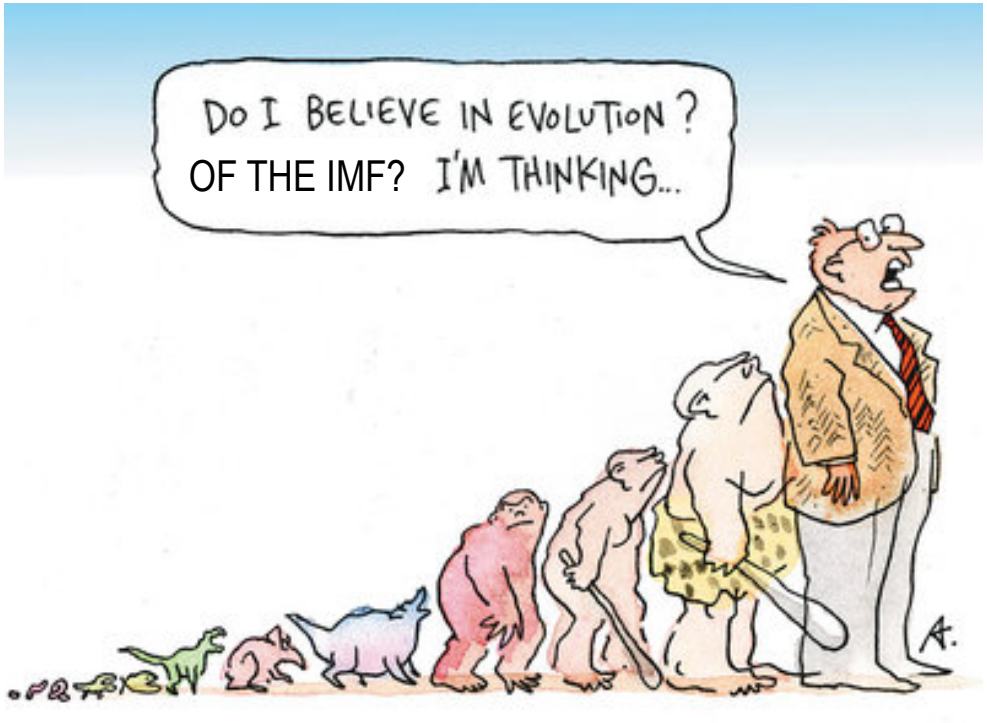
Probing the Evolution of the Stellar IMF with Redshift using Supernovae



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Adapted
From philly.com

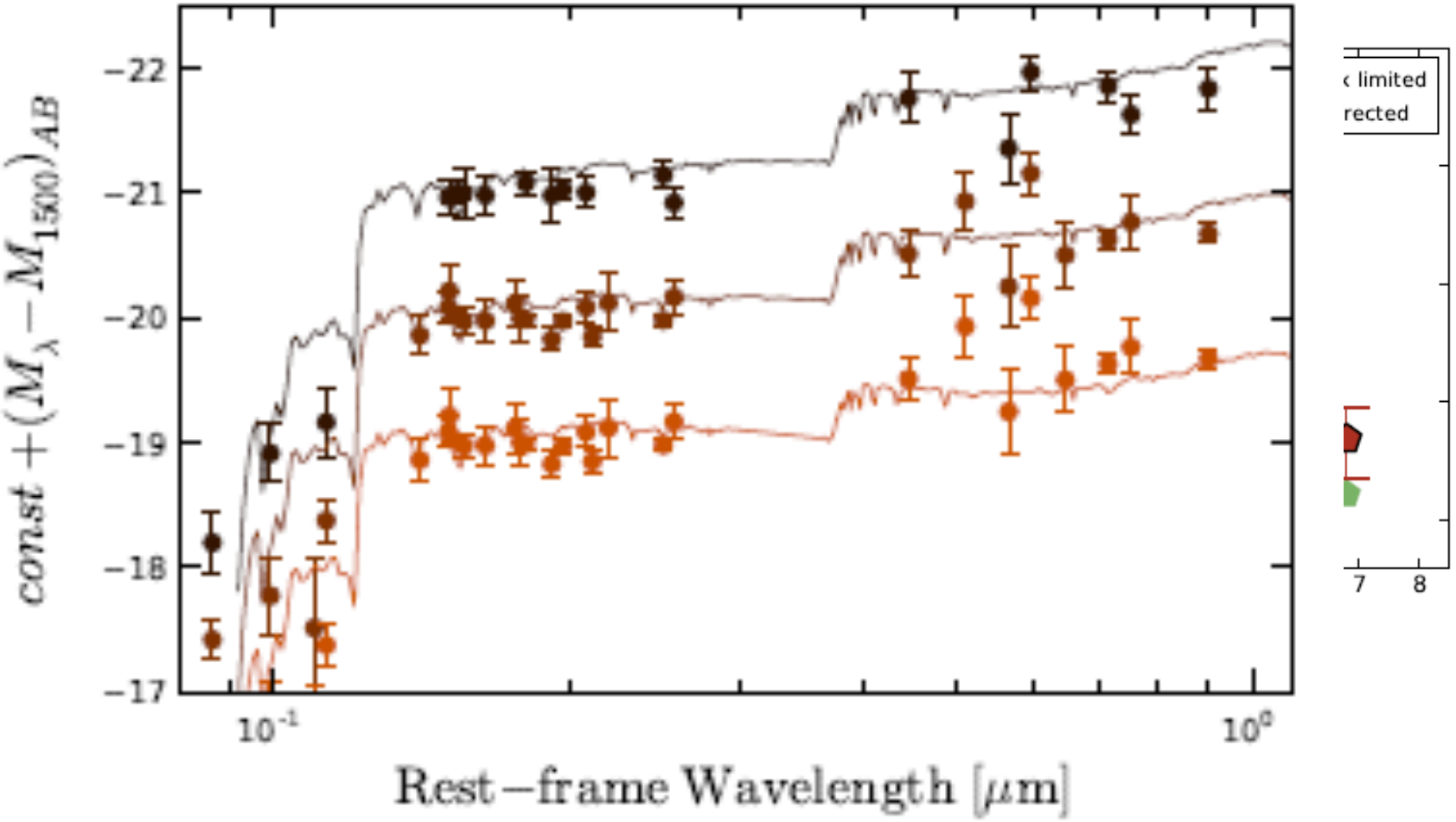
Outline

- What is the stellar IMF and why is it important?
- Current constraints on the IMF
  - Long Duration Gamma-ray Bursts
  - Field Galaxy Studies
  - Type Ia Supernovae
  - Metal Yields
- Future constraints on the IMF using wide-area NIR surveys

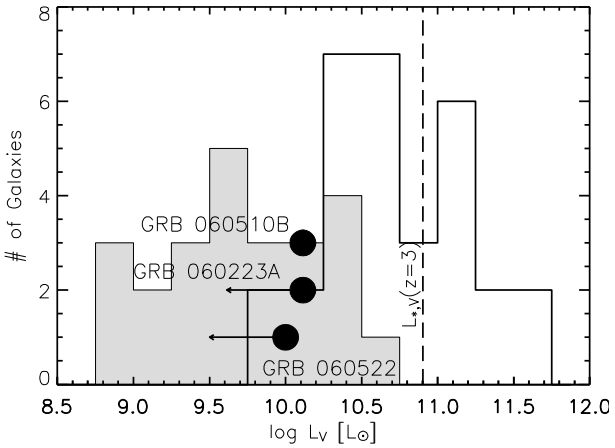
An Empirical Power-Law Parameterization

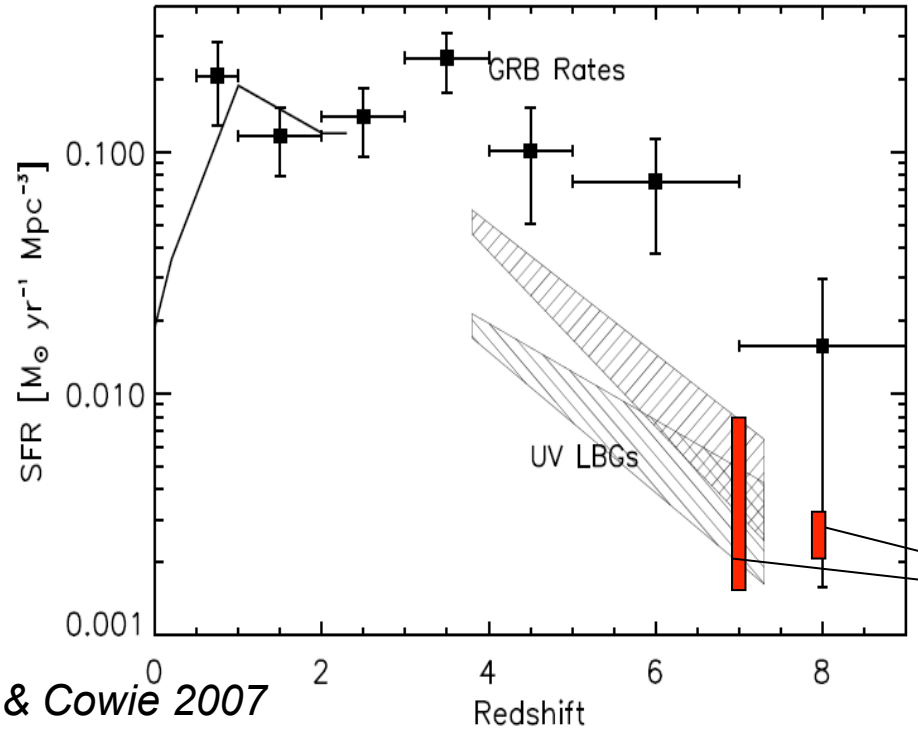
- $dN/dM \propto M^{-\alpha}$
- $\alpha = 2.35$ is Salpeter
- Could be a double power-law with a break

The IMF Forms the Key Foundation of Galaxy Evolution Studies



I. Gamma-ray Burst Rates are Unusually High at z>3

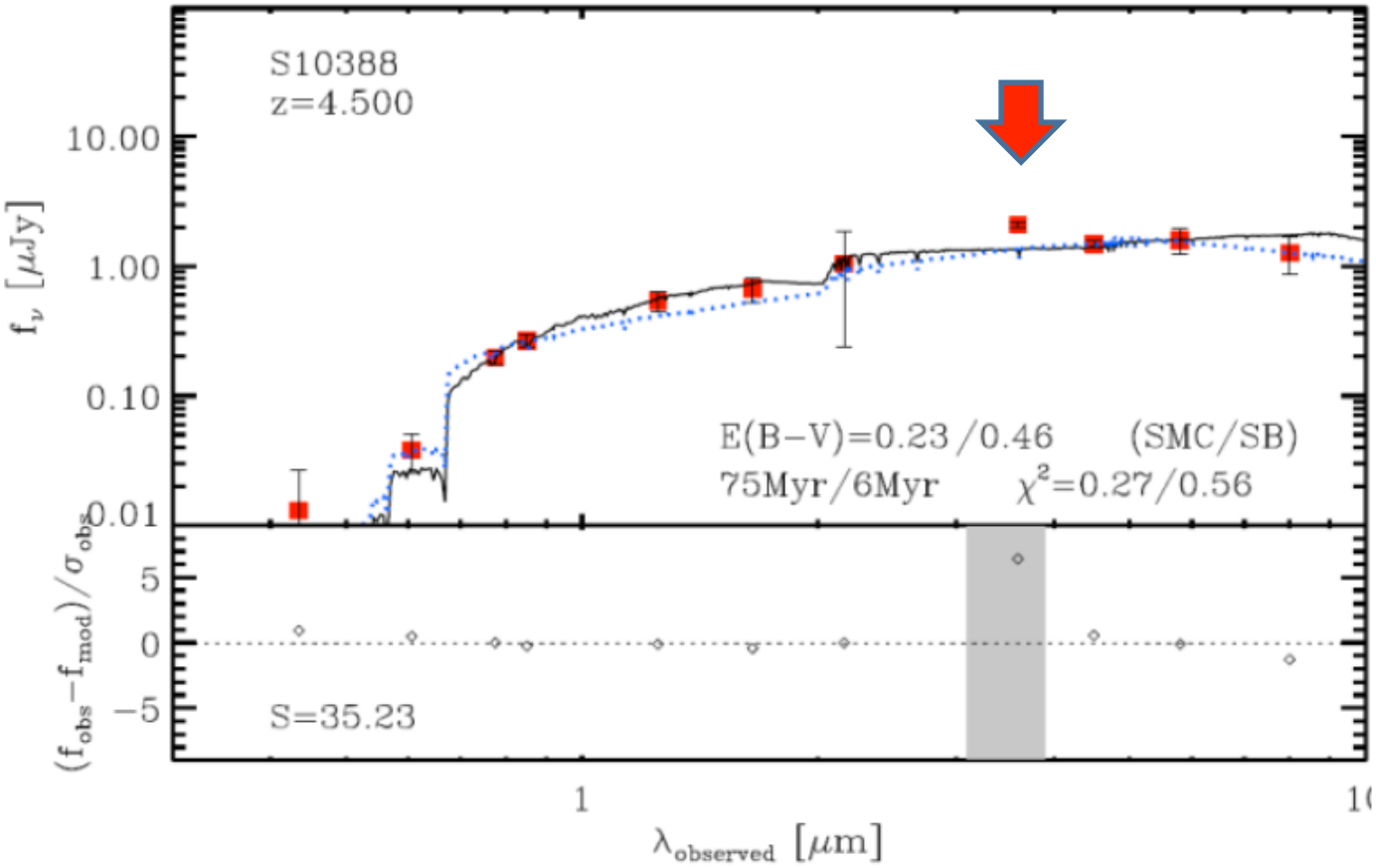




WFC3 UDF (Bouwens)

Chary, Berger & Cowie 2007
Also more recently Robertson & Ellis 2012

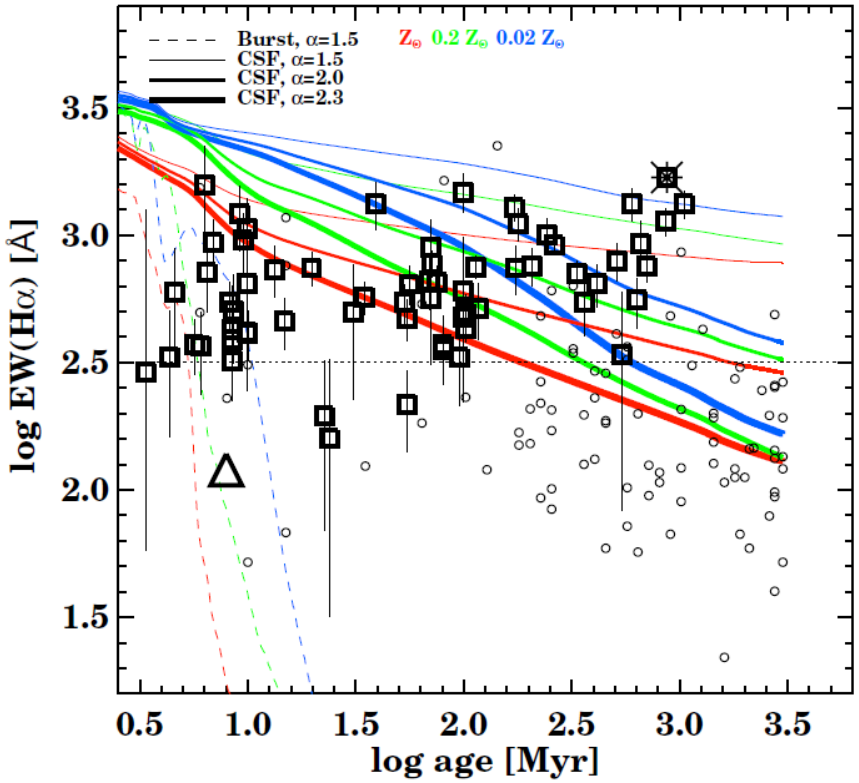
II. From Halpha in Field Galaxy Surveys at z~5

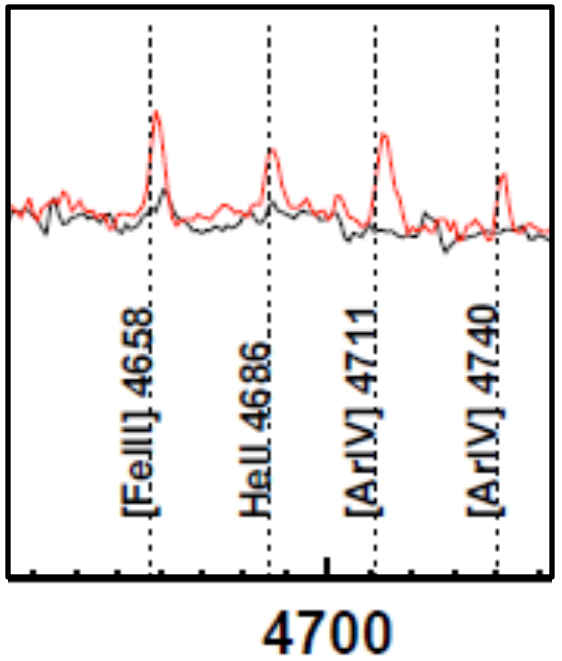


Halpha nebular emission: ubiquitous in z~5 galaxies as seen in Spitzer data

Chary et al. 2005
H. Shim, RC, et al. 2011

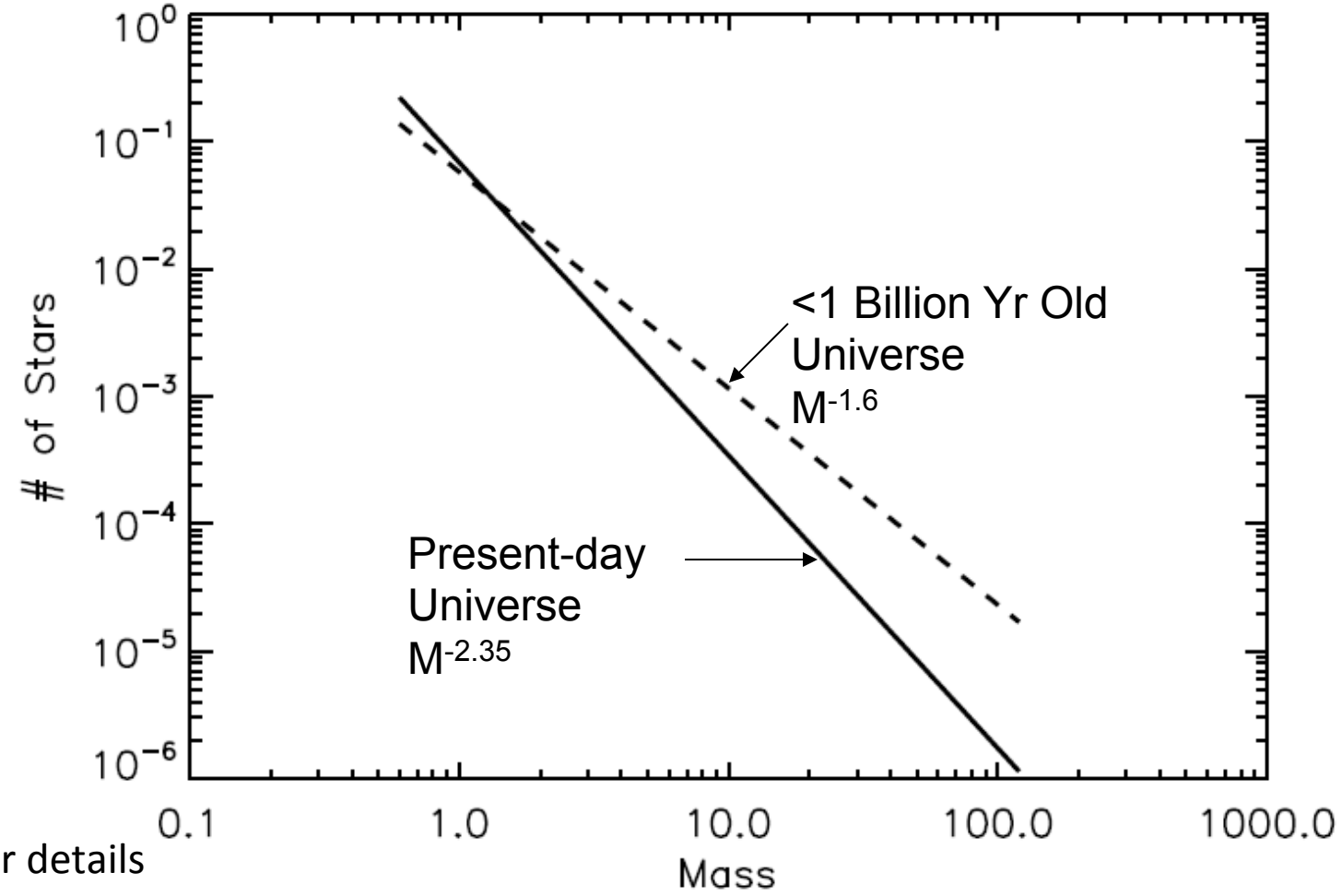
II contd. Booming Halpha Emission in z~5 galaxies: Massive, Hot Stars





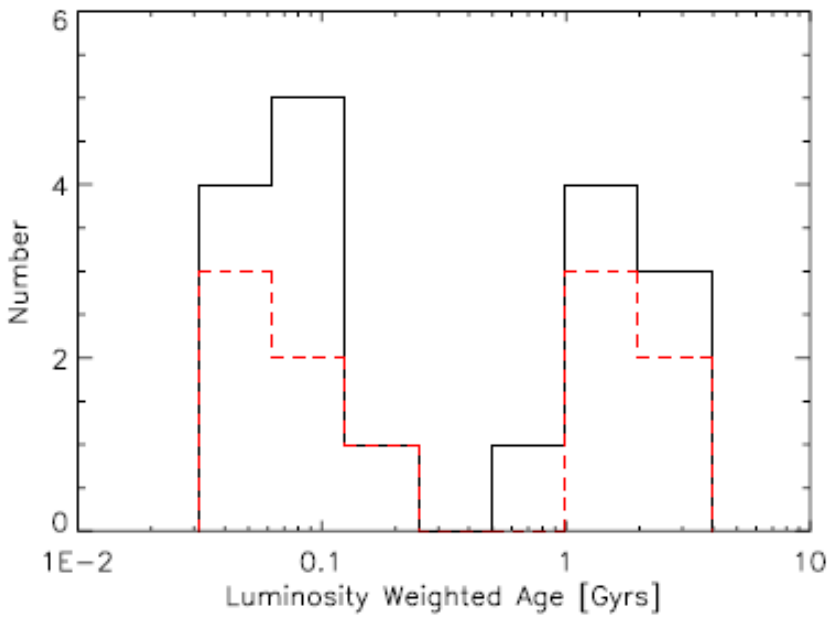
Chary et al. 2005
Shim, RC, et al. 2011

Obesity is ubiquitous in the early Universe

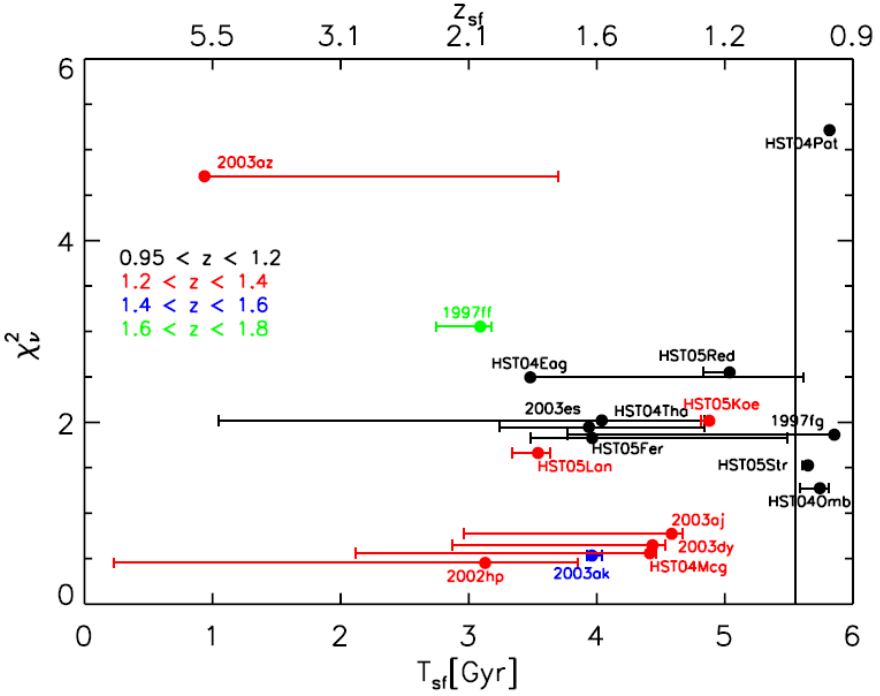


RC 2008 for details

III. Ages of Stellar Populations in z~1 Type Ia SNe Host Galaxies



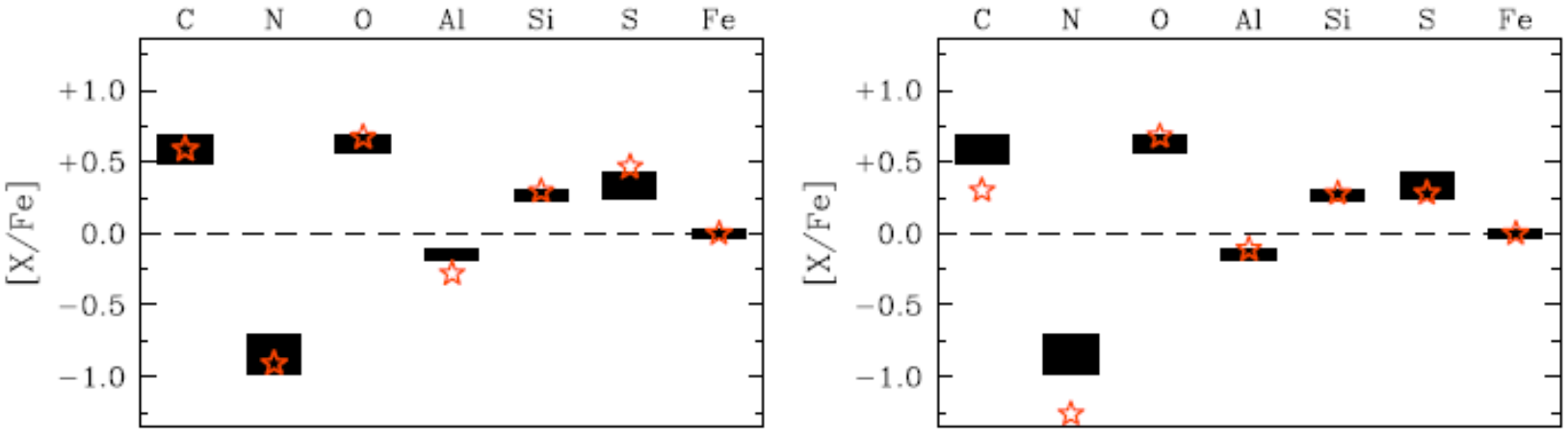
Thompson & RC 2010



Ages of z~1 SNe hosts imply that 8 Msun Stars are in place by z~5

➢ **This might be the dominant reason for a paucity of Type Ia's @ z>1.5**

IV. Metal yields in CEMP DLAs

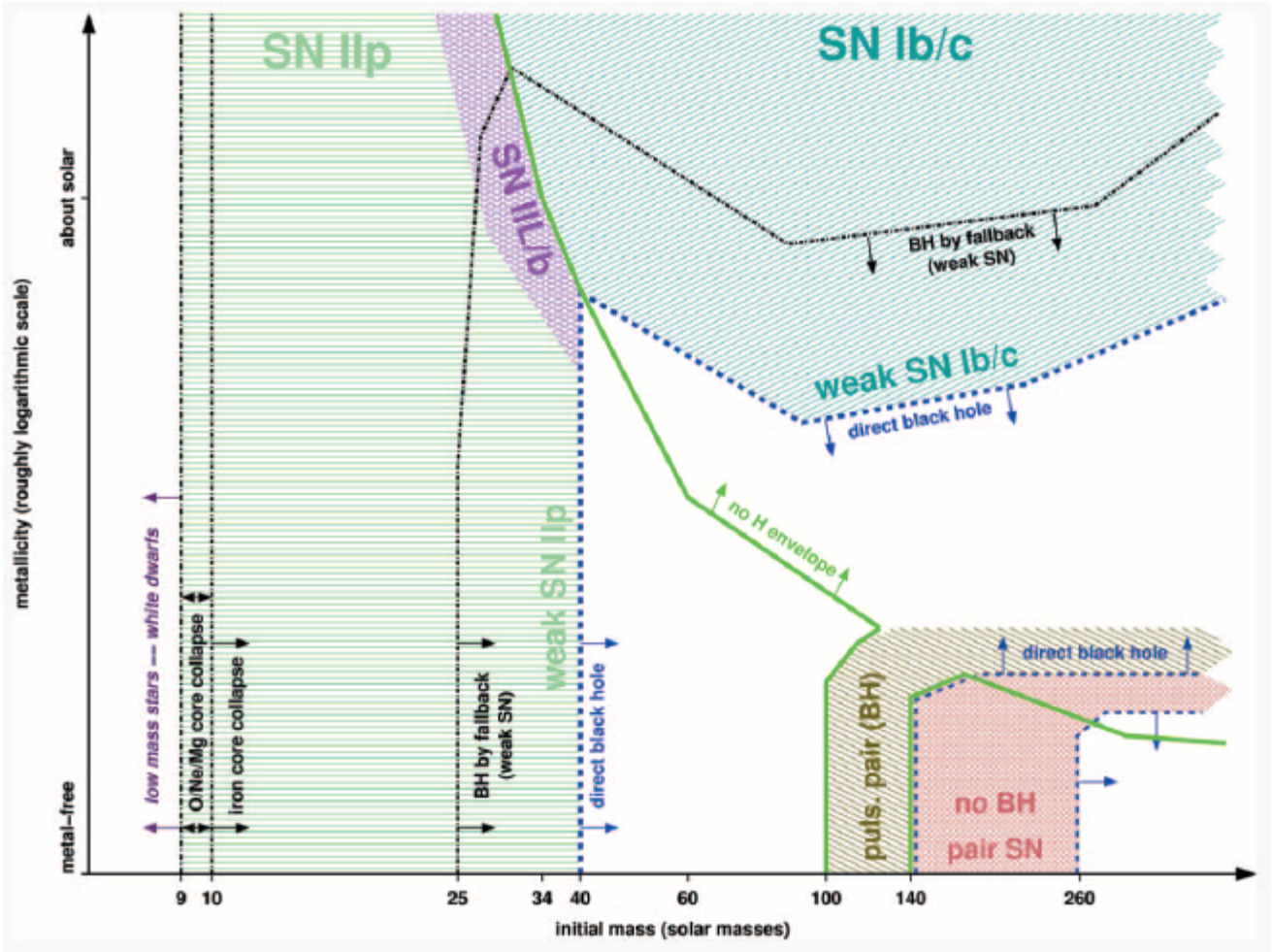


Left Panel: Observed yields fit by PopIII stars, Right panel: same yields fit by 35 Msun PopII star

R. Cooke, M. Pettini et al, 2012

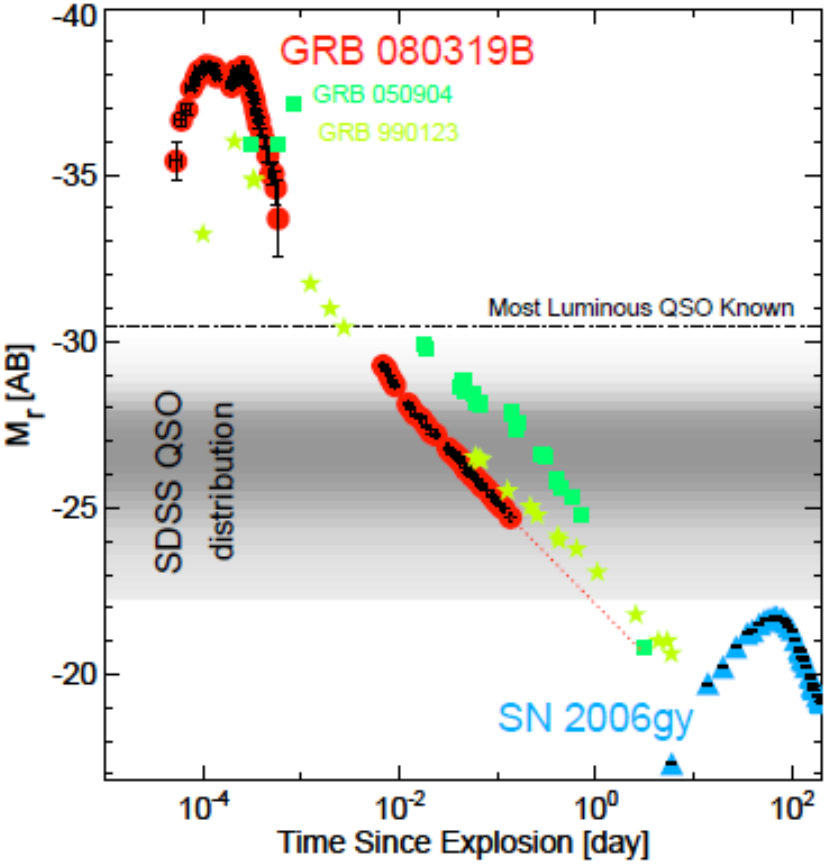
Metal Abundance Patterns are Degenerate!

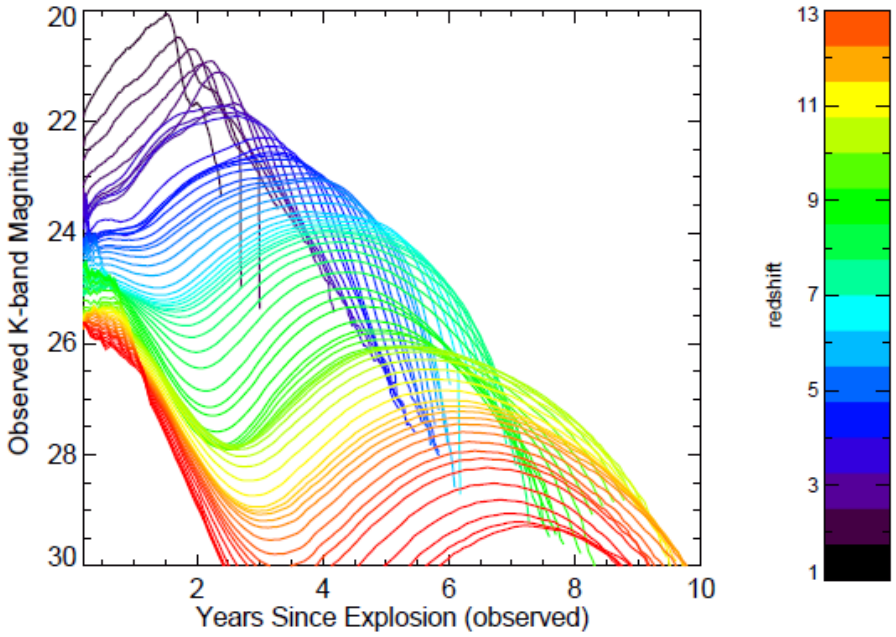
Detecting Pair Instability Supernovae with WFIRST



Heger et al. 2003

After GRBs, the most luminous are Pair Instability SNe





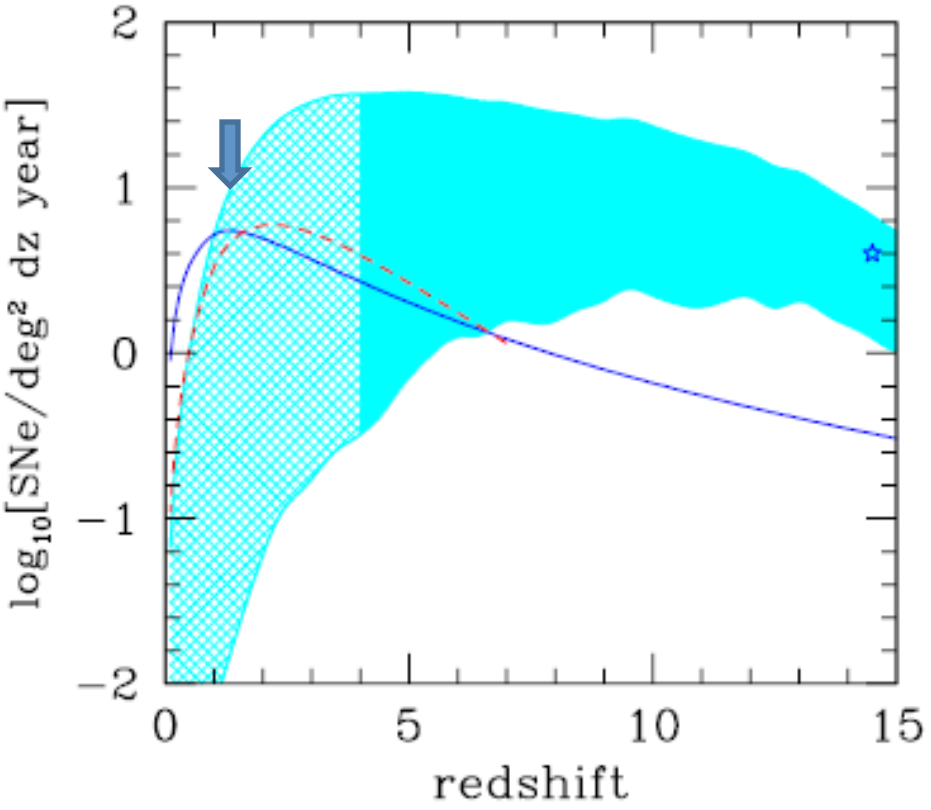
And they are bright for 100s of days
Kasen et al. 2011

Bloom et al. 2008

Rates are Challenging

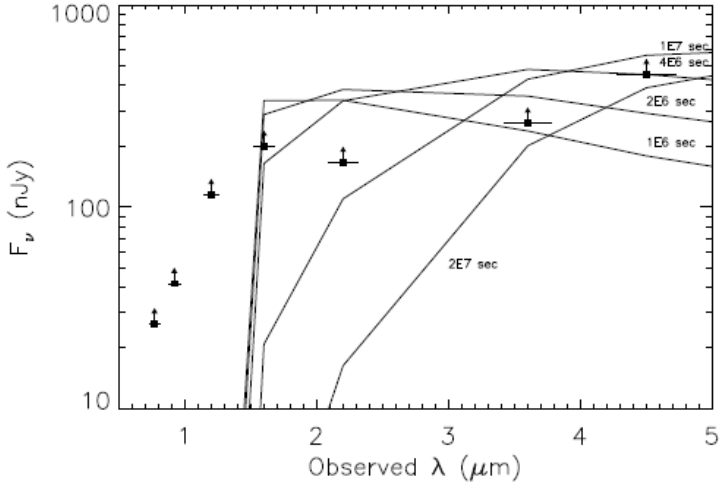
Scannapieco et al. 2005, Frost et al. 2009

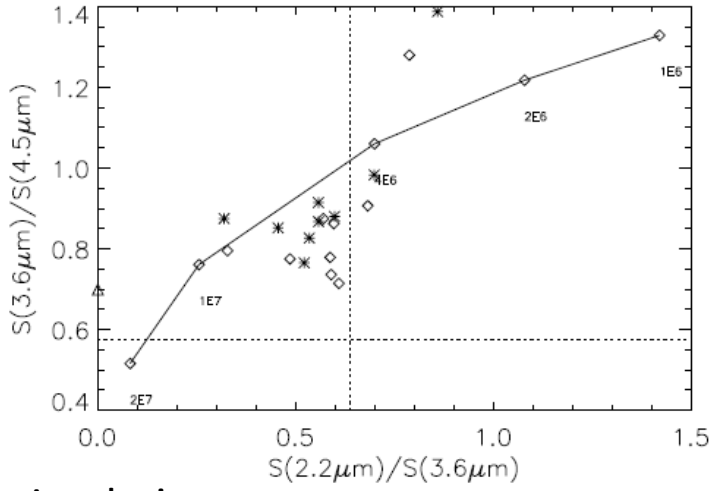
- 1000 times less numerous than Type Ia (e.g. Quimby et al.)
- 1-10 /deg2/yr
- 3-4 epochs of 24 AB mag in the NIR to identify
- Need to use colors to distinguish them from galaxies



SED Evolves from Blue to Red

- Photosphere expands and cools
- Identification in the 1st million seconds after the explosion is easiest due to time dilation.





z~10 200 Msun simulation

Summary

Adapted
From nwcreation.net

I grant you IMF evolution was a theory to begin with
But it evolved into a fact recently.

- Time domain astrophysics in the NIR is under-explored territory.
- IMF evolution is high impact science with implications for reionization, galaxy evolution and metal/dust enrichment.
- Current WFIRST configuration well suited to detecting luminous SNe at z<5