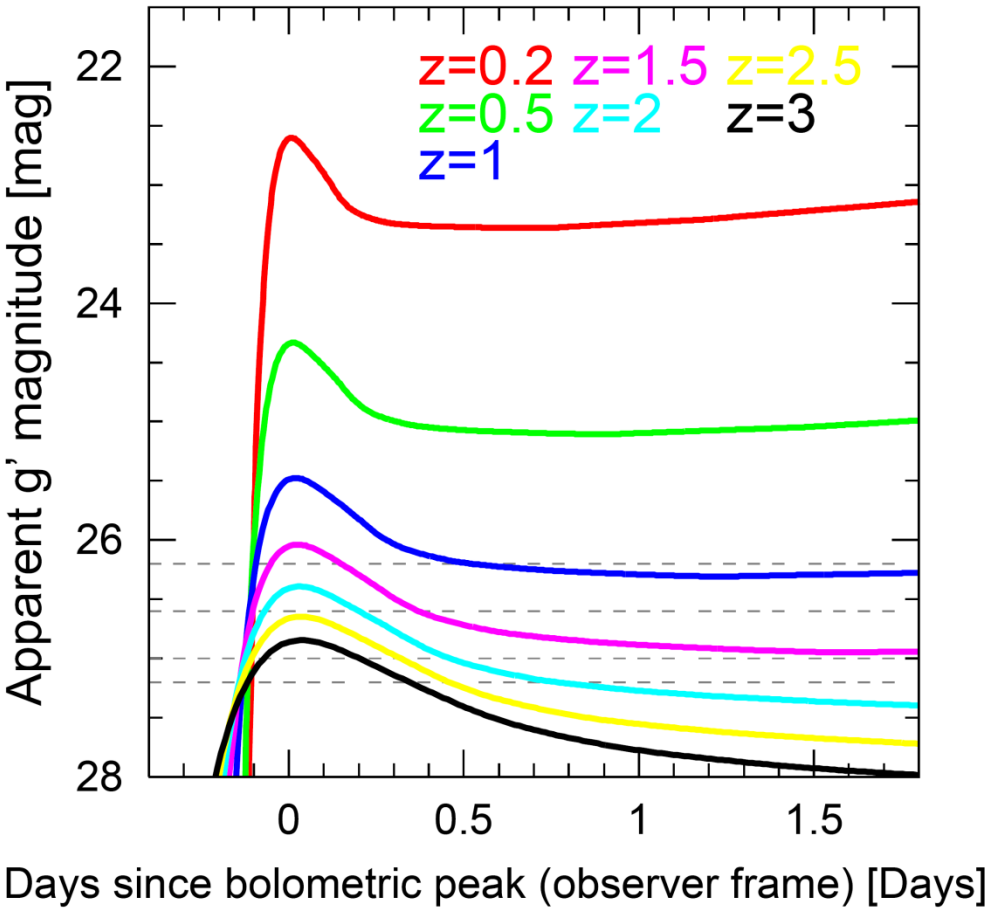
Shock breakout

wide/deep/UD

led by Tominaga, Morokuma-san

- Brightest phenomenon (normal SNe @z~3)
- >3 g- and >1 r-bands obs. in 1 night
- 1st year science
- Discovery channel
  - only 3 events
  - no opt. obs.

	Num.SNe (1st year)	Num. SNe	Redshift	
			50%	10%
Wide	19	96	$\gtrsim$0.5	$\gtrsim$0.9
Deep	9	52	$\gtrsim$0.6	$\gtrsim$1.4
UD	2	14	$\gtrsim$0.8	$\gtrsim$1.7

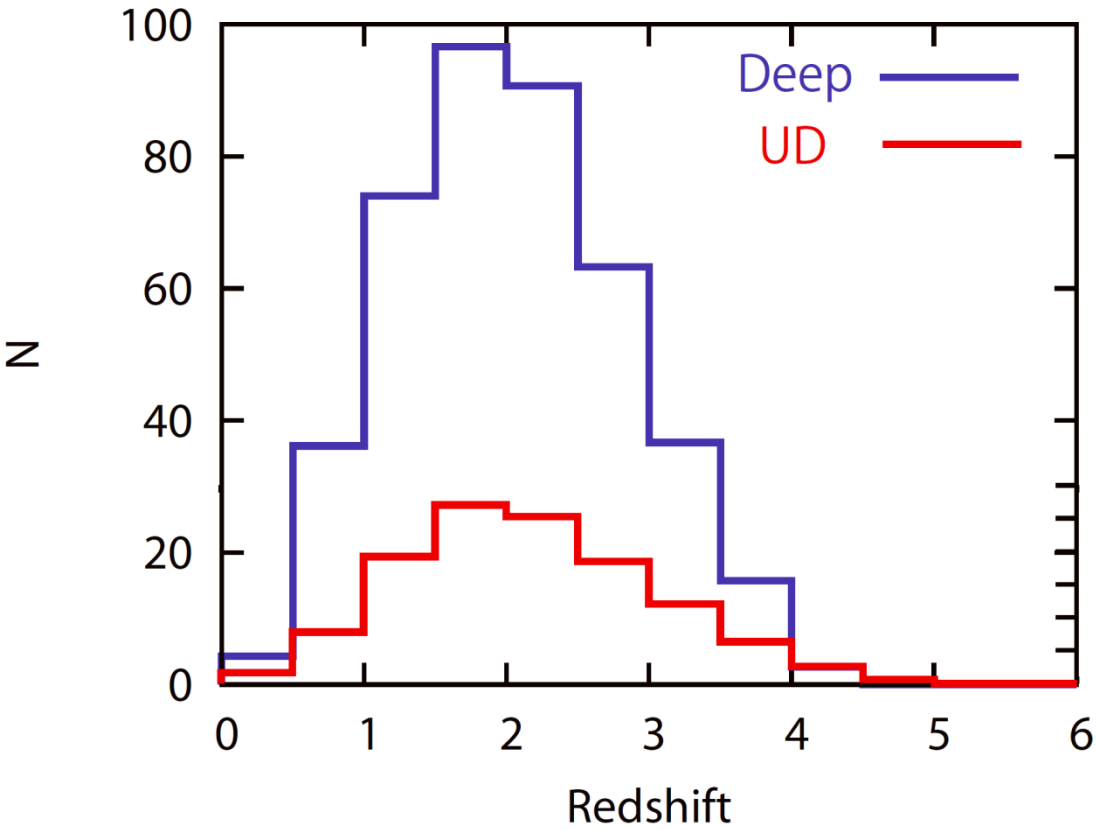


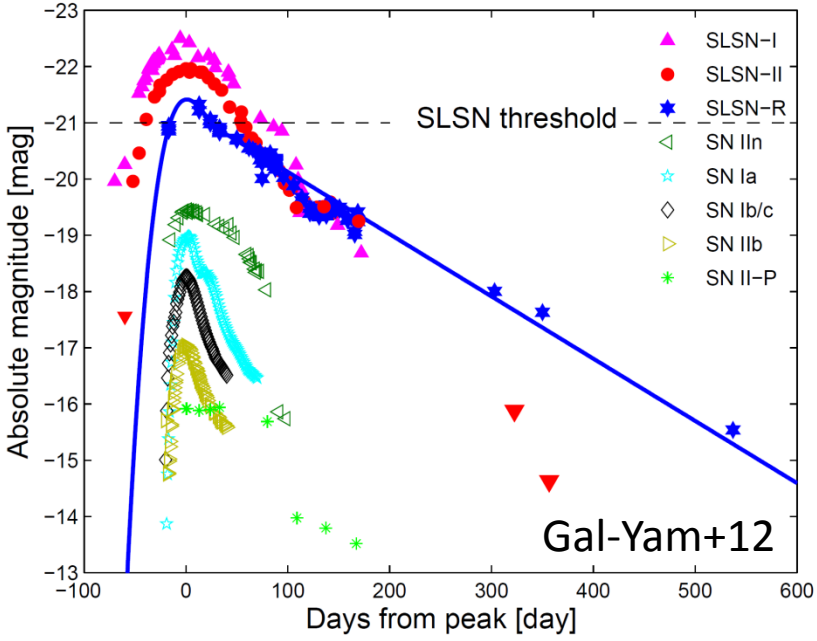
deep/UD

Super Luminous Supernova

led by Moriya-san

- Rare extremely bright SNe
- CCSN detection @ z~4



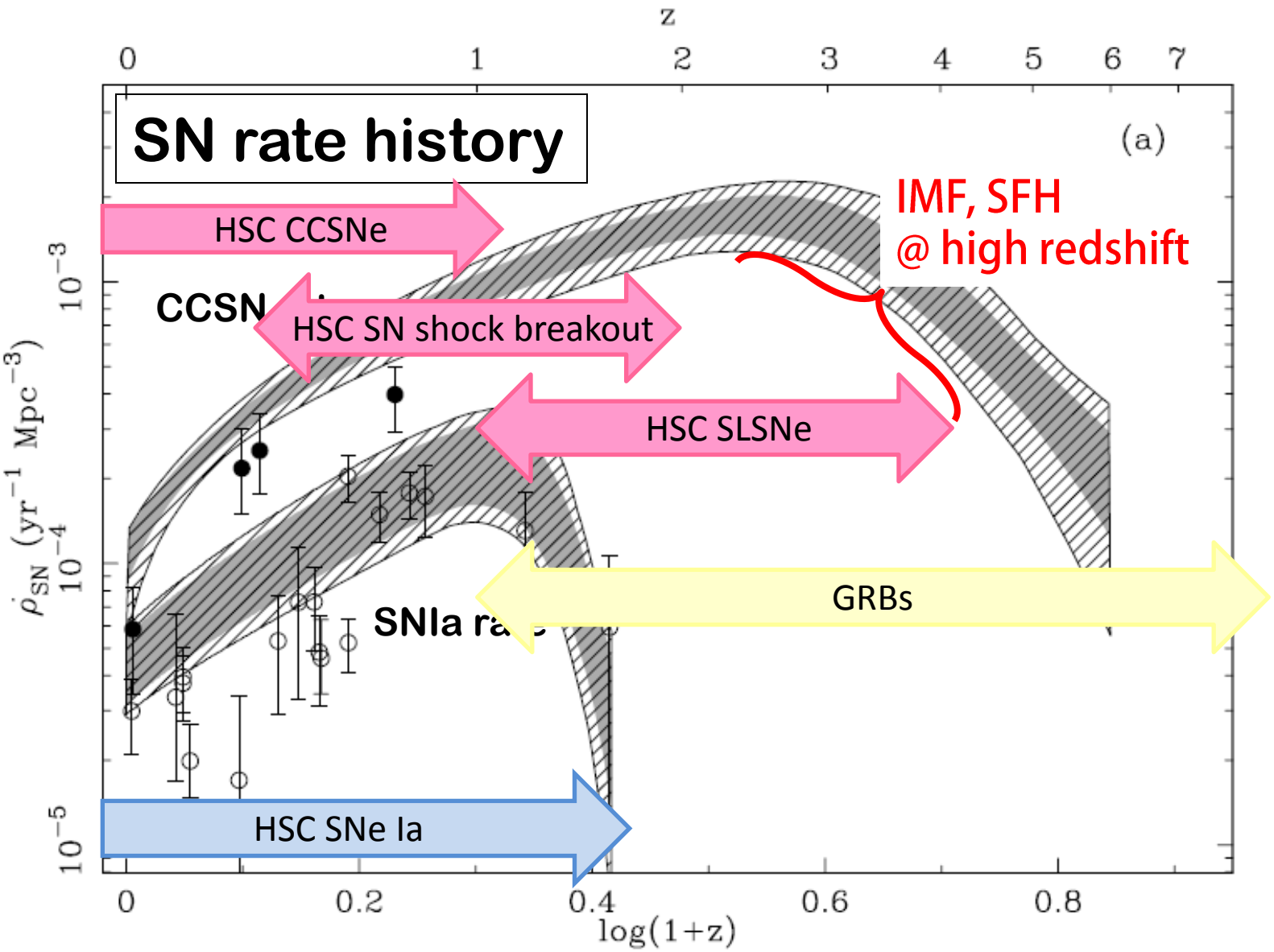


Slow follow-up obs.

1-month stacked data

Moriya-san's talk for detail

Distance ladder in SNe



Hopkins & Beacom 06 and references therein

Other transients

deep/UD

- **GRB orphan afterglow** led by Huang-san & Urata-san
  - off-axis view of GRBs
  - 1 candidate in SDF data
- **Tidal disruption event (TDE)** led by Kong-san
  - a BH swallows an orbiting star
  - several events observed so far
- **Variable stars** led by Morokuma-san, Tominaga
  - High proper motion stars
  - RR Lyrae stars

Summary

- Many SN science cases are available with HSC-wide/deep/UD.
- Cadence requirements range from day to year (but are flexible and feasible).
- Science cases
  - SNe Ia: cosmology, rate, large sample at z>1
  - CCSNe: rate, large sample at z>0.5
  - Shock breakout: first detection in optical
  - SLSNe: detection at z~4
- Distance ladder in SNe upto z~4