FINDING TYPE Ia SUPERNOVAE WITH THE SUBARU STRATEGIC PROGRAM

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WHAT IS THE SUBARU STRATEGIC PROGRAM (SSP)?

• Imaging survey in grizy with the Hyper Suprime-Cam on the Subaru Telescope on Mauna Kea.

• Primary science goals: weak lensing, high-redshift galaxies, galaxy evolution.
• Cadenced observations of the Deep and Ultradeep fields allow for SN search.

• Existing catalogs of spec- and photo-zs reduce amount of followup needed.
OBSERVATION FIELDS

Yasuda+ 2019
SCIENCE GOALS:

Redshift range targeted by SSP

Projected numbers for two seasons on the COSMOS field:

- $z < 0.8$: 120
- $0.8 < z < 1.1$: 120
- $z > 1.1$: 50 (with HST IR)
CANDIDATE FOLLOWUP STRATEGY

• Hubble Space Telescope WFC3:
  • Used to get an IR measurement at peak for the highest redshift objects.
    ➡ this allows for color at maximum.

• Ground based spectroscopy:
  • VLT, Keck, Subaru, etc.
    1. Live spectrum for certain objects.
    2. Spec-z of host later on.
  • Also benefitting from AAT fiber spectrograph.

• Future: Subaru Prime Focus Spectrograph
DATA PROCESSING

• Dual Pipelines:
  
  • IPMU uses Princeton Pipeline — being developed as a branch of the LSST pipeline.
    
    • Forced photometry on subtractions to produce lightcurves
  
  • LPNHE uses an independent pipeline descended from the SNLS pipeline, which can be used for testing different techniques and validating the calibration.
    
    • Scene-modeling to produce lightcurves
KEY PIPELINE IMPROVEMENTS

• Astrometry tied to the Gaia DR2 catalog
  ➡ residual floor at 6-8 milliarcsec

• Photometry tied to the JLA catalog, and will be tied to SNLS5 (tied to CALSPEC with 80 visits)
  ➡ uniformity at 0.2%

• Incorporation of the Brighter-fatter PSF anomaly underway.
CURRENT STATUS

Original Program:

• Spring 2017: 24 epochs observing on COSMOS

• Spring 2018: 6 epochs on COSMOS—not enough for good lightcurves, but observations can be used for references.

Extended Program:

• Fall 2018: Volcano! SXDS observations cancelled

• Fall 2019: Beginning observation on SXDS/XMM-LSS
WHAT DO WE HAVE SO FAR?

• $z < 1.0$: 130+ SNe Ia in the COSMOS UltraDeep field
• $z > 1.0$: 60+ SNe Ia in the COSMOS UltraDeep field
• 200+ more in the COSMOS Deep field
• HST triggered on 26 $z > 1$ events
• 60+ spectra taken of SNe or hosts to obtain redshifts, plus more underway.
PRELIMINARY RESULTS:
BEAUTIFUL LIGHTCURVES AT $z \sim 0.5$
PRELIMINARY RESULTS:
BEAUTIFUL LIGHTCURVES AT $z \sim 0.7$
PRELIMINARY RESULTS:
BEAUTIFUL LIGHTCURVES AT $z \sim 0.9$

$$z = 0.6778 \pm 0.0011$$
$$k = 5778.39 \pm 0.34$$
$$x_0 = (2.500 \pm 0.051) \times 10^{-6}$$
$$x_1 = 0.88 \pm 0.79$$
PRELIMINARY RESULTS: BEAUTIFUL LIGHTCURVES AT $z \sim 1.1$
PRELIMINARY RESULTS:
BEAUTIFUL LIGHTCURVES AT $z \sim 1.3$
PRELIMINARY RESULTS:
BEAUTIFUL LIGHTCURVES AT $z \sim 1.5$

$z = 1.49 \pm 0.11$

$c = 0.03 \pm 0.13$

$\delta = 0.07871 \pm 0.24$

$m_{\text{mag}} = 0.017464660$

$m_{\text{mag}0} = 3.1000000$

$x_0 = (6.2 \pm 1.5) \times 10^{-7}$

$x_1 = -0.11 \pm 0.089$
CONCLUSIONS

• 200+ SNe Ia observed, with 60+ at z > 1.0, plus more in the COSMOS Deep field

• The Fall season on SXDS / XMM-LSS is underway

• Number of SNe Ia expected to double with a second full season.

• Release of data from the completed half of the survey planned in the following months.