Host Environments of Nearby Core-Collapse SN + LGRBs

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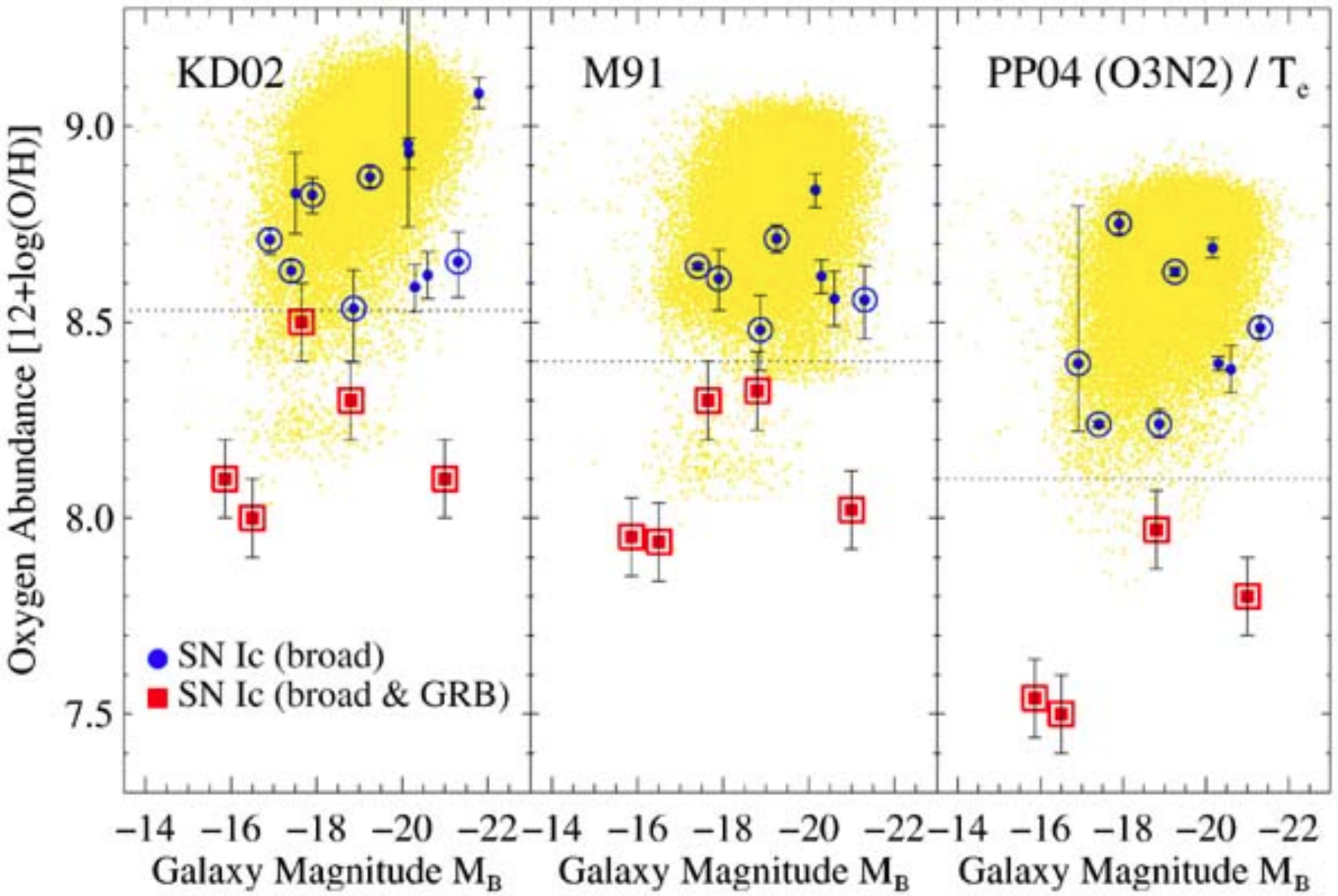
Outline

1. Long-duration gamma-ray burst (LGRB) host chemical abundances
2. Core-collapse SN environments from Sloan Digital Sky Survey (SDSS) galaxy data

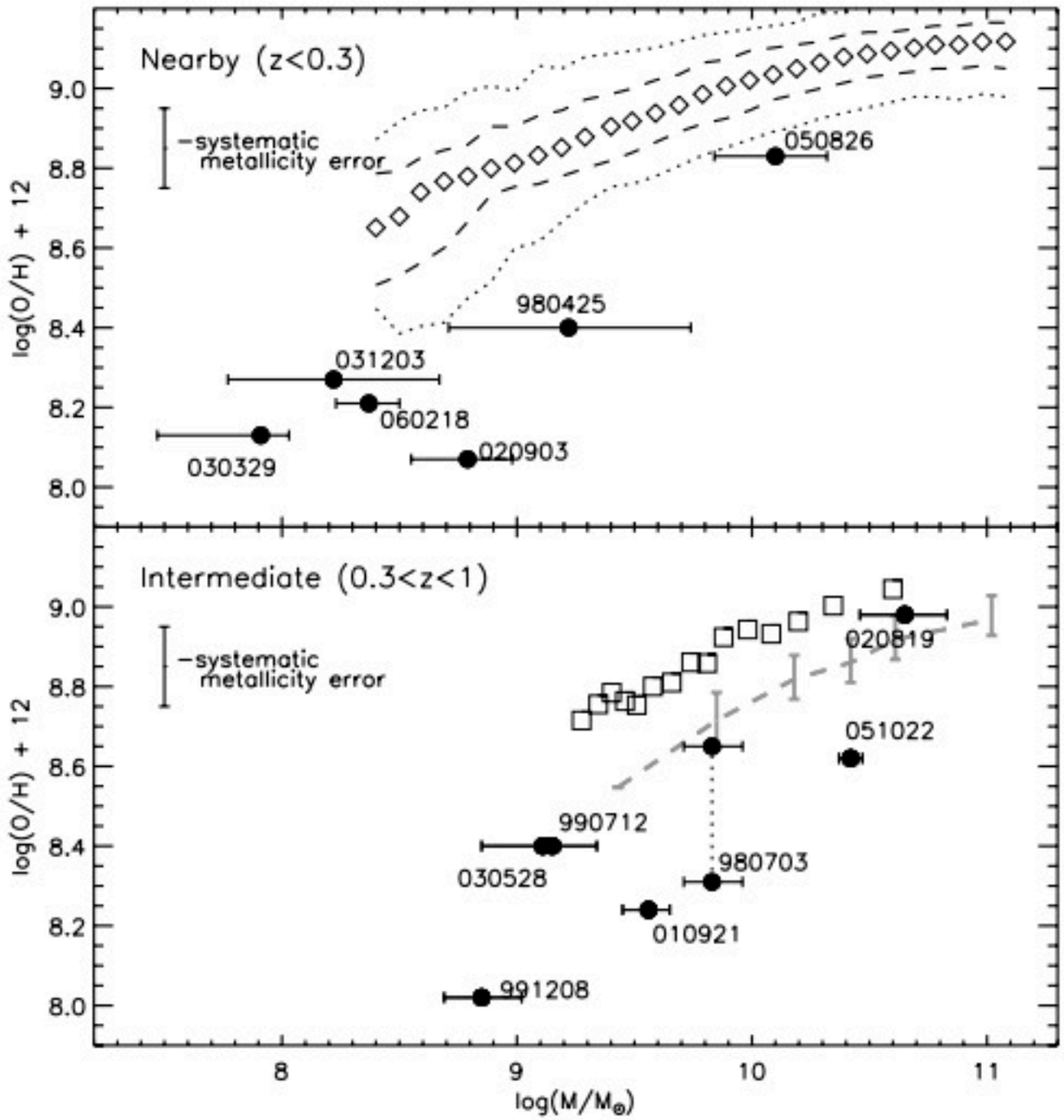
Evidence that SN-GRBs prefer metal-poor hosts



Modjaz et al. 2008

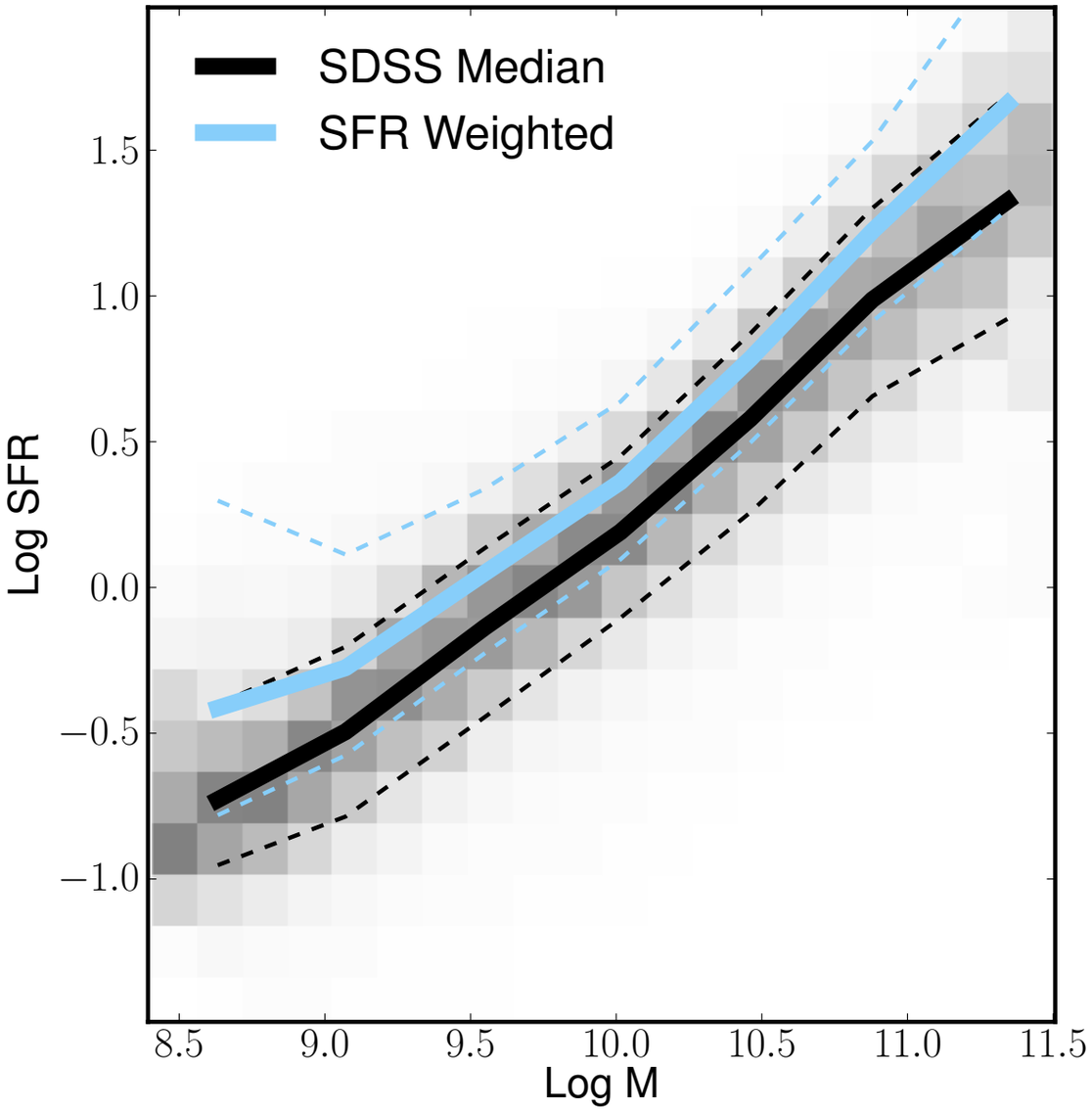
GRB hosts have an metal-poor M-Z relation?

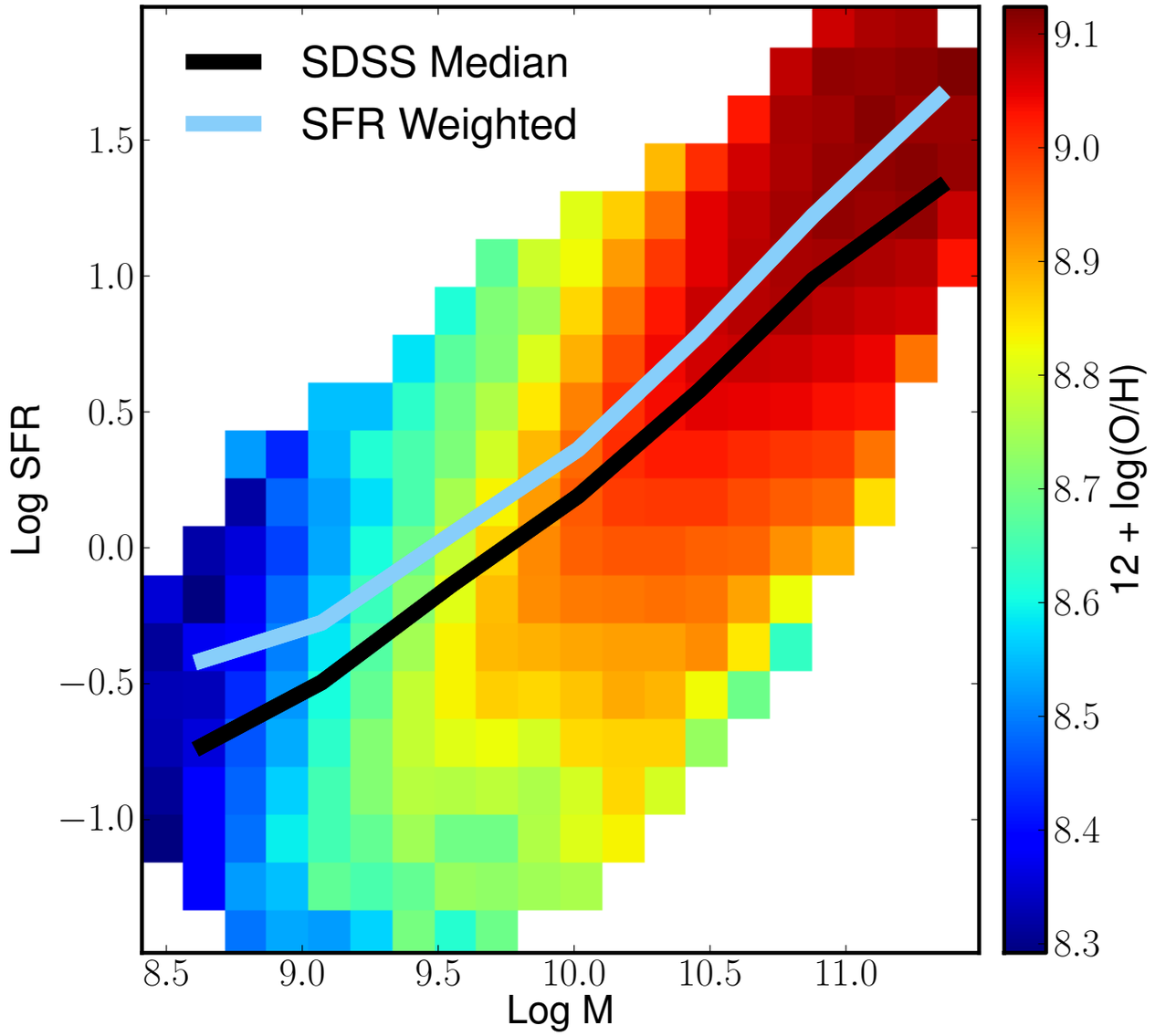
Levesque et al. 2010; Han et al. 2010



also Graham et al. 2012 for GRB host L-Z relation

Tight M-SFR relation -> small transient M-Z offset





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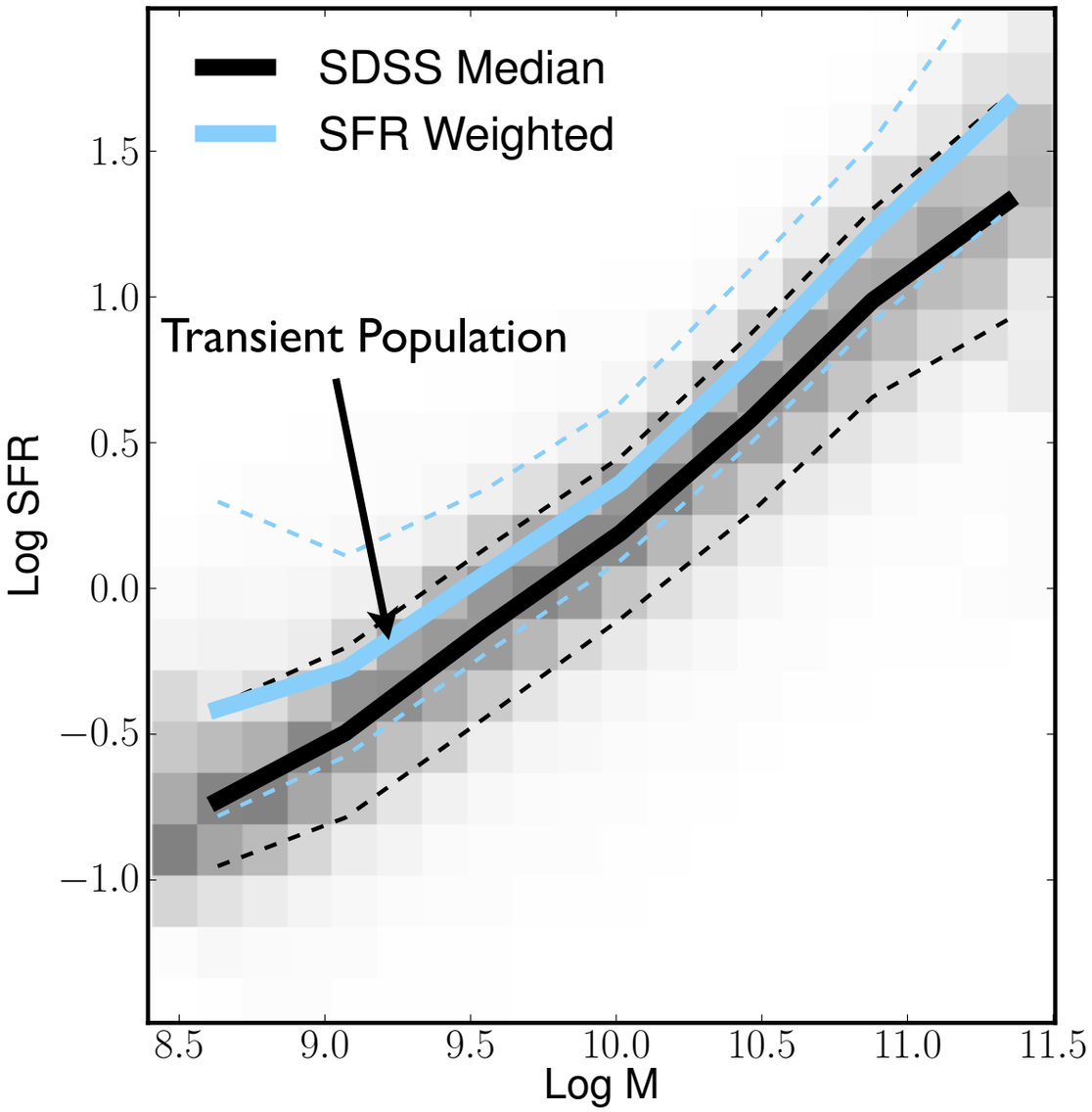
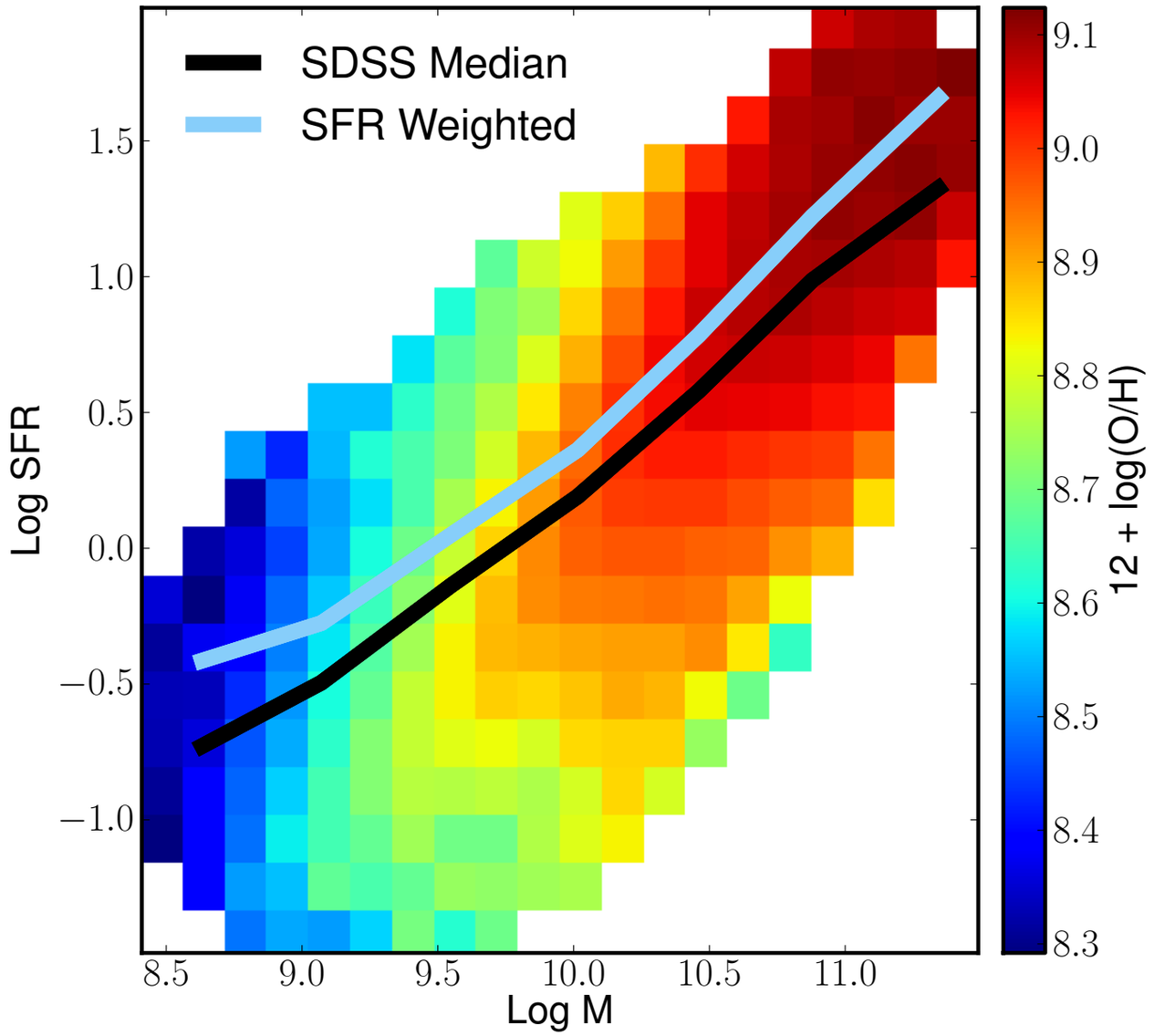
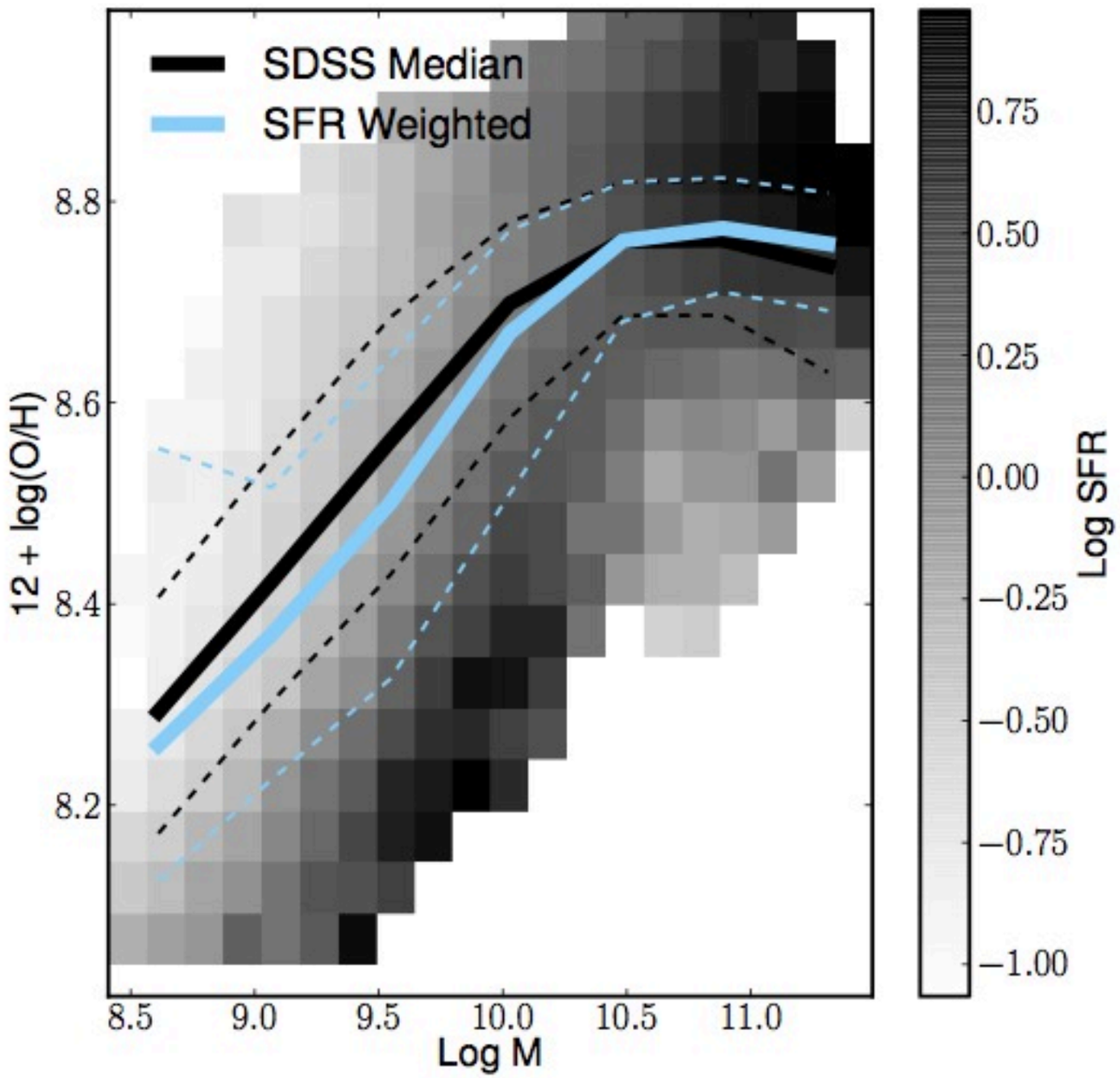
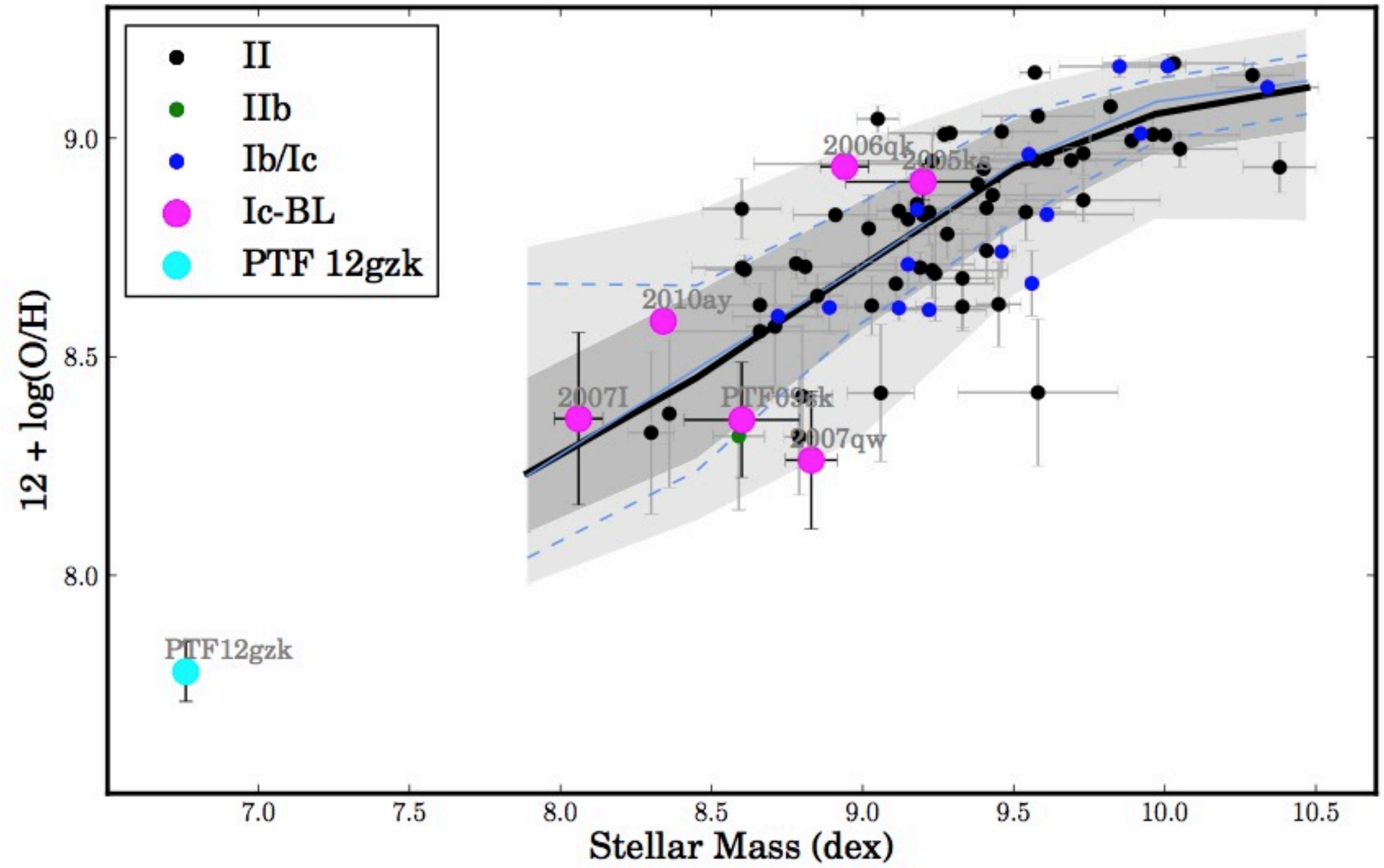




Modest offset, depends on diagnostic

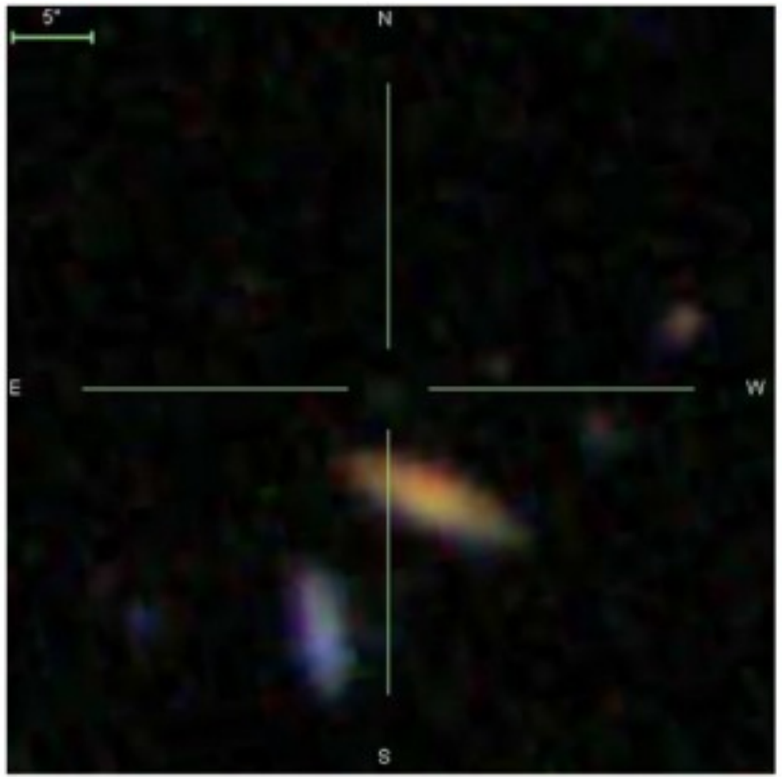


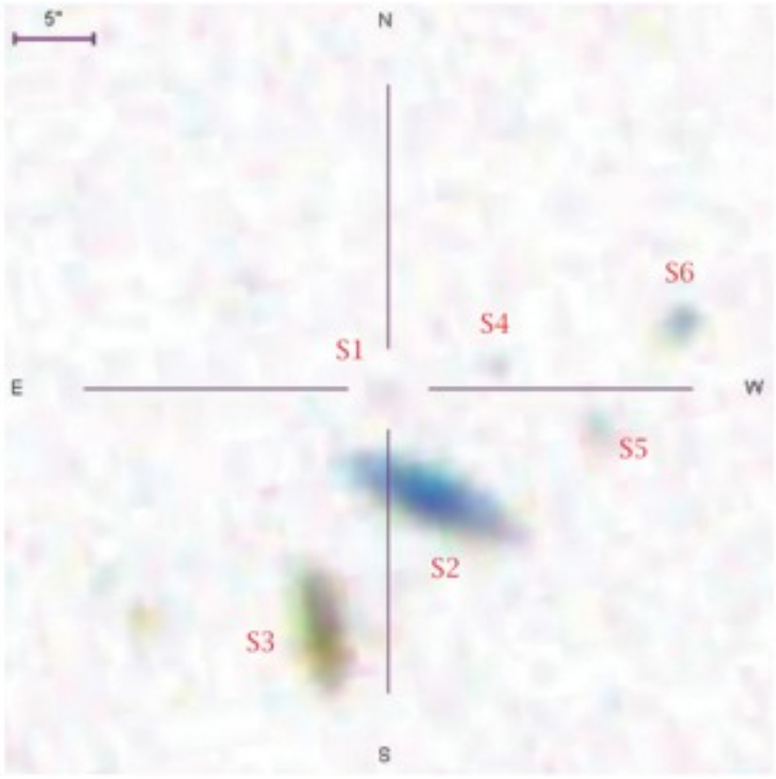
No strong metallicity offset for CC SN



w/ M. Modjaz

GRB 130702A Exploded in Metal-Poor Satellite





12 + log(O/H) < 8.16 dex

log M ~ 7.7

Δv < 60 km/s

z = 0.145

Kelly et al., ApJL, 2013

Superpositions, unresolved satellites?

Environments of Nearby Core-Collapse SN

- Uniform SDSS host imaging + spectroscopy
- Low-redshift events ($z < 0.08$) with accessible explosion sites

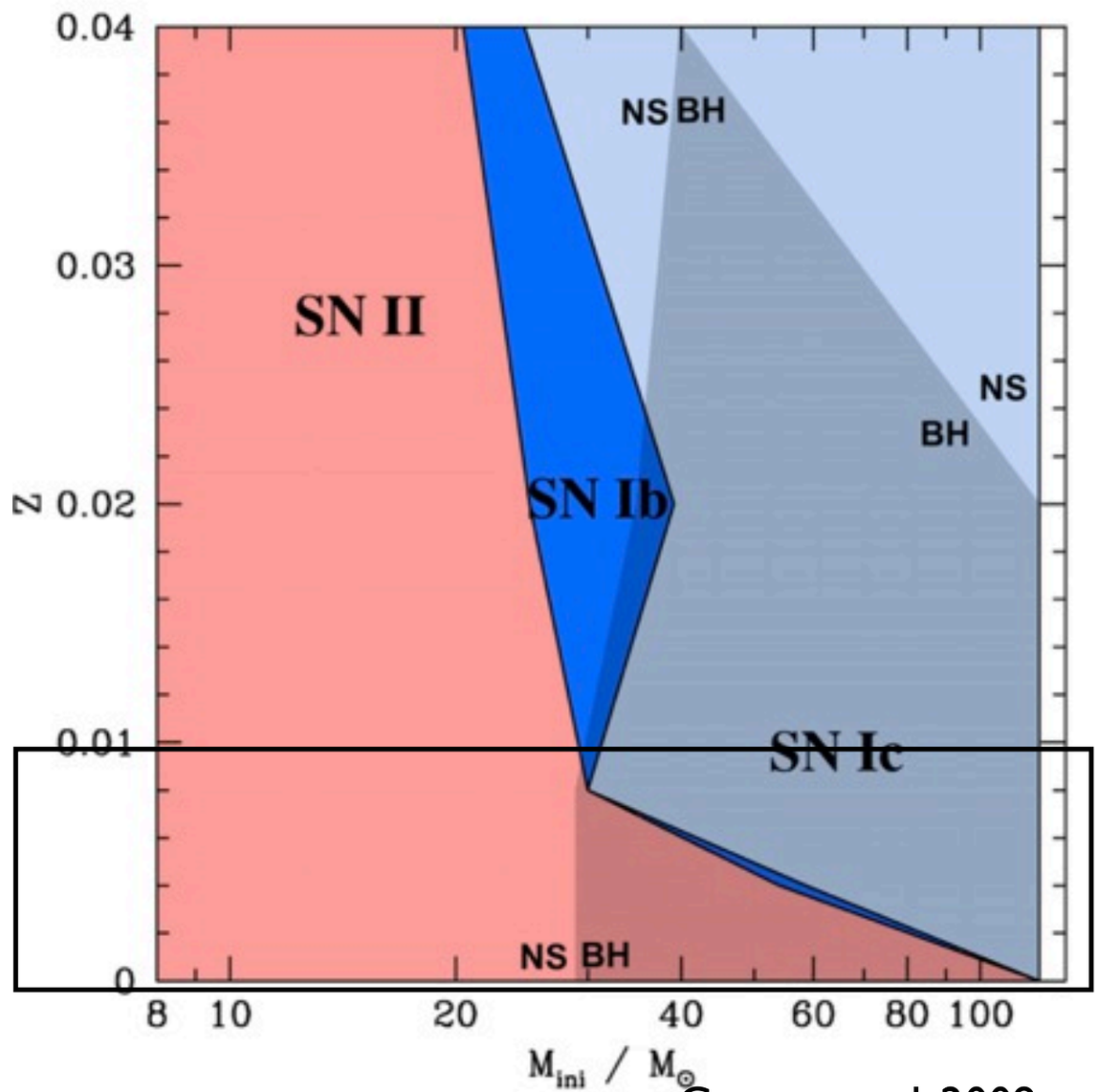
- What are the massive progenitors of the different spectroscopic species?
- Importance of chemistry, age, star-forming conditions

Mass loss through binary transfer or winds?

II	H
IIb	Thin H
Ib	He, No H
Ic	No He, No H
Ic-BL	High ejecta vel.

- Stellar winds are enhanced by metals in atmosphere
- Look for metallicity dependence of CC SN population
- Angular momentum

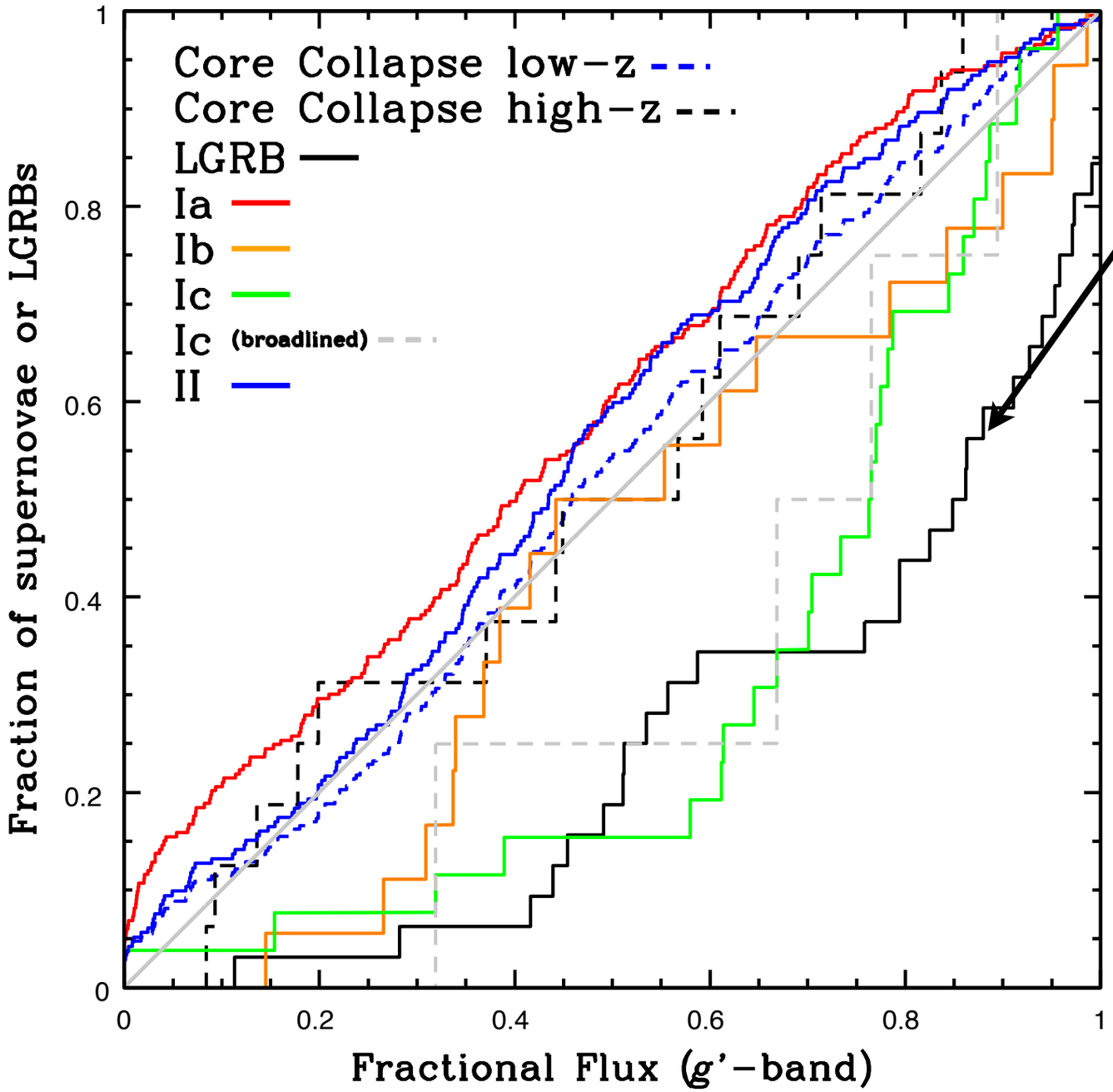
low-metallicity →



Georgy et al. 2009

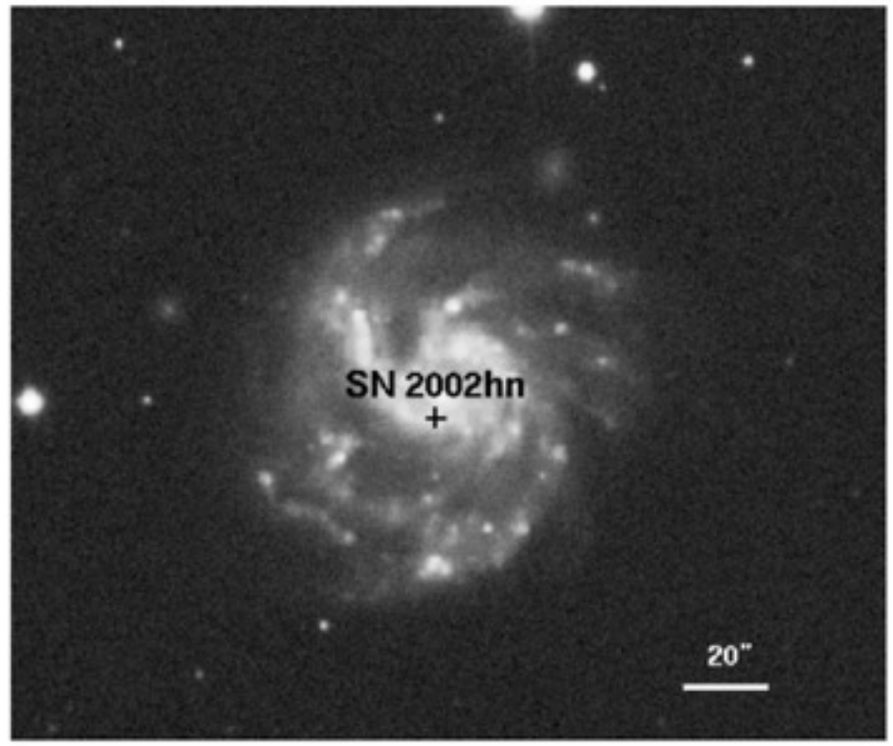
SN Ic in brighter regions than SN Ib

Kelly, Kirshner, & Pahre, ApJ 2008



brighter →

LGRB Fruchter et al. 2006



SN Ic

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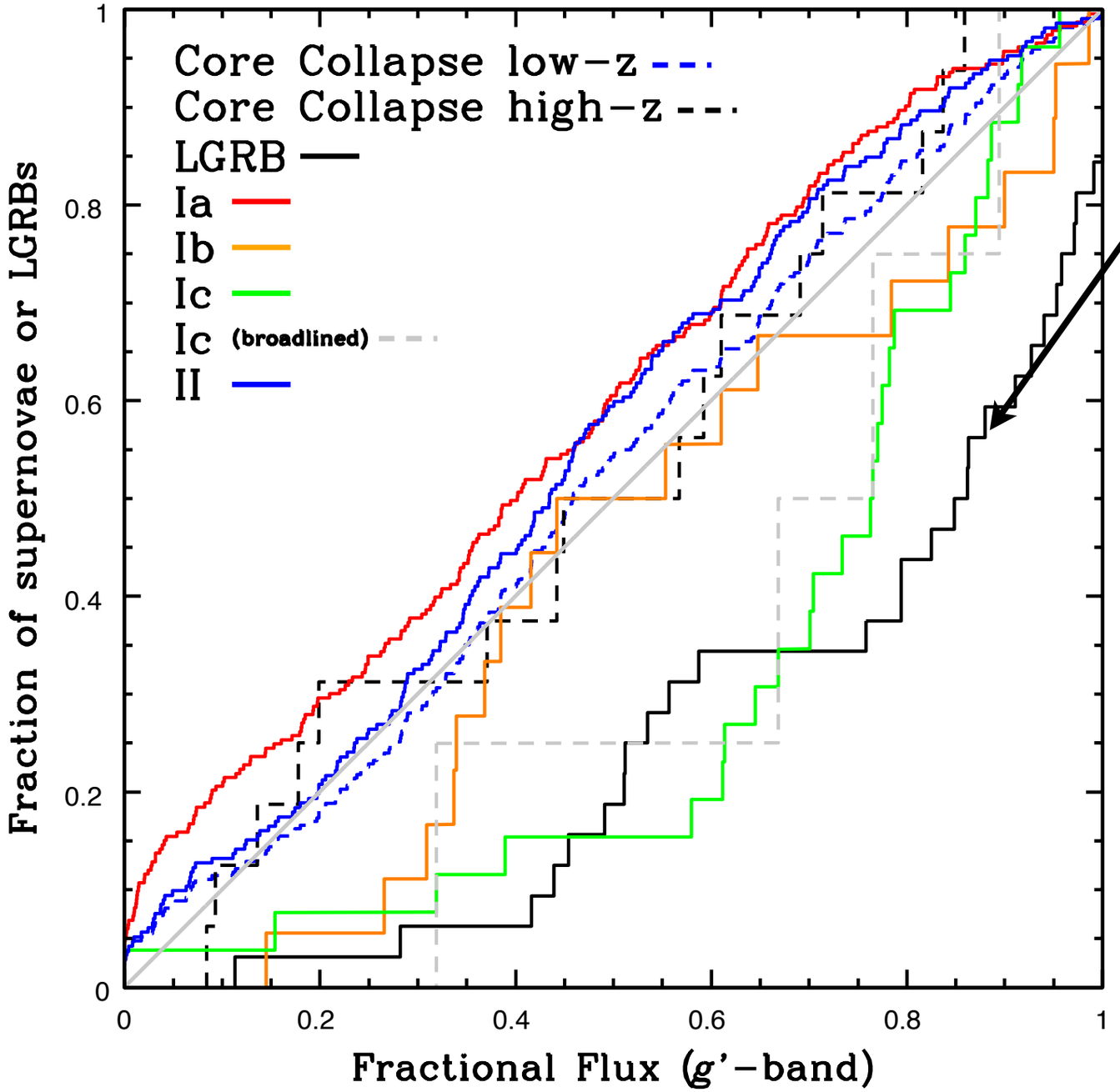

LGRB Fruchter+ 2006

Mass:
Raskin+ 2009; Eldridge+ 2011

WR Progenitors:
Leloudas+ 2010

Host Metallicity:
Prieto+ 2008

Metallicity at/near Site:
Modjaz+ 2011; Leloudas+ 2011; and Anderson+ 2010

Anderson+ 2008; Crowther 13 (Halpha)

SDSS+ Analysis

Kelly & Kirshner, ApJ, 2012

- Uniform SDSS host imaging + spectroscopy
- 520 core-collapse supernovae
    - z < 0.023 SN discovered by 'targeted' surveys (e.g., KAIT), high-mass hosts
    - z < 0.08 SN discovered by 'galaxy-untargeted' surveys (e.g., SDSS-II, PTF), sensitive to explosions in low-mass hosts

Colors and brightnesses at explosion sites

Kelly & Kirshner ApJ 2012

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Ic	No He, No H
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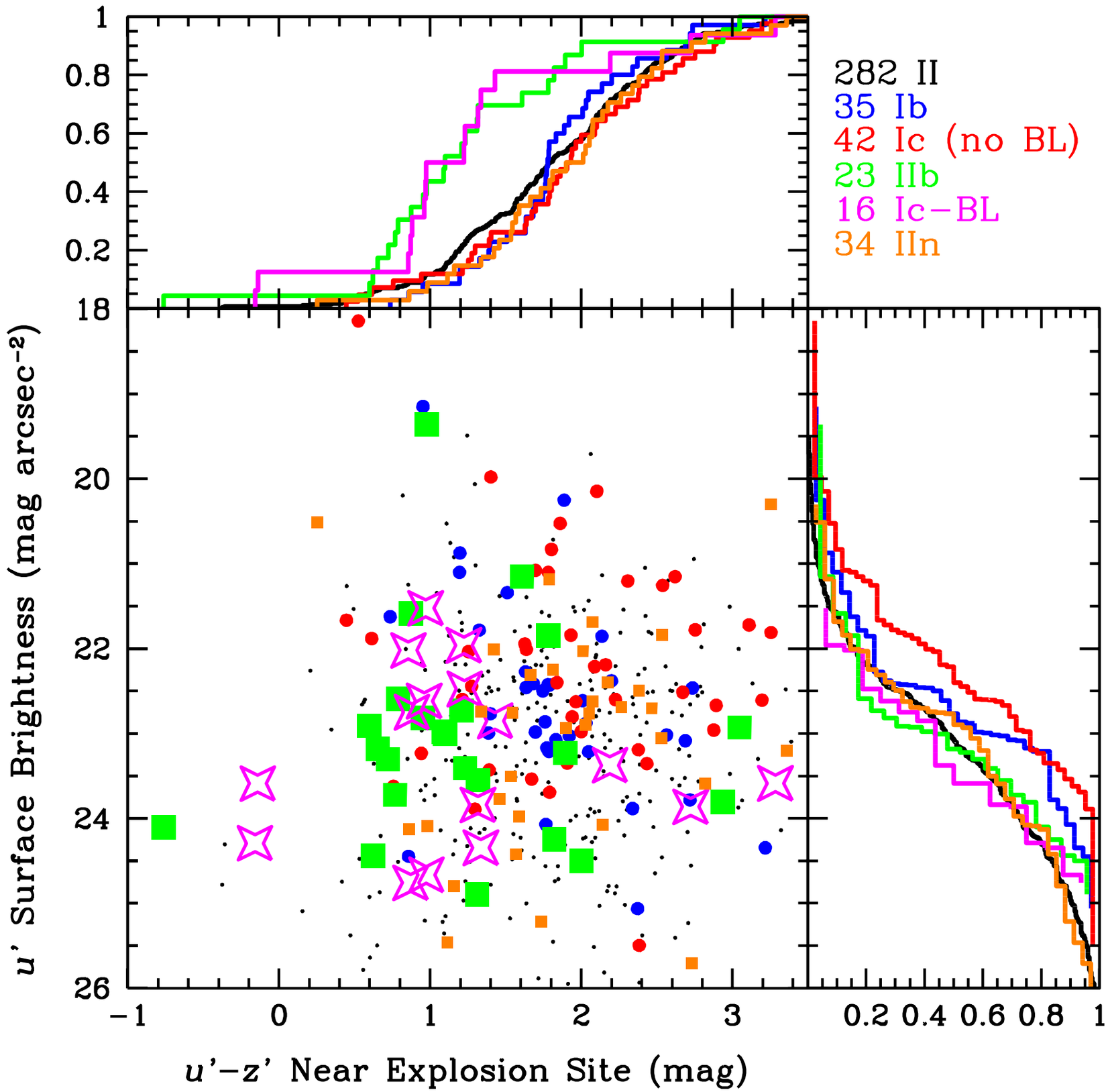

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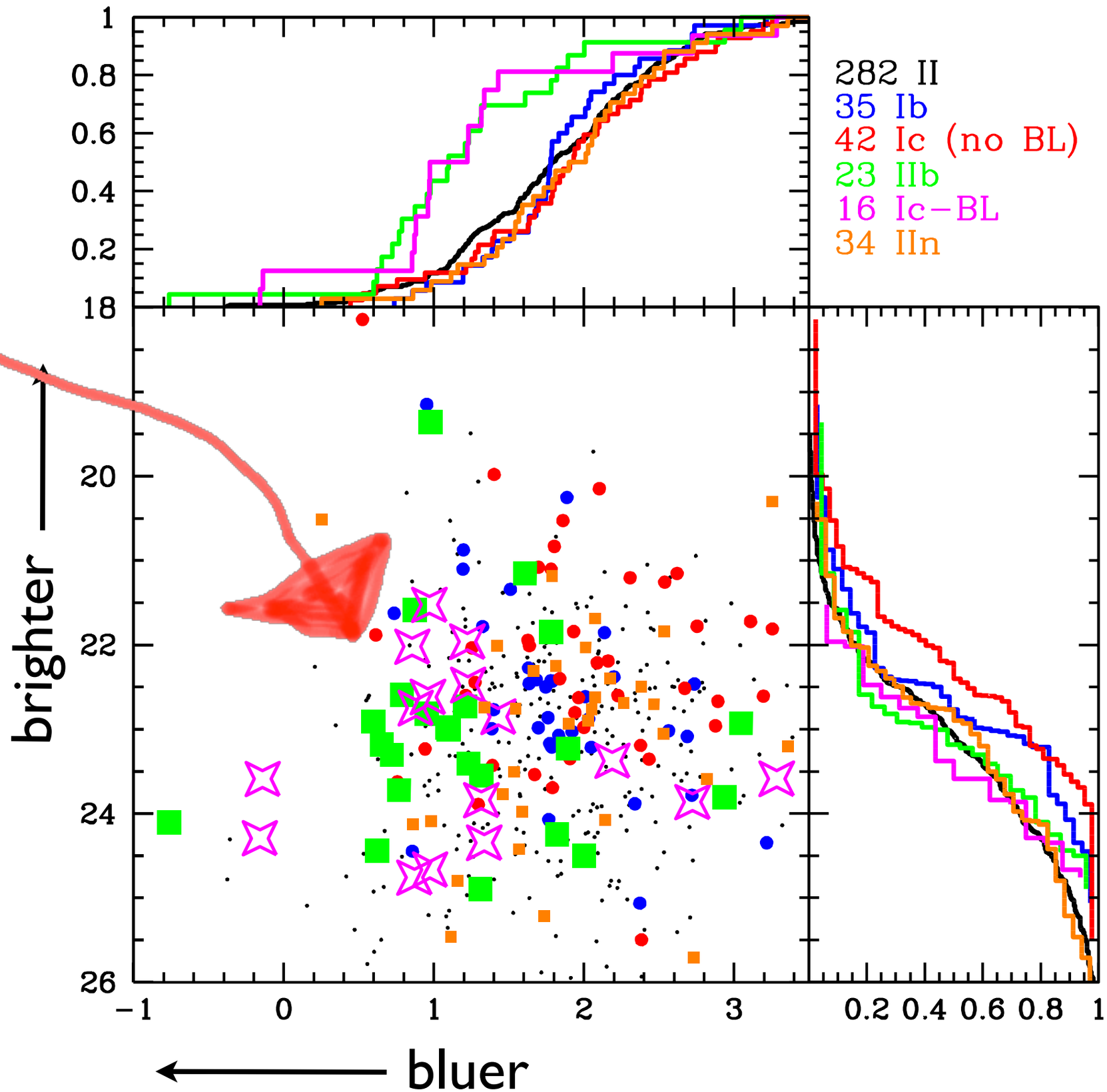
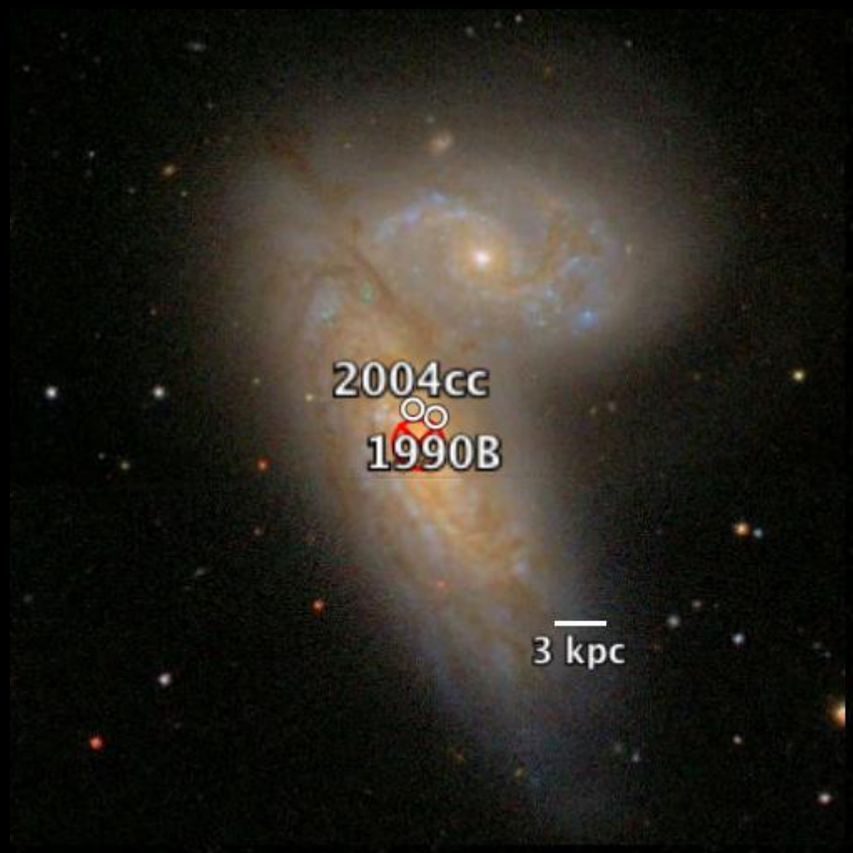
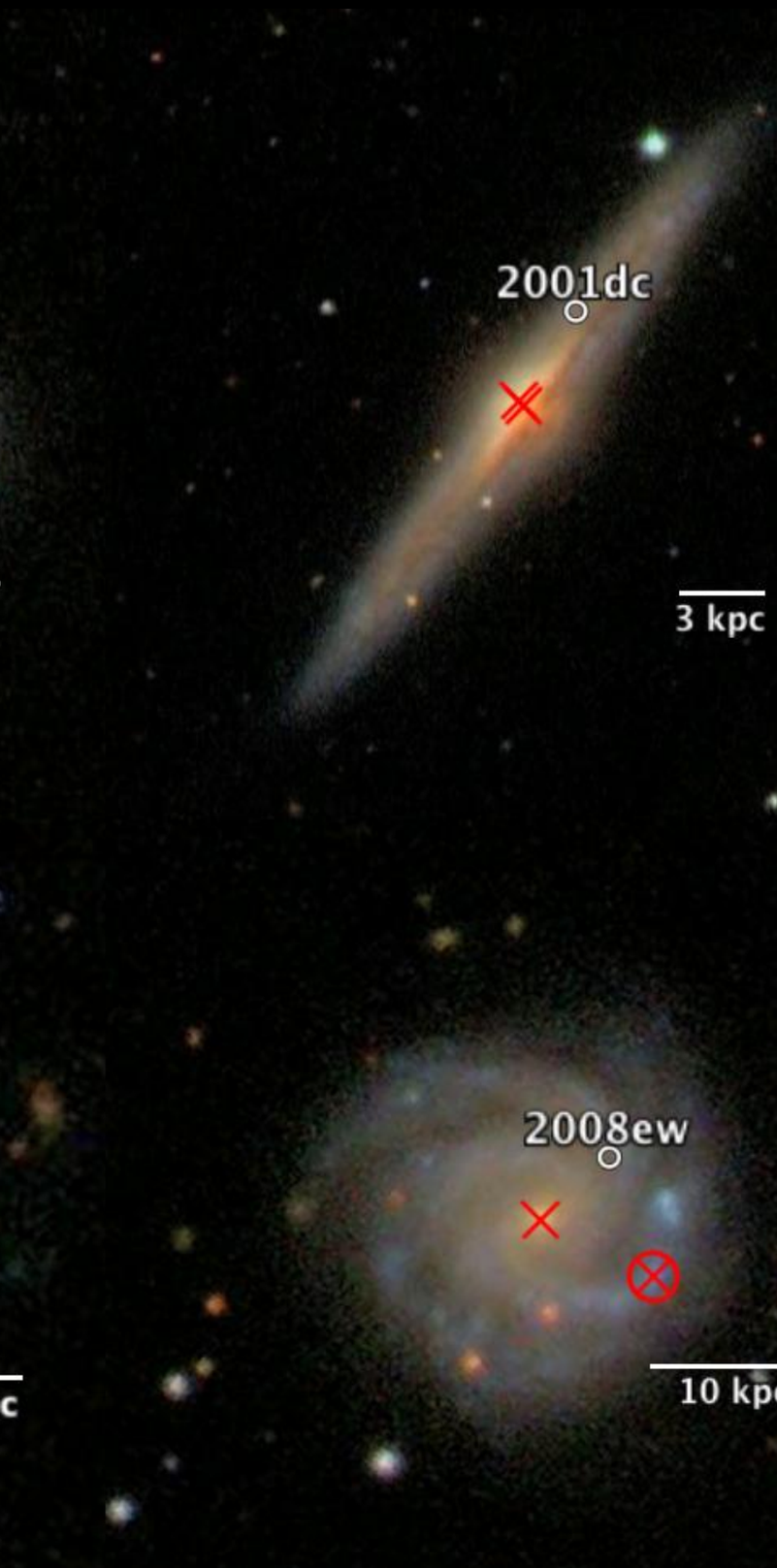
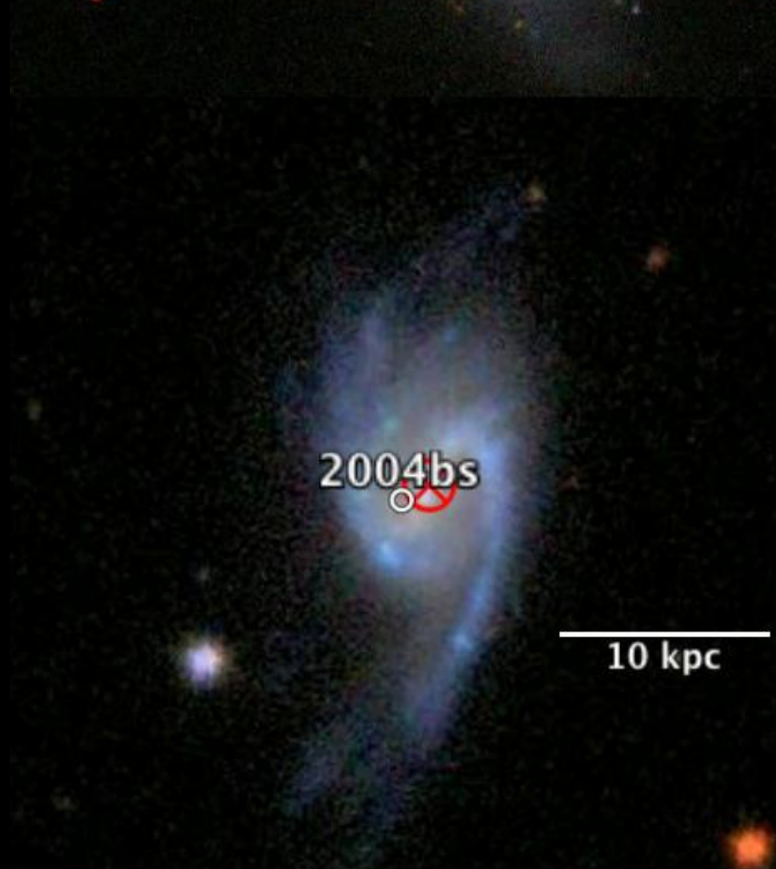


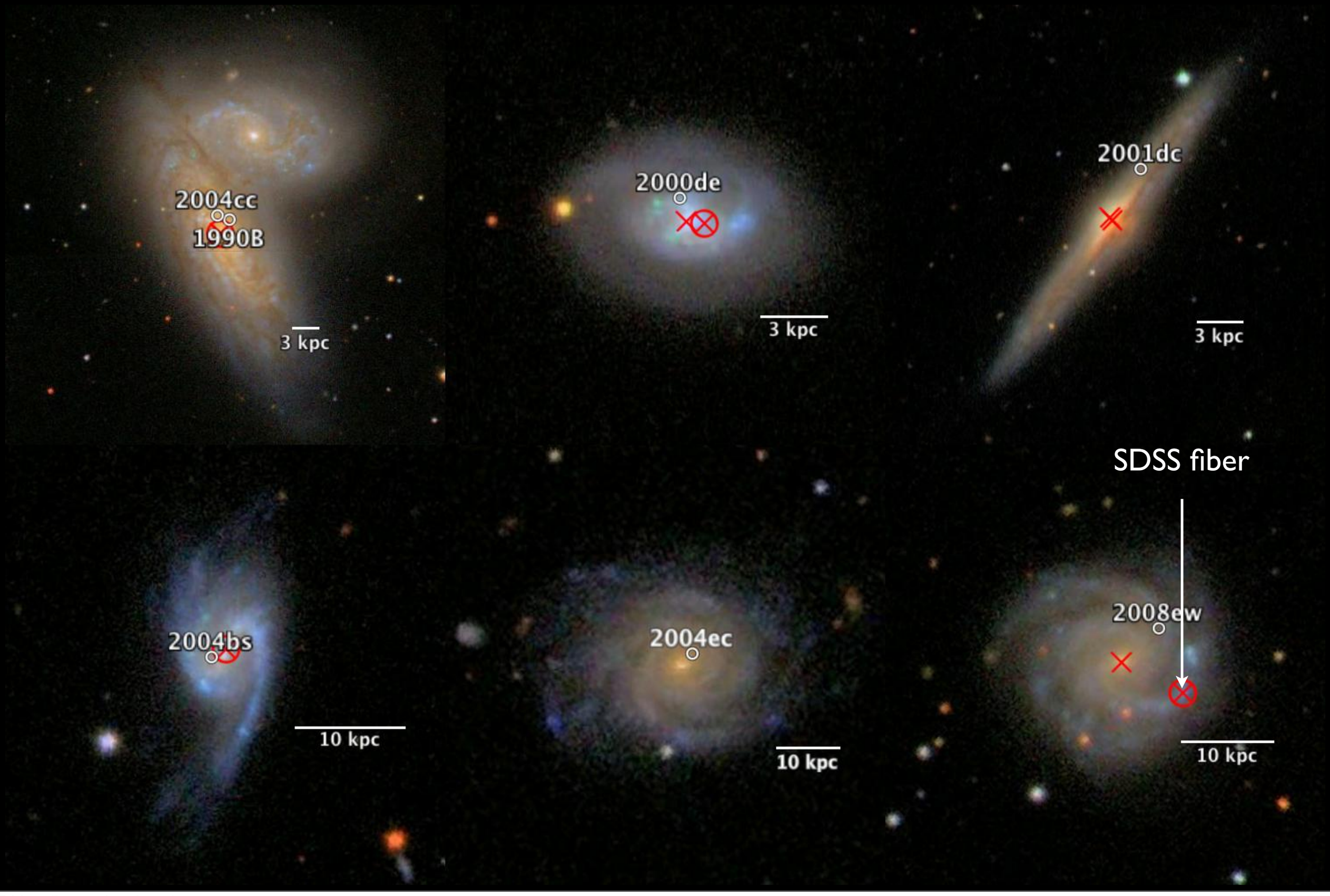
SN Ib, SN Ic, and SN II Host Galaxies



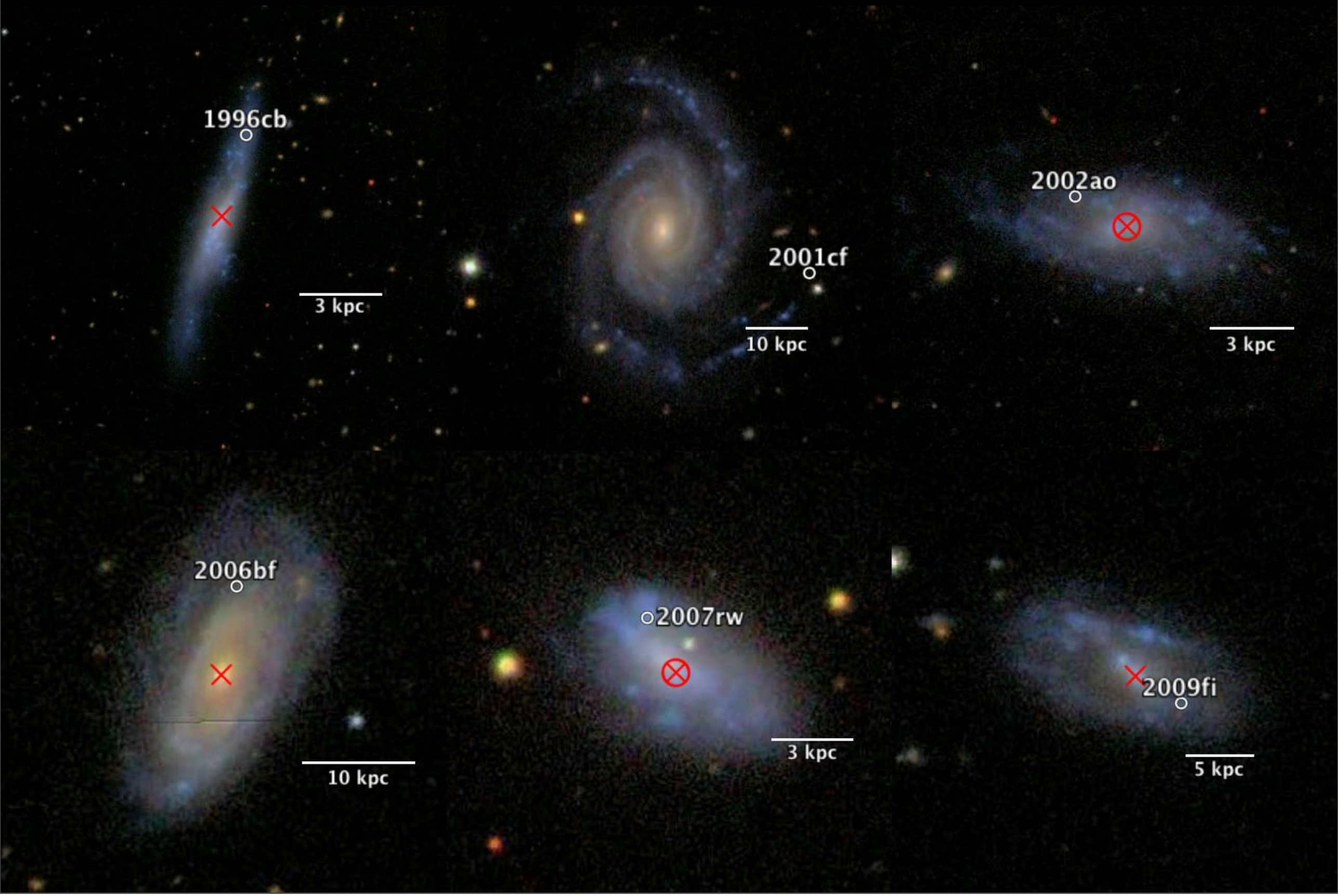




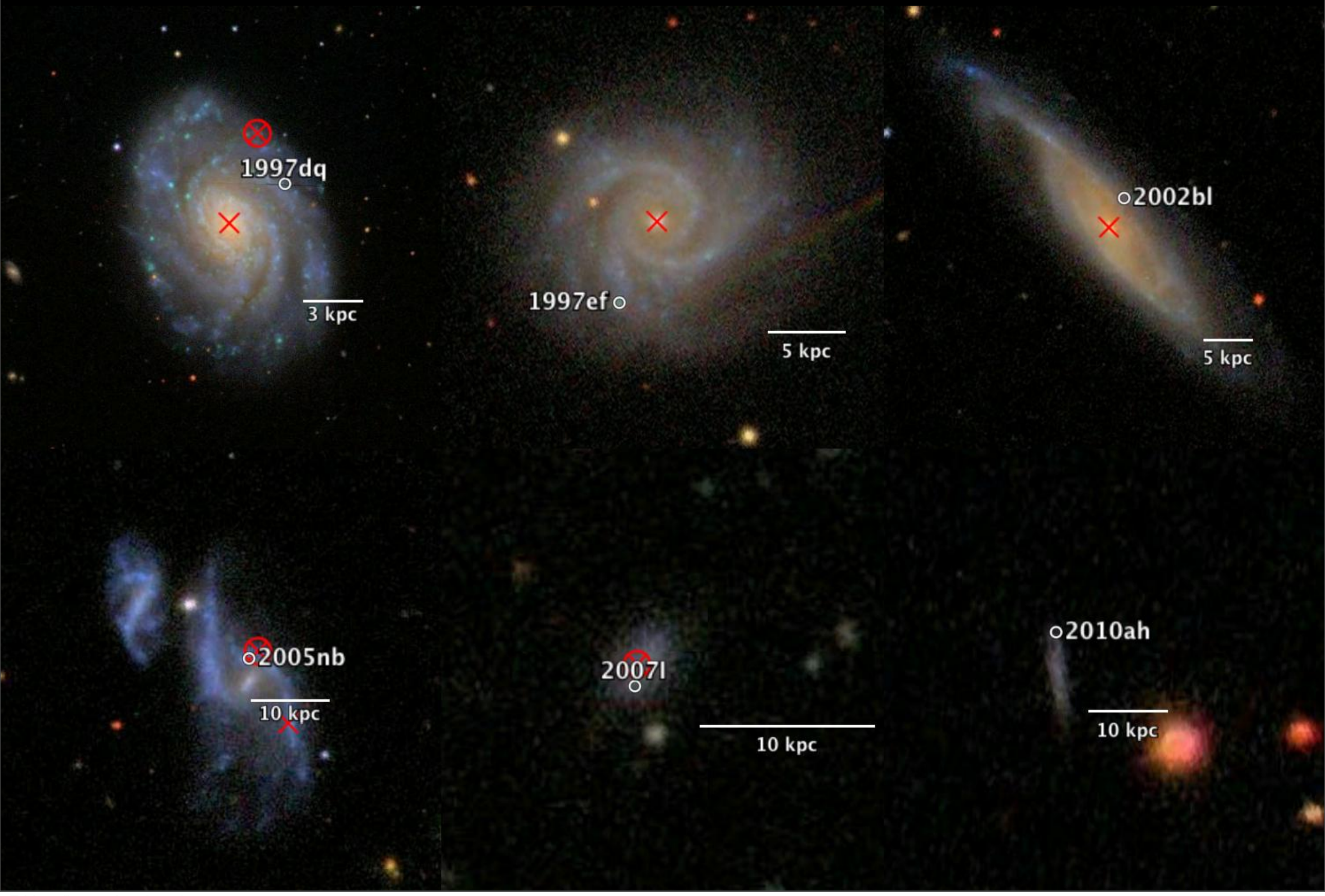
SN Ib, SN Ic, and SN II Host Galaxies



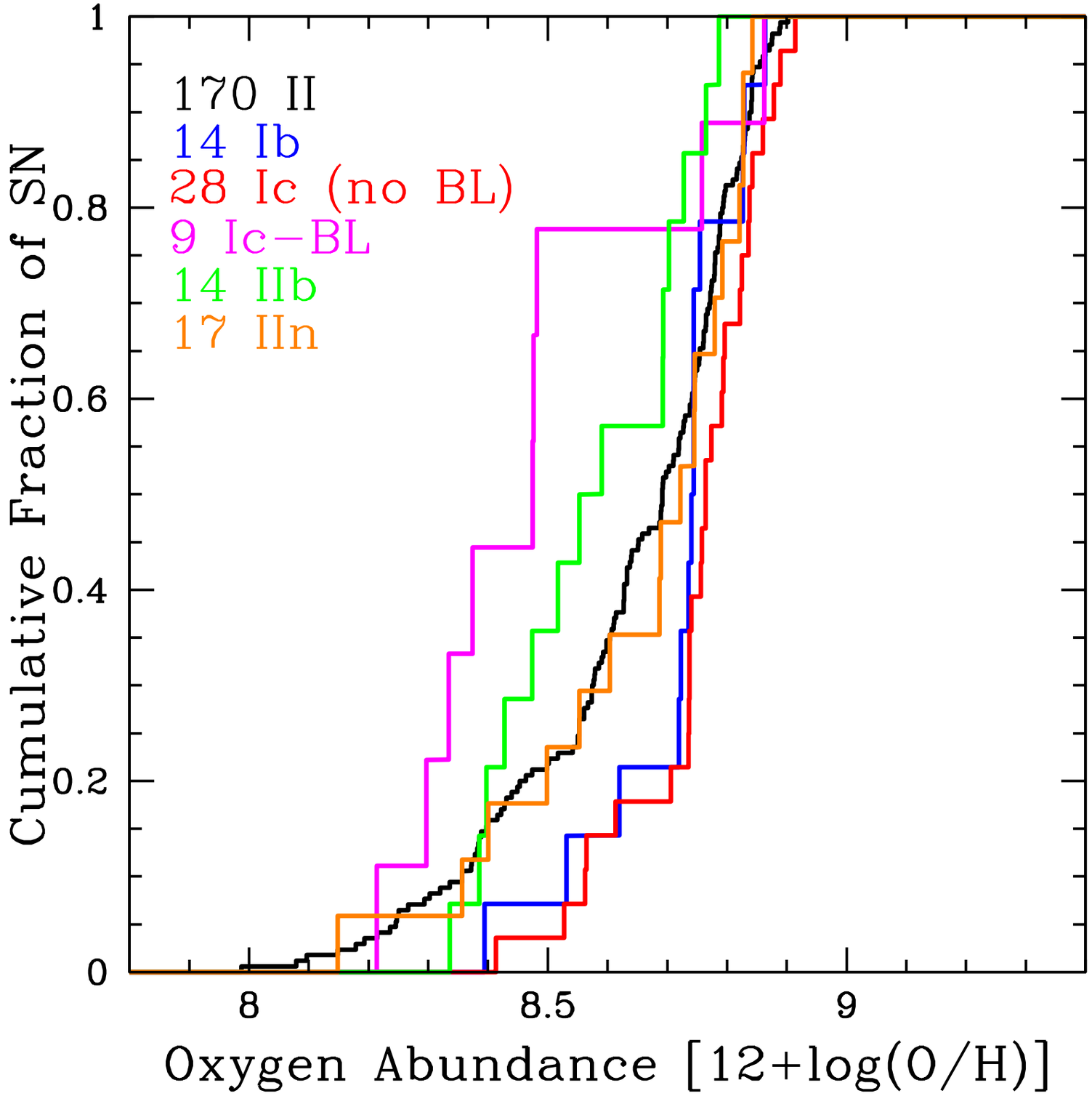
SN IIb Host Galaxies



Broad-lined SN Ic Host Galaxies

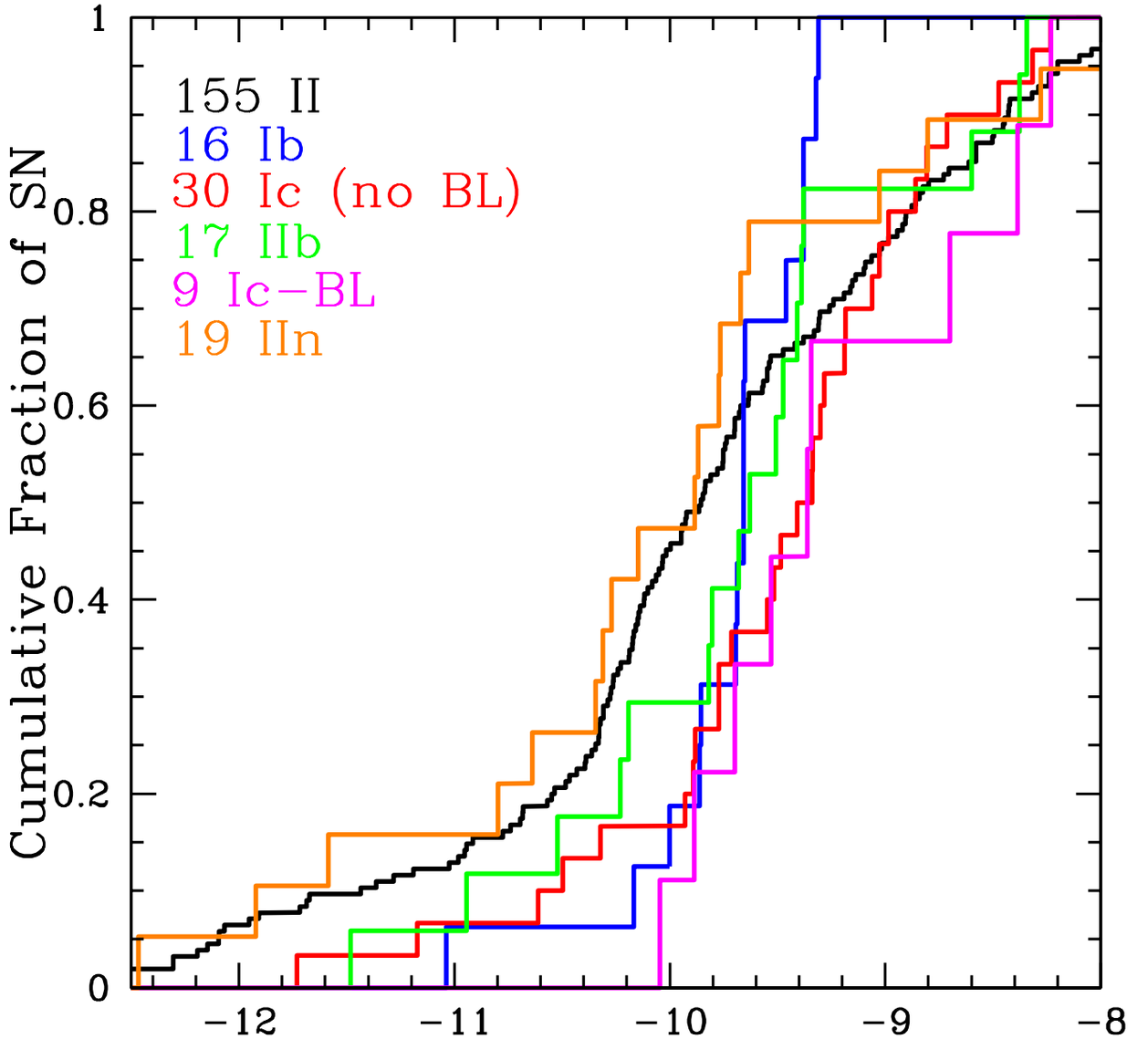


SN Ic-BL (w/o GRBs) have metal-poor hosts



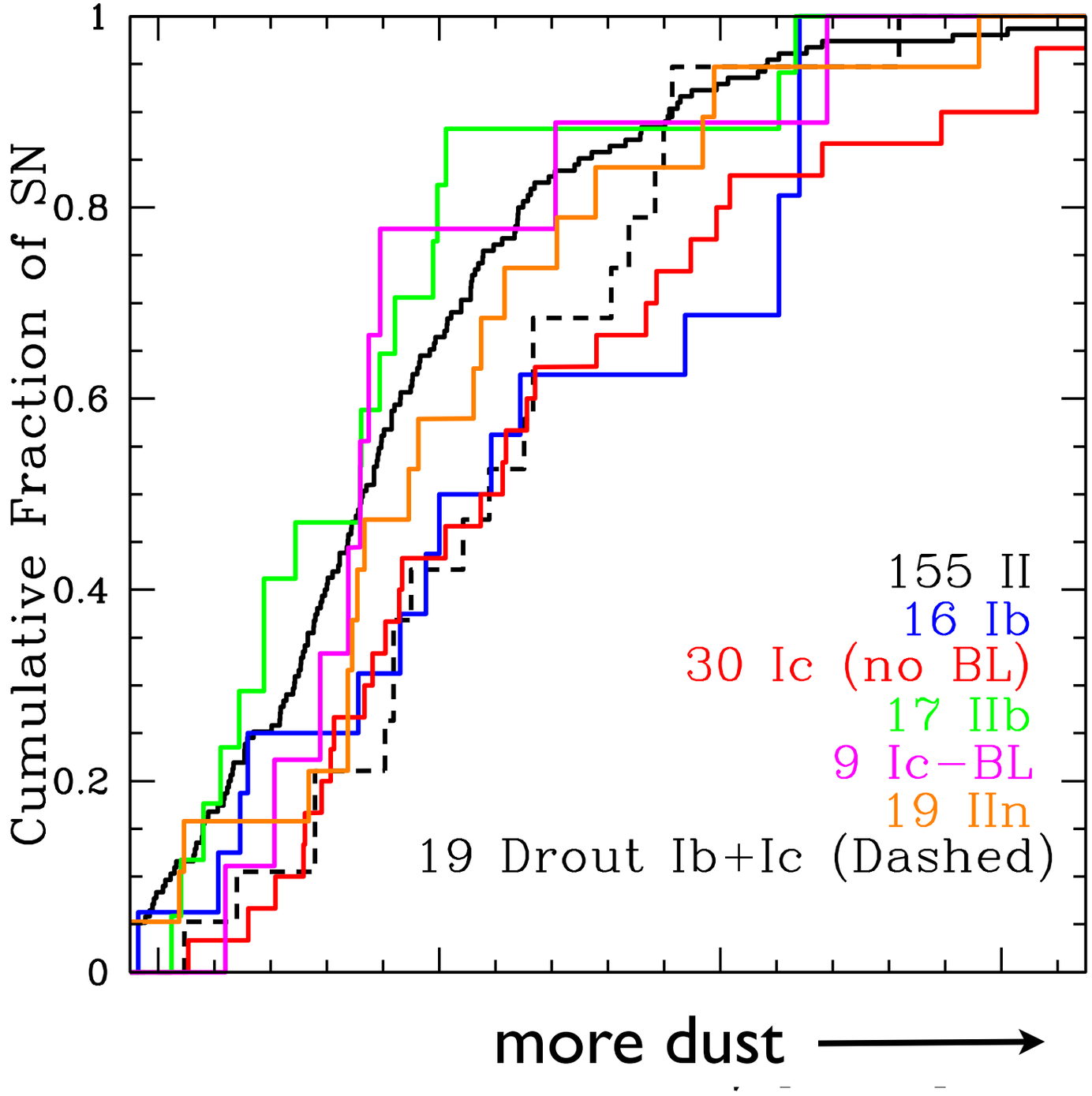
Sanders et al. 2012 confirm metal-poor preference for SN Ic-BL

Stripped-envelope SN hosts have higher specific SFRs

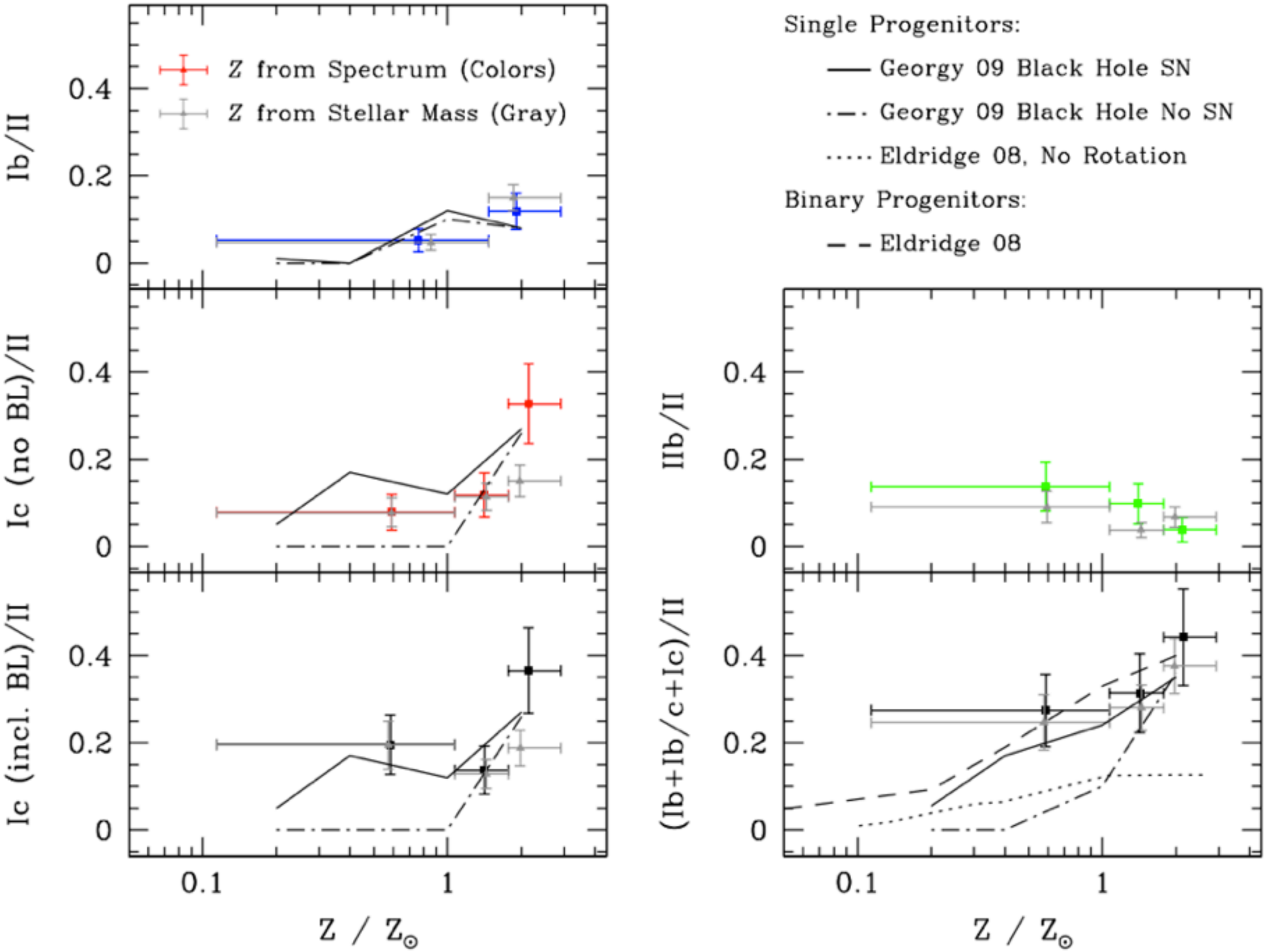


But why aren't SN Ib/Ic sites blue?

SN (Ib+Ic) hosts have more dust



Consistent w/ Extinction Estimated from Light Curves (Drout 2010)


Z from Spectrum (Colors)
Z from Stellar Mass (Gray)
Ib/II
Ic (no BL)/II
Ic (incl. BL)/II
IIb/II
(Ib+Ib/c+Ic)/II
0.4
0.2
0
0.1
1
Z / Z⊙
Single Progenitors:
Georgy 09 Black Hole SN
Georgy 09 Black Hole No SN
Eldridge 08, No Rotation
Binary Progenitors:
Eldridge 08

Summary

Kelly & Kirshner, ApJ, 2012

II	H
IIb	Thin H
Ib	He, No H
Ic	No He, No H
Ic-BL	High ejecta vel.

- Very strong dependence on environment
- Type Ic SN have exceptionally strongly star-forming, metal-rich, and dusty stellar population near host centers + they expode at small offsets
- SN IIb and SN Ic-BL have exceptionally blue, metal-poor environments
  - Effect of metals on mass loss, angular momentum?