
GRB

Host Galaxies and Progenitors

Michael Lang

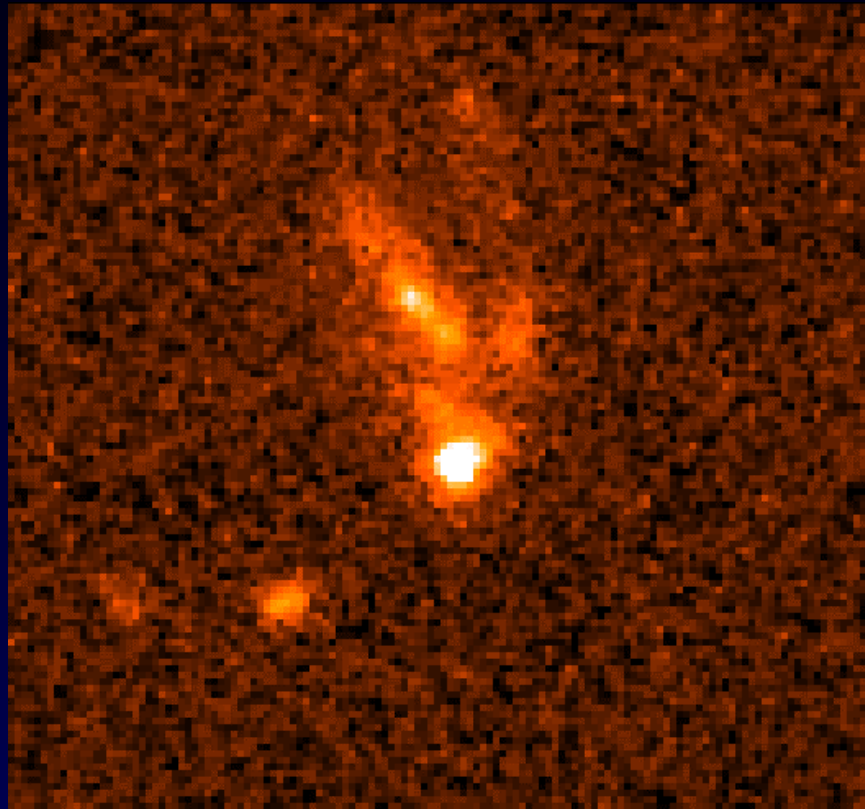
30.01.2004

Advisor: Arne Rau

Overview

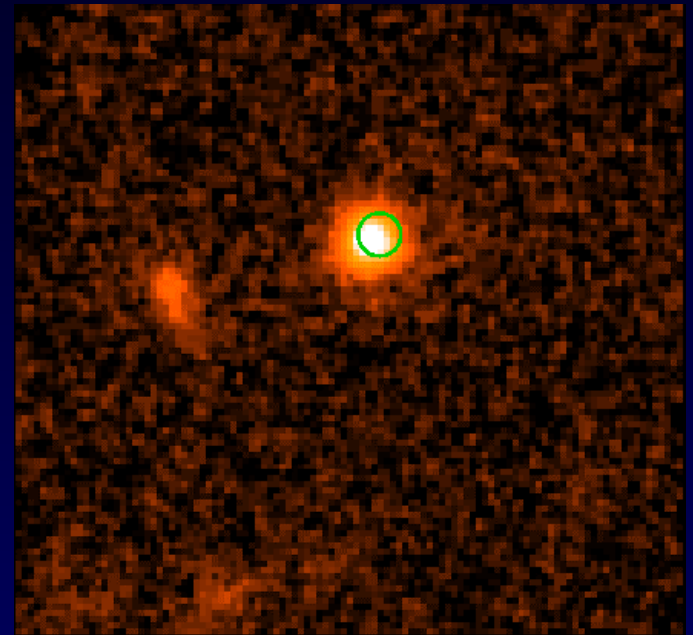
- Detection and Observations
- The Sample of GRB Host Galaxies
- Star Formation
- Progenitor Clues from Afterglow Positions

Detection – Host Galaxy

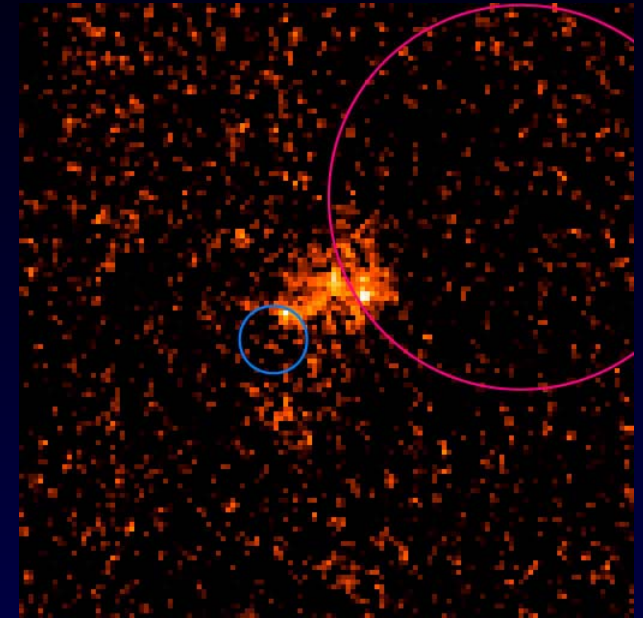
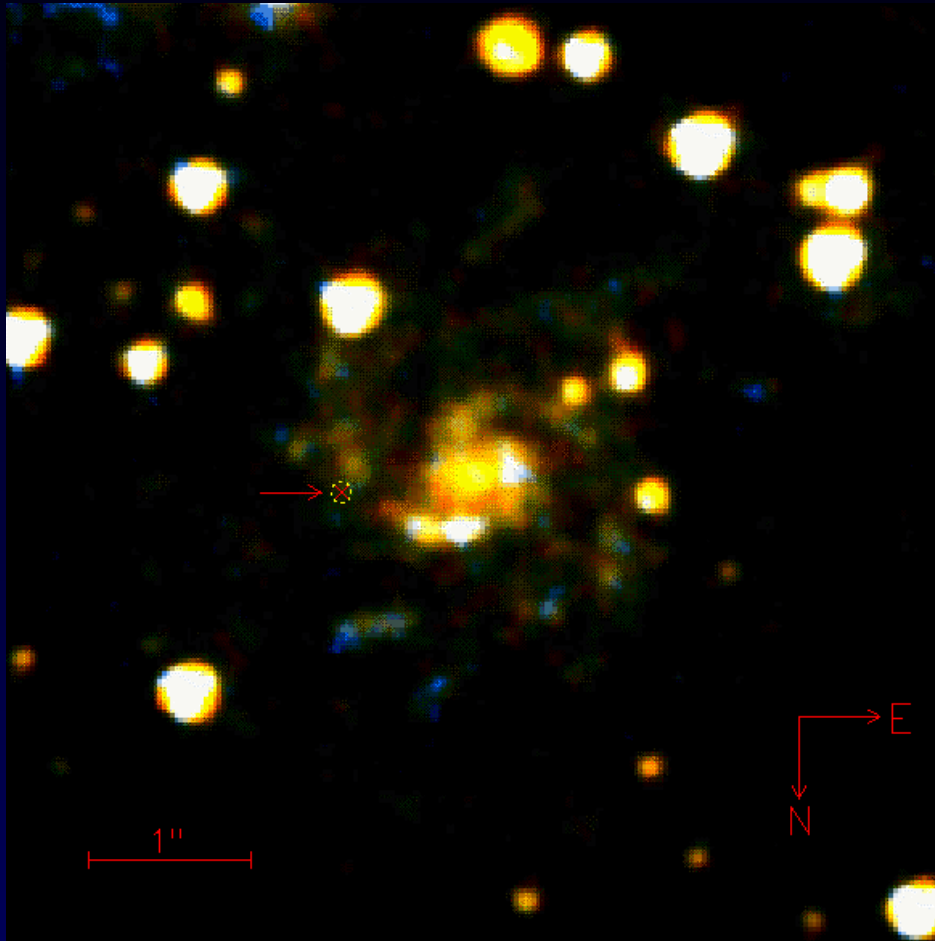


GRB 990123 (STIS/HST)
3.2" \times 3.2" (Fruchter et al.
2000)

Host of GRB 991208 (HST)
2.5" \times 2.5" (Fruchter et al. 2000)



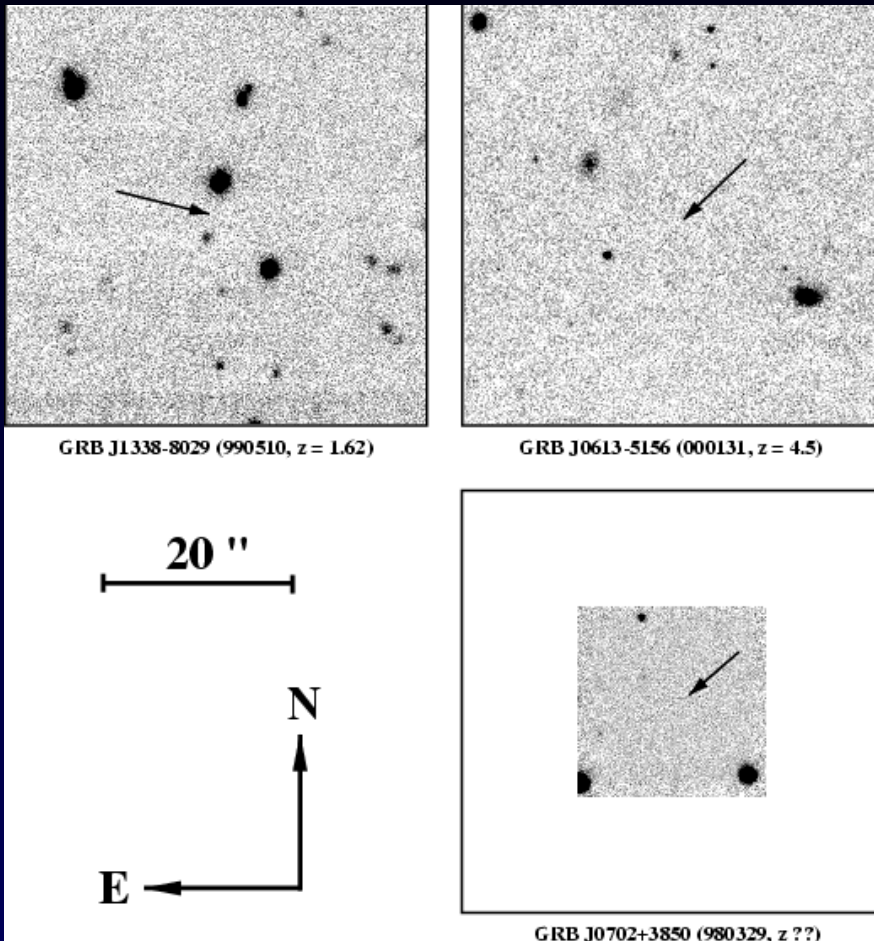
Detection – GRB Position



Host of GRB 011030 (HST)
3.2" \times 3.2" (Fruchter et al.
2001)

Host of GRB 990705 (HST)
Holland et al. 2002

Detection – Uncertainties



It's not always that clear ...

ISAAC/VLT

Hokupa'a/QUIRC

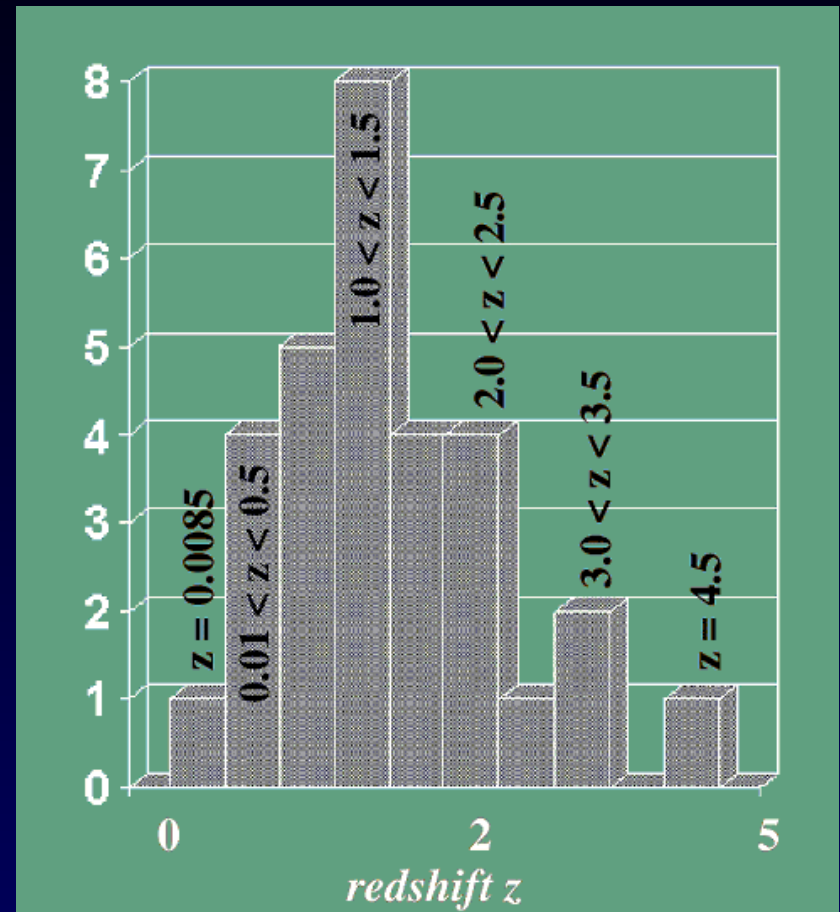
NIR images (K -band)

(Le Floc'h et al. 2003)

Sample – Properties

- Small (~ 50)
- ~ 30 redshifts known
- Long bursts

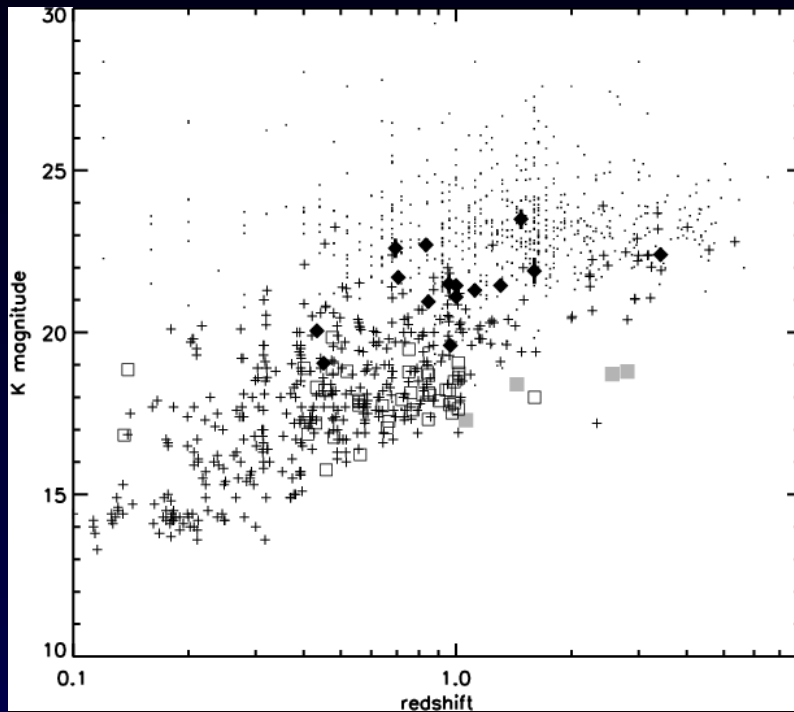
Redshift distribution
(Klose 2003)



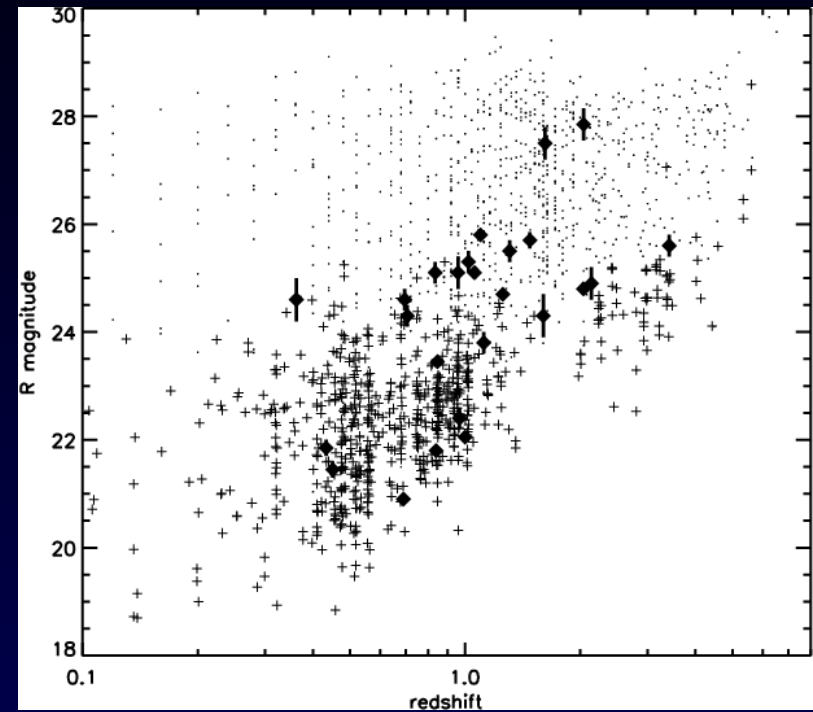
Sample - Unique

- Galaxies selected only by GRB
 - ◆ Not limited by luminosity
- Chance to go to very high redshift
- Trace galaxy populations
 - ◆ evolution of galaxies and star formation rate (SFR) in the Universe
- Clues to Progenitor model

Sample – K and R luminosities

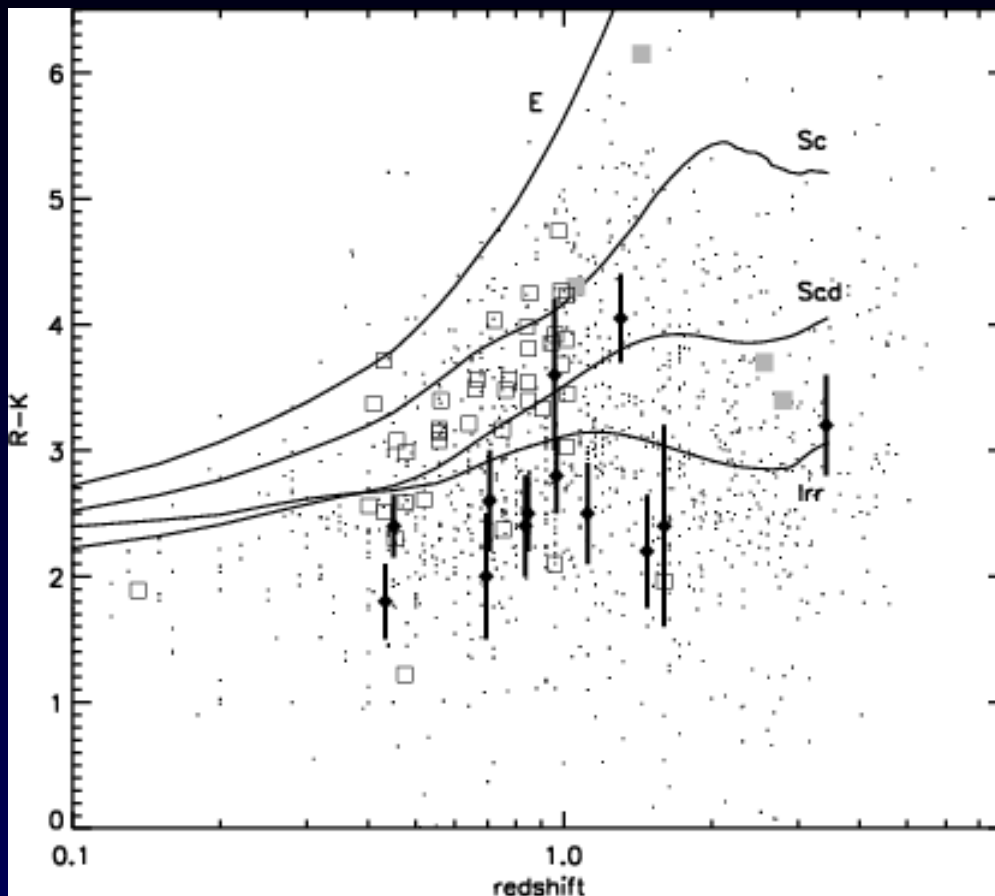


Observed K magnitudes
(Le Flocc'h et al. 2003)



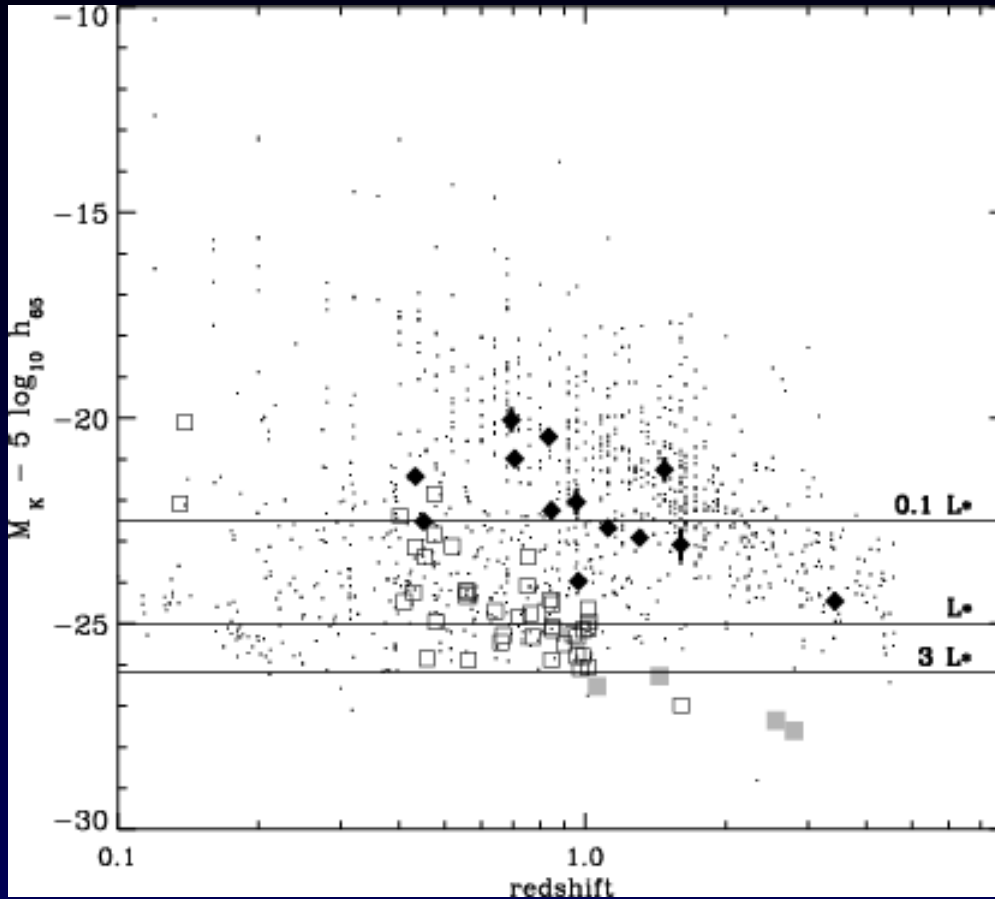
Observed R magnitudes

Sample – Blue Galaxies



Observed R-K colours
(Le Floc'h et al. 2003)

Sample – Sub-luminous



Absolute K magnitudes
(Le Floc'h et al. 2003)

SFR – Determination

1. UV continuum methods
2. Far-IR and radio continuum methods
3. Analysis based on recombination lines
4. Forbidden lines

SFR – General Assumptions

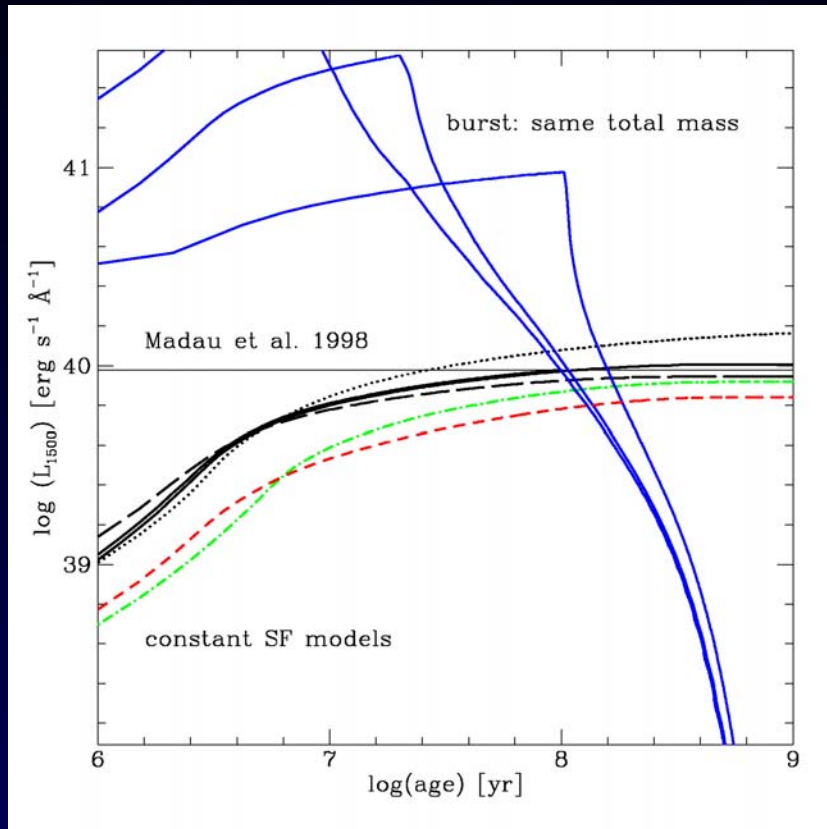
Input parameters of
evolutionary synthesis models

1. Metallicity of the stars
2. Star formation history
3. Description of the IMF
4. Stellar tracks
5. Stellar atmospheres

1. UV continuum
2. far-IR and radio continuum
3. recombination lines
4. forbidden lines

$$\text{SFR (M}_{\odot}\text{ yr}^{-1}) = \text{const} \cdot L_x$$

SFR – Calibration



Schaerer (1999)

1. UV continuum
2. far-IR and radio continuum
3. recombination lines
4. forbidden lines

- Emission from young stars
 \mathcal{M}_\odot ongoing star formation
- $\sim 1250 - 2500 \text{ \AA}$
- dust absorption of UV
 \mathcal{M}_\odot extinction correction

SFR – Calibration

- Significant fraction of the bolometric luminosity is absorbed by interstellar dust
- Absorption cross section of dust peaks in the UV
- Tight correlation between radio (1.49 GHz) and FIR

1. UV continuum
2. far-IR and radio continuum
3. recombination lines
4. forbidden lines

SFR – Calibration

- Nebular lines re-emit radiation shortward of the Lyman limit
- Observed line flux measures the ionizing photon flux

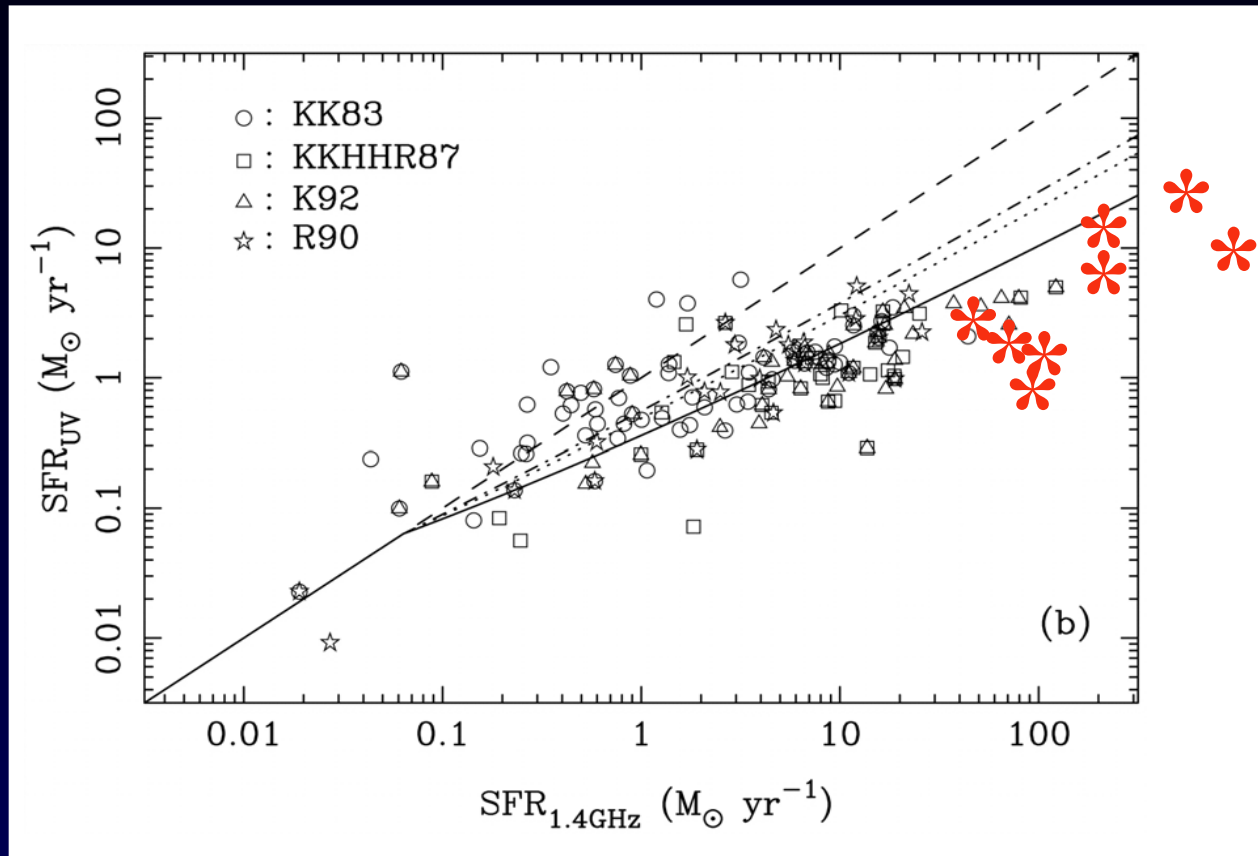
1. UV continuum
2. far-IR and radio continuum
3. recombination lines
4. forbidden lines

SFR – Calibration

- [O II] $\lambda 3727$
- Depends on ionization parameter
- “Cross” calibration with H α

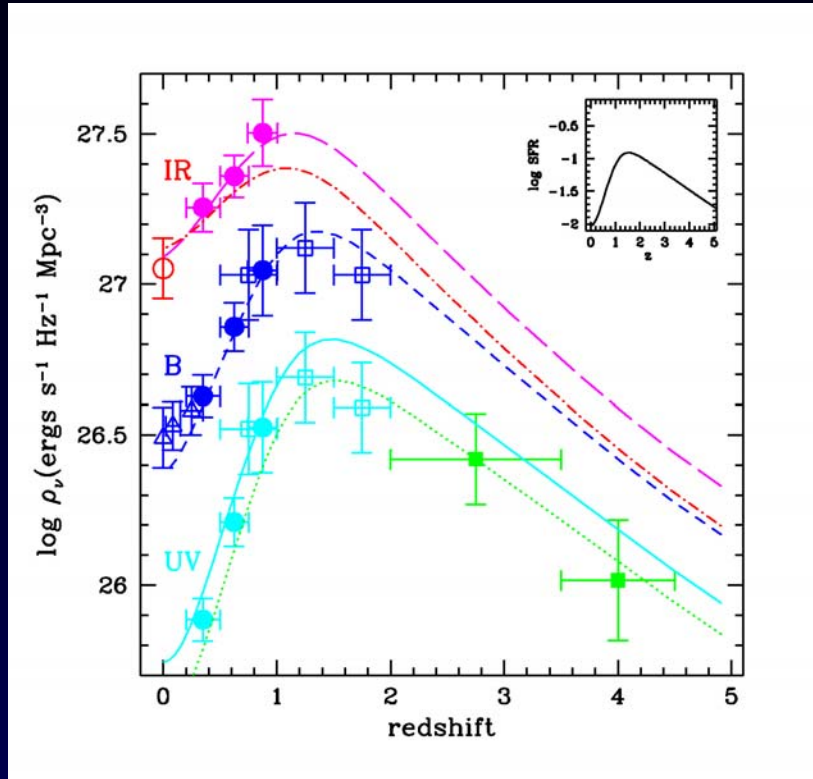
1. UV continuum
2. far-IR and radio continuum
3. recombination lines
4. forbidden lines

SFR – Hosts and Estimators



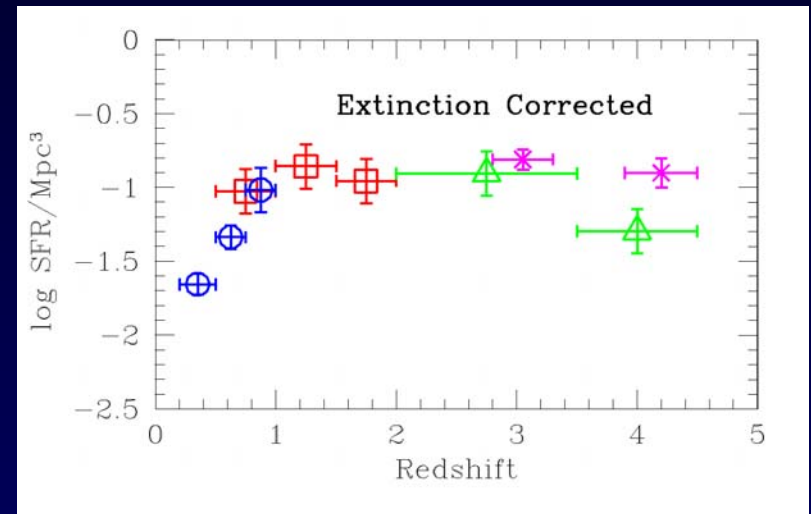
Hopkins et al. (2001)

SFR – Peaks or stays constant?

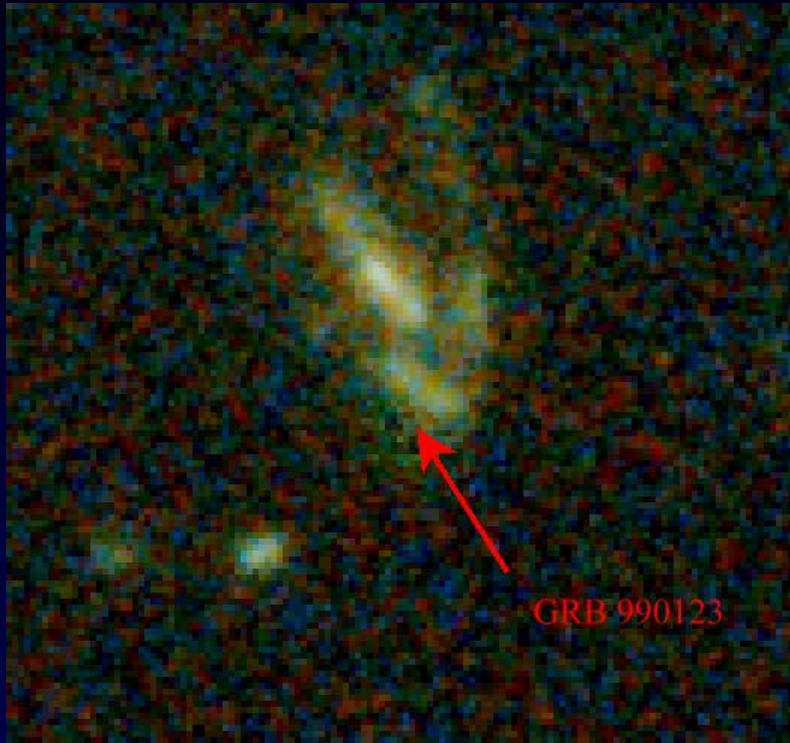


Madau et al. (1998)

Steidel et al. (1999)

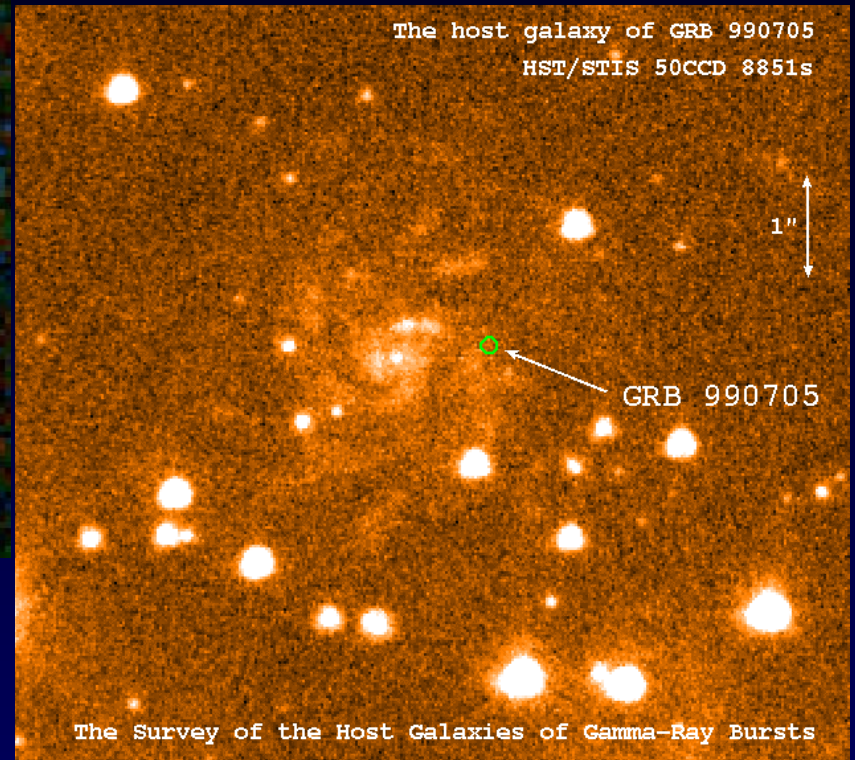


Progenitor Clues – GRB Position

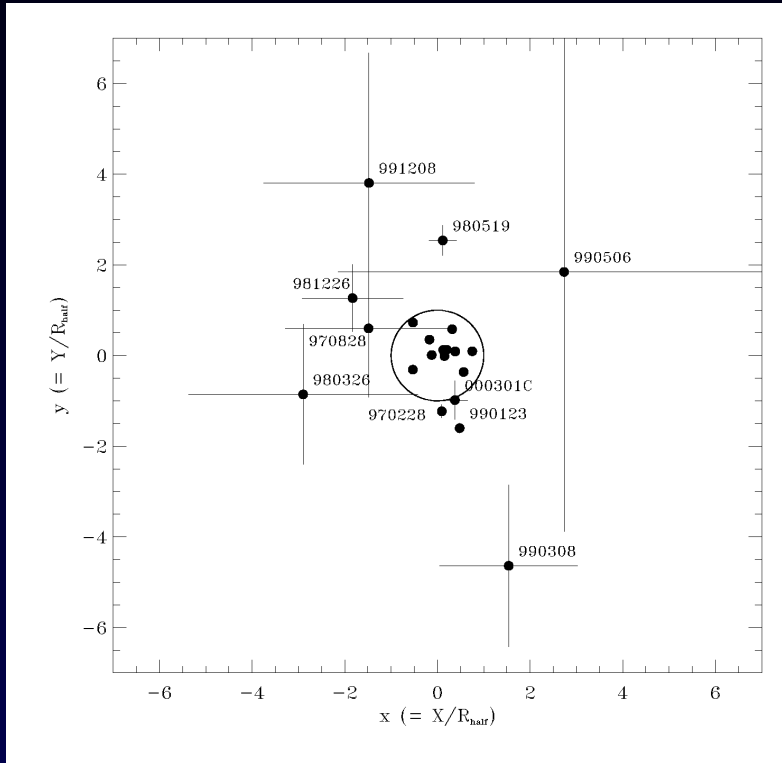


Host of GRB 990123 (HST)
3.2" × 3.2" (Fruchter et al. 2000)

Host of GRB 990705 (HST)
Holland et al. 2002



Progenitor Clues



Host-normalized offset distribution
(Bloom et al. 2002)

- Massive stars explode soon (\odot 10^7 yr)
- Merging neutron stars require a time to merge $\sim 10^8$ yr
- No elliptical host galaxy has jet been uncovered

Conclusions and Future

- Locations are connected to host galaxies
 - ◆ Collapsar Model

Future aims:

- Improve SFR estimators
- Only ~50 GRB host galaxies known
 - ◆ Swift (rapid locations)
 - ◆ GROND (determination of redshift)
- Short duration bursts

References

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- Schaerer, D. Building Galaxies; from the Primordial Universe to the Present, Proceedings of the XIXth Rencontres de Moriond. Ed. F. Hammer et al. World Scientific Publishing Co., ISBN 981-02-4411-8, 2000., p.389
- Bloom, J. S. 2002, PhD Thesis
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- Hopkins, A. M., Connolly, A. J., Haarsma, D. B., Cram, L. E. 2001, AJ, 122, 288.
- Madau, P., Pozzetti, L., Dickinson, M. 1998, AJ, 498, 106.
- Steidel, C. C., Adelberger, K. L., Giavalisco, M., Dickinson, M. Pettini, M. 1999, AJ, 519, 1.