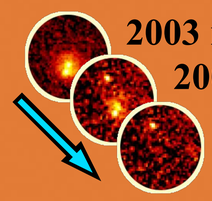
Supernovae at z > 1.2 Discovered with the ACS on HST

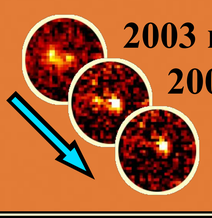
R. A. Gibbons, R. A. Knop (Vanderbilt U.), N. Kuznetsova (LBNL),

et al.

Supernova Cosmology Project



2003 reference
2004 April 03
SN Mingus



2003 reference
2004 July 10
SN Dolphy

Abstract

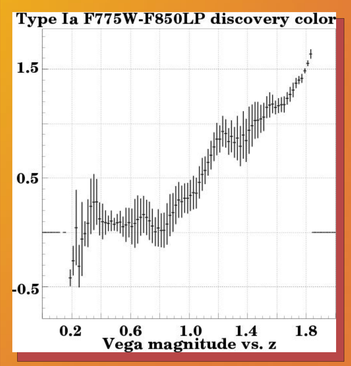
We report on follow-up observations of supernovae found during searches conducted using the ACS on HST between 2004 April and 2004 August. The search area of 170 square arcminutes covered the GOODS-North field. The searches successfully discovered supernovae in the redshift range 1.0 < z < 1.7. We present preliminary results from multicolor follow-up observations obtained with the ACS and NICMOS of two supernovae that exploded well within the epoch of deceleration. These two supernovae may represent the most distant ever found during an intentional search and followed in detail both photometrically and spectroscopically.

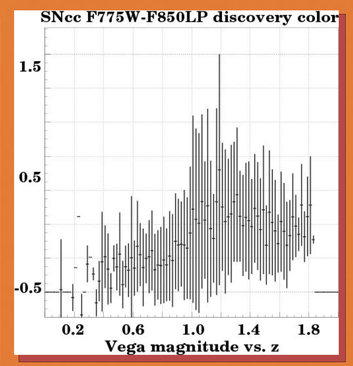
Introduction

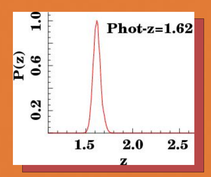
Four searches were conducted at ~7 week intervals. At each epoch 4x400s ACS/WFC/F850LP plus 1x400s ACS/WFC/F775W exposures were obtained at 15 pointings well aligned with the GOODS-N ACS pointings (Giavalisco et al. 2004). The search was done on the deep F850LP imaging, with the F775W serving as additional confirmation of new detections as well as providing color information. A. Riess and L. Strolger lead an independent search on these same data. The two teams alternated first priority on choice of follow-up candidates.

High Redshift Candidate Selection

Follow-up targets are chosen based on both SN color and photometric redshifts of the host galaxy (provided at search time by B. Mobasher at STScI). SNOC (Goobar et al. 2002) simulations give the expected Type Ia discovery magnitudes and colors. At redshifts above 1.2 their colors distinguish them from core-collapse SNe and AGN. The 1st and 3rd search runs yielded two excellent candidates at high SNR. The first, SN Mingus, appears to be a Type Ia at z=1.6. The second, SN Dolphy, is possibly at z=1.7, and requires NICMOS final reference imaging for further analysis. Hence, we only present our preliminary analysis of SN Mingus.



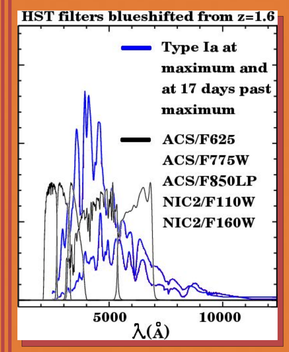




Best-fit photo-z of host of SN Mingus from multi-color HST photometry.

z=1.6 Follow-up

Follow-up cadence, exposure times, and instruments were determined from template Type Ia's convolved with instrument responses. 27 HST orbits were spent on SN Mingus in order to obtain light-curve data in z (ACS/F850LP), J (NIC2/F110W), and H (NIC2/F160W). During the 1st follow-up visit we also obtained a spectrum with the ACS grism. The analysis of these data are not complete, but appear consistent with the estimate of the host photometric redshift.



Follow-up observations of Mingus

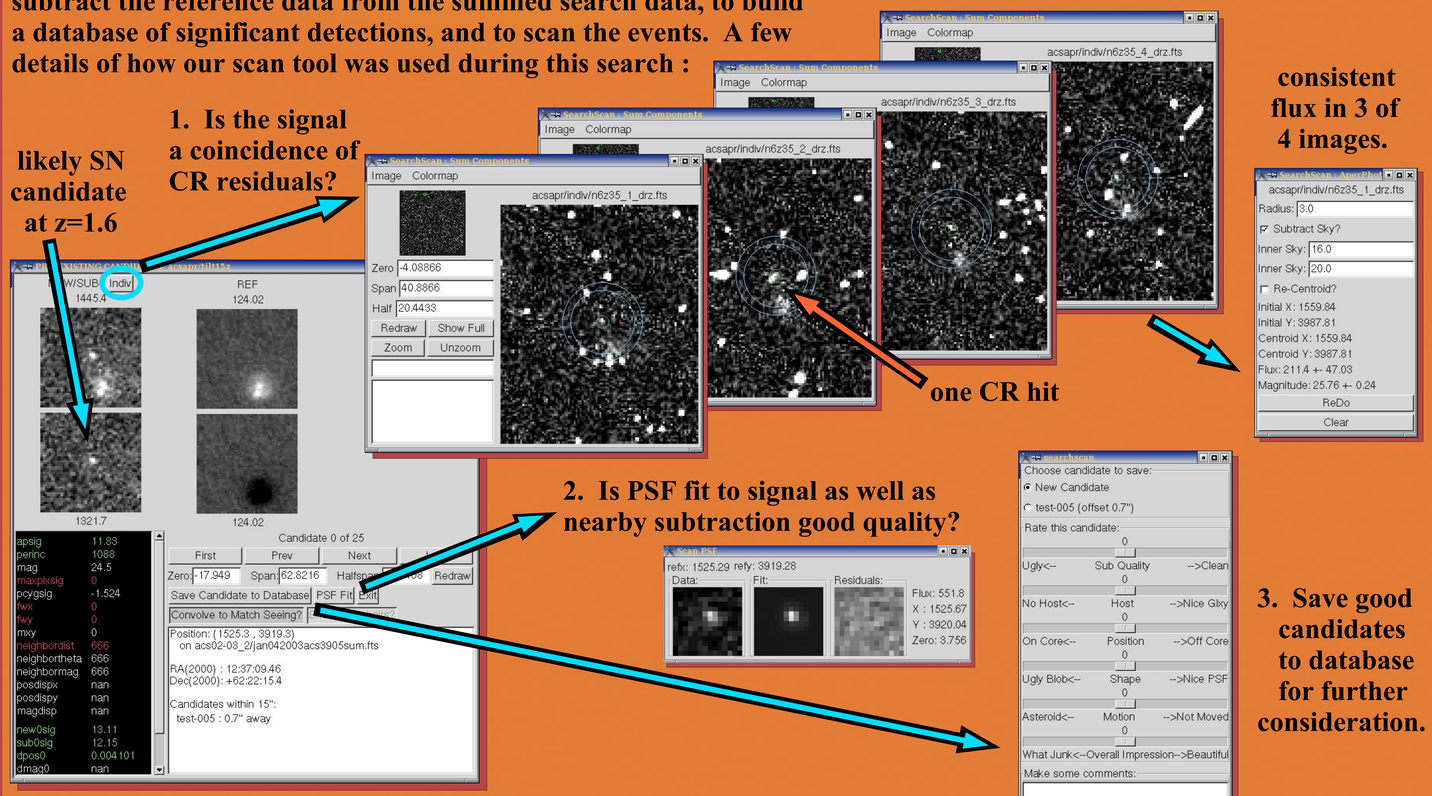
date	CONFIG	EXPTOT	HST orbits
04 Apr 12	ACS/F850LP	4564	2
04 Apr 26	ACS/F850LP	4384	2
04 Apr 16	NIC2/F160W	5376	2
04 Apr 16	NIC2/F110W	2688	1
04 May 05	NIC2/F160W	5376	2
04 May 11	NIC2/F110W	2688	1
04 May 17	NIC2/F160W	8064	3
04 May 23	NIC2/F110W	8064	3
04 Apr 12	ACS/G800L	23816	11

Search Details

We built year-old reference imaging from the GOODS-N observations. After initial processing of the newly obtained search data, SCP developed software was used to subtract the reference data from the summed search data, to build a database of significant detections, and to scan the events. A few details of how our scan tool was used during this search :

likely SN candidate at z=1.6

1. Is the signal a coincidence of CR residuals?



2. Is PSF fit to signal as well as nearby subtraction good quality?

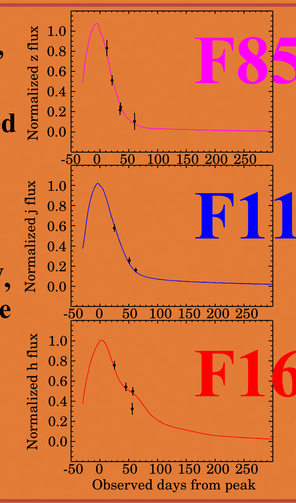
3. Save good candidates to database for further consideration.

Useful statistics displayed in color show which pass or fail user-defined cuts. High SNR and percent increase are key.

3-color Lightcurve Fit

The "standard candle" parameter to be measured is the SN brightness at maximum light. For a given SN, the Knop et al. (2003) templates is fitted to all the lightcurve data simultaneously. A four parameter $\chi 2$-minimization is performed; the fitted parameters being time of B-band peak, flux at peak, color at peak, and stretch. For our z=1.6 candidate, a U-band template is fitted to the F850LP lightcurve, B-band to F110W, and R-band to F160W, with proper k-corrections computed using the templates. The fitted parameters are :

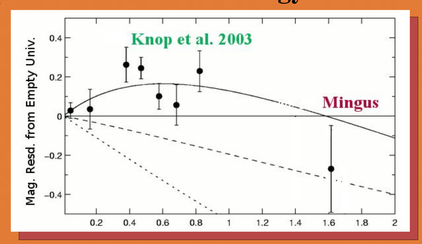
Perhaps include a short "to do" list here.



Cosmology Section need writing

Because our analysis is only preliminary, we do not present a best-fit cosmology including SN Mingus. Instead, the SN is simply plotted on top of the best-fit cosmology from Knop et al. (2003).

Conclusions go here and will wrap around figure...



References

Giavalisco et al. 2004, ApJ, 600, 93

Goobar et al. 2002

Knop et al. 2003, ApJ, 598, 102