SDSS-II Supernova Survey
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SDSS II Supernova Program

Goal is to obtain densely sampled, multi-band light curves and spectral typing for ~200 Type Ia SNe in the redshift range z ~ 0.05-0.35
- Improve constraints on Dark Energy
- Improve understanding of SN Ia as standard candles
- Provide rest frame u-band templates for high-z surveys
- Determine SNe rates

Imaging along the celestial equator, Sept-Nov of 2005-2007
- 300 sq. deg total coverage (2.5 deg x 120 deg)
-- imaging alternates between ~150 sq deg section every other night
-- dense light curves
-- large volume allows for study of rare/peculiar SNe

Multi-Telescope Follow-up/Spectroscopy

Spectroscopic follow-up for SN typing, redshift determination, and multi-epoch spectrophotometry is done using:
• HET 9.2m, ARC 3.5m, MDM 2.4m, Subaru 8m, WHT 4.2m, Keck 10m

Additional imaging to reduce edge effects and follow SNe lightcurves below SDSS flux limit
• NMSU 1m, ARC 3.5m, MDM 2.4m, VATT, WIYN, UH88in, LT, INT

Limited coordinated follow-up in near IR from Carnegie SN Project

Monitoring Efficiencies: Simulated SNe

1000 simulated type Ia SNe inserted into data stream in real time
--> quantify pipeline/human scanning efficiencies
- realistic lightcurves
- pre-compiled catalog of positions; proximity to known galaxies (with photometric redshift)
-- specify redshift, luminosity, MJD at peak for each "fake"
-- real time calculation of magnitudes by convolving redshifted spectral templates (A. Riess) with SDSS filter curves

SDSS SNe detection efficiencies as a function of redshift from simulated SNe

Software   Human Scanning

2005hc @ z = 0.0459

Discovered by SDSS Oct. 2005
Multi-epoch spectroscopy
Also imaged by MDM, UH88, VATT (opportunity for cross-calibration)

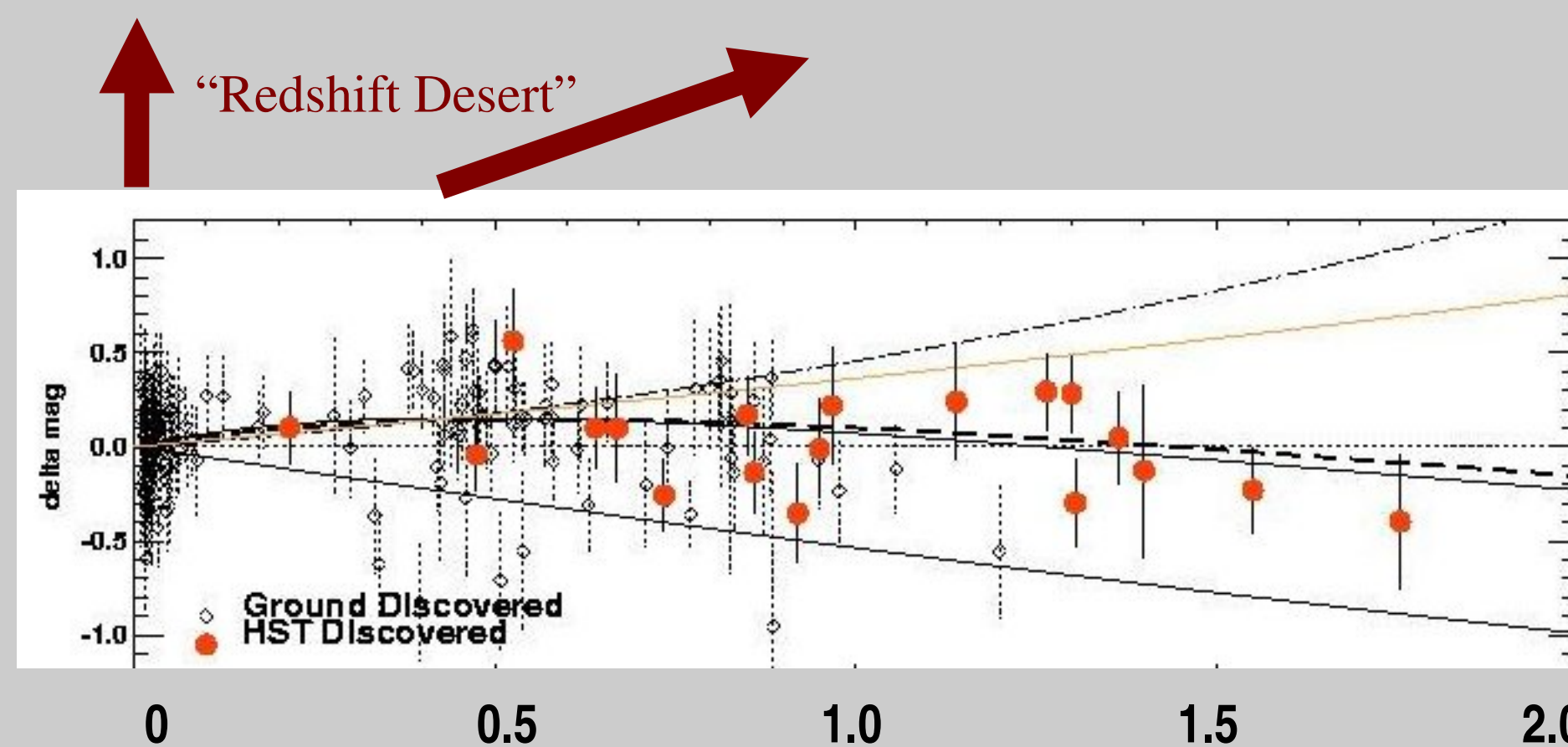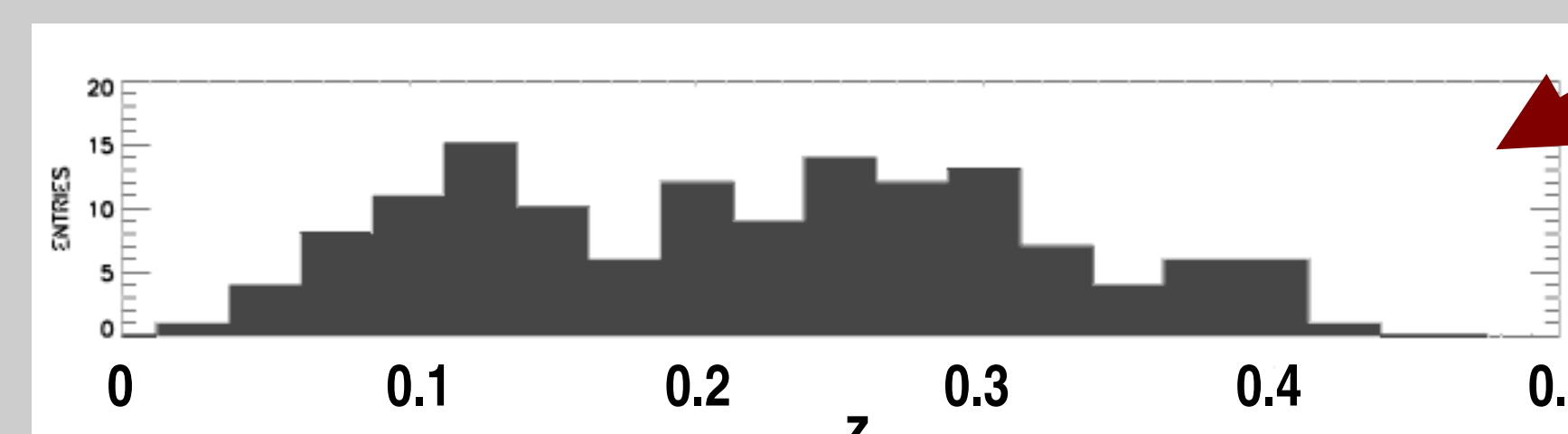Co-added reference image: SDSS archive   Search image: Oct 2005

2005 Survey

139 spectroscopically confirmed Ia SNe
(includes 13 probable)
6 type Ib/c, 10 type II SNe

SDSS 2005 Ia Sample

"Redshift Desert"

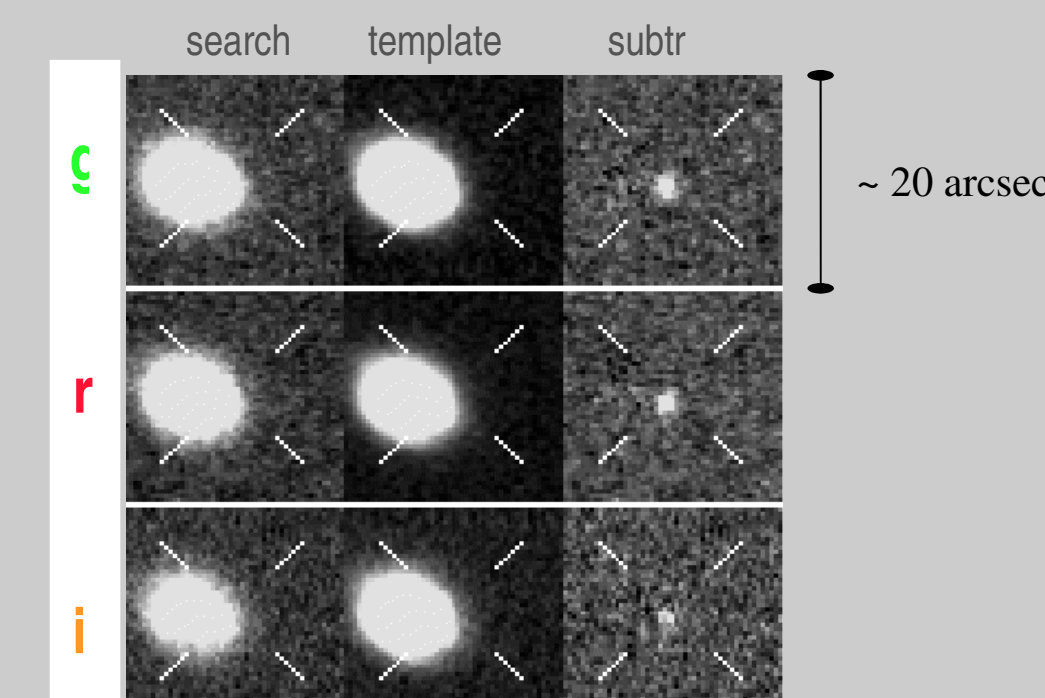◇ Ground Discovered
● HST Discovered

SN Ia Hubble diagram: compilation from Riess et. al., AJ 607 (2004) includes data from Calan Tololo, HZT, SCP, CfA, Higher-Z, ACS.

The Supernova Search Pipeline
Difference Imaging

On mountain difference imaging/photometry using co-added reference images (5-10 input images)
Rapid turn around/ follow-up opportunity
--> ~800 x SDSS {g,r,i} fields in ~20 hours
- Require a match within ~0.6 arcsec in at least two filters
-- rejects fast moving asteroids
- Veto known stars and variables

Human Scanning

Discard slow moving asteroids, other non-SNe
Tag candidates for closer inspection
- ~ 10 % of objects

Lightcurve Fit

Chi square fit to SNe (Ia,Ib/c,II) template lightcurves
- vary redshift, reddening, luminosty-decline
- select probable SN Ia
-- can efficiently distinguish type Ia/II with ~2 epochs
- estimate MJD, magnitude of SN at peak

Best fit Ia template lightcurve for 2005ir

Difference imaging/ forced photometry in u-band for SN candidates
- distinguish types Ia/II

search   template   subtr
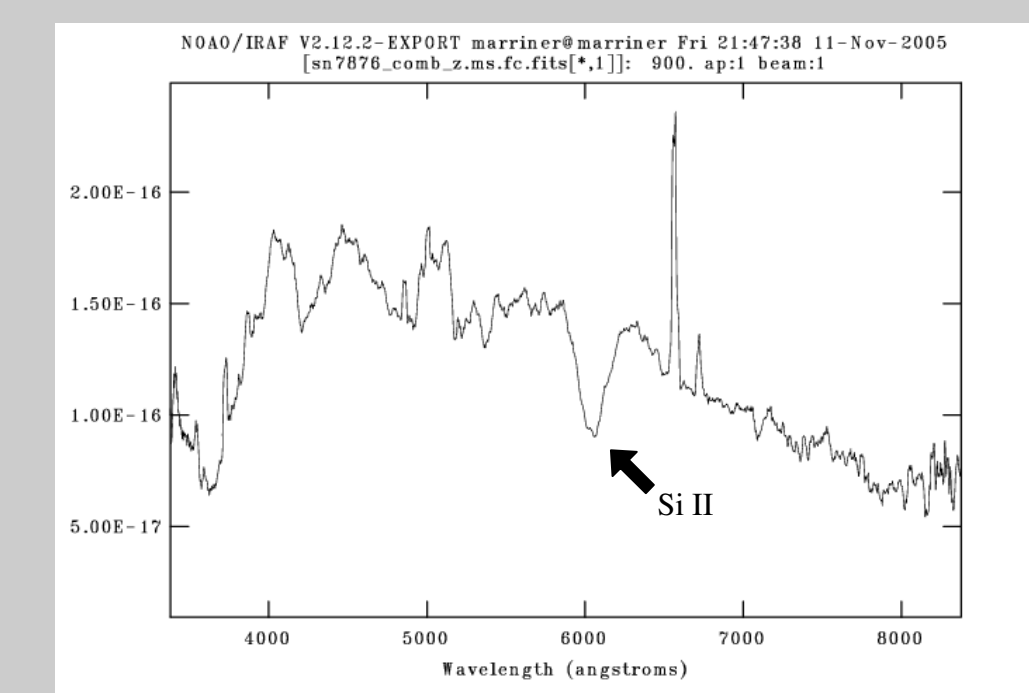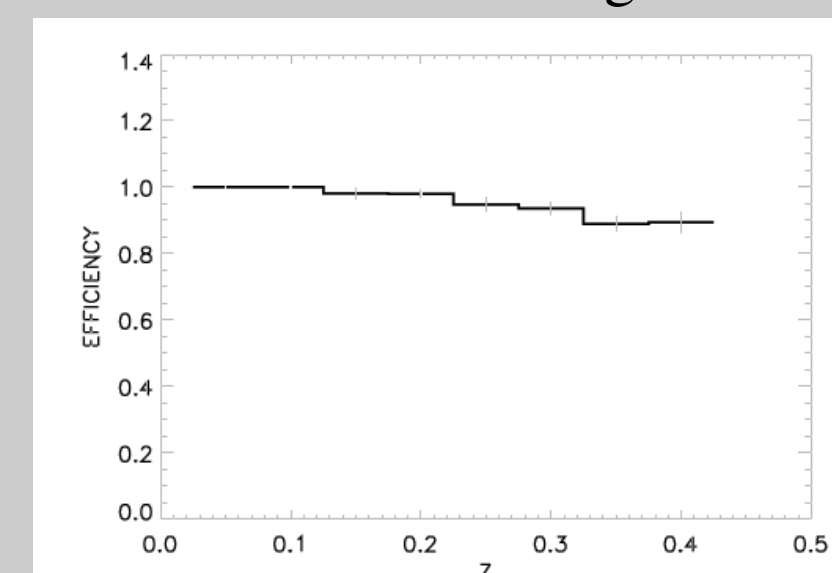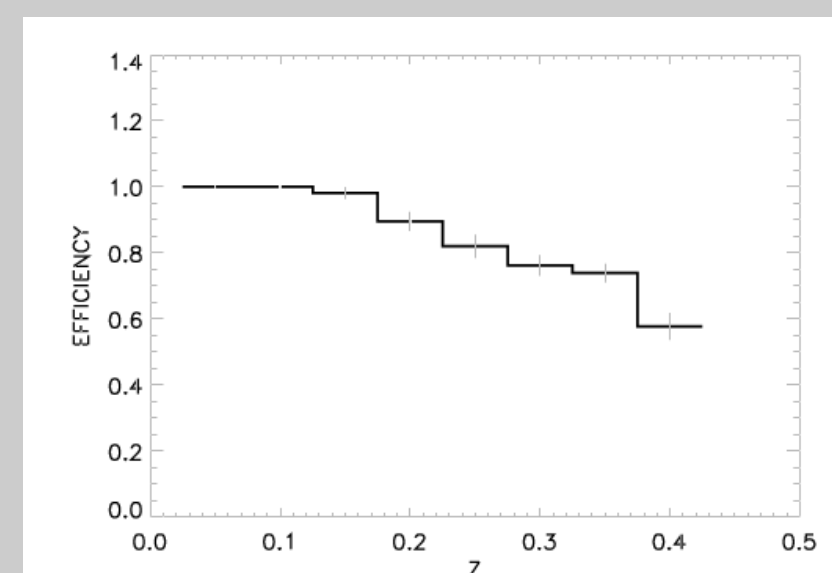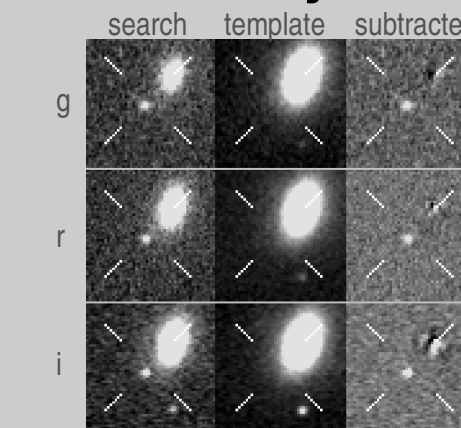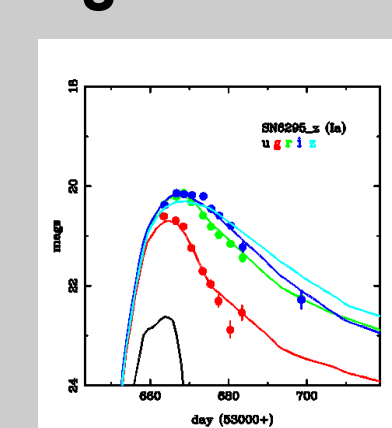~ 20 arcsec

Example of human scanning of objects; Discovery image of 2005ir @ z=0.0765

Spectroscopy

Si II

Spectrum of 2005ir taken with ARC 3.5m. Contains unsubtracted galaxy background

Examples of SN Ia discovered by SDSS

Discovery Image — search template subtracted

Type Ia SN lightcurve fit

Low-z 2005js @ z = 0.079

Mid-z 2005gg @ z = 0.230
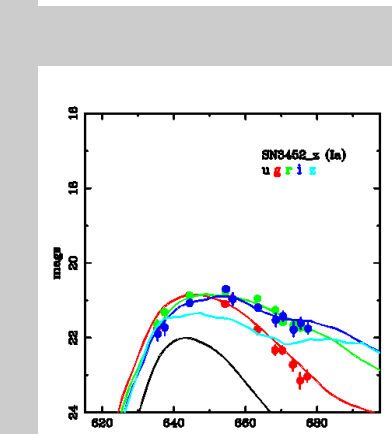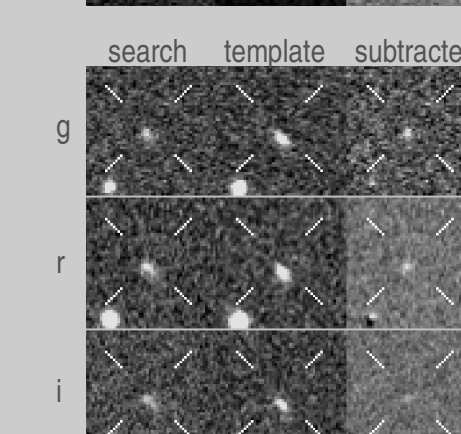
High-z 2005kq @ z = 0.391
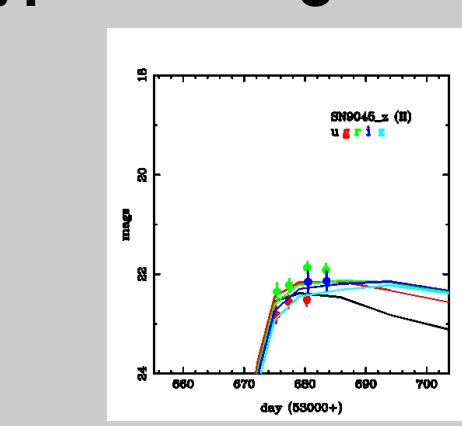
Discovery Image — search template subtracted
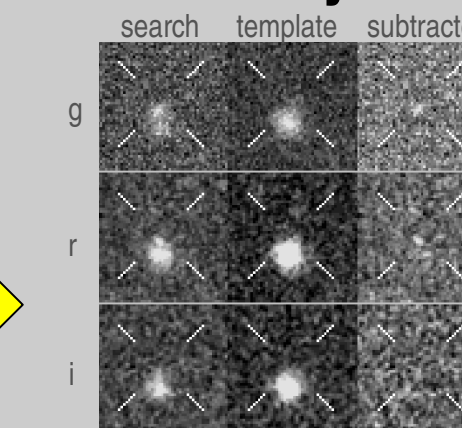
Type Ia SN lightcurve fit
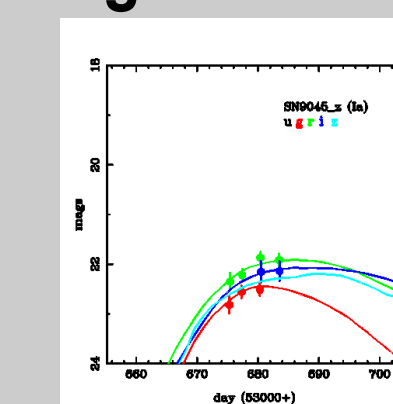
Type II SN lightcurve fit

Significantly better fit to Ia template with only a few points