Type Ibc supernovae in disturbed galaxies: evidence for a top-heavy IMF

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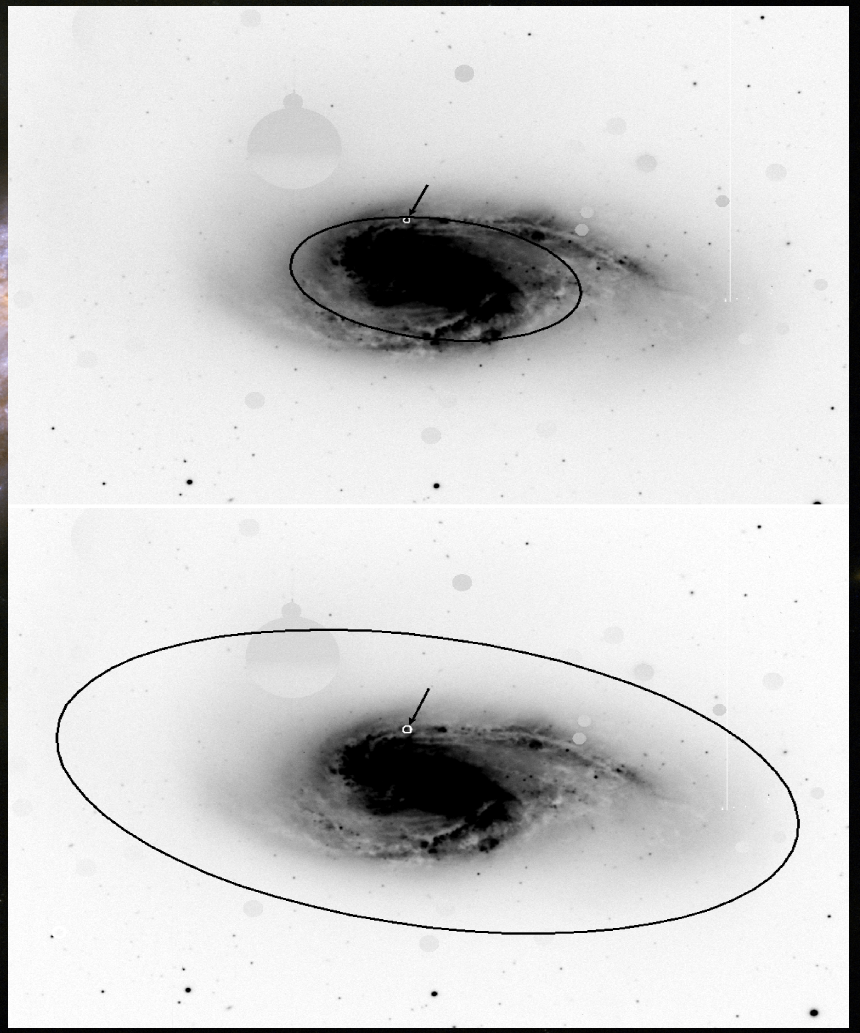
Introduction

Using our current knowledge of CCSNe what can we say about the local properties of the host galaxies?

Statistics

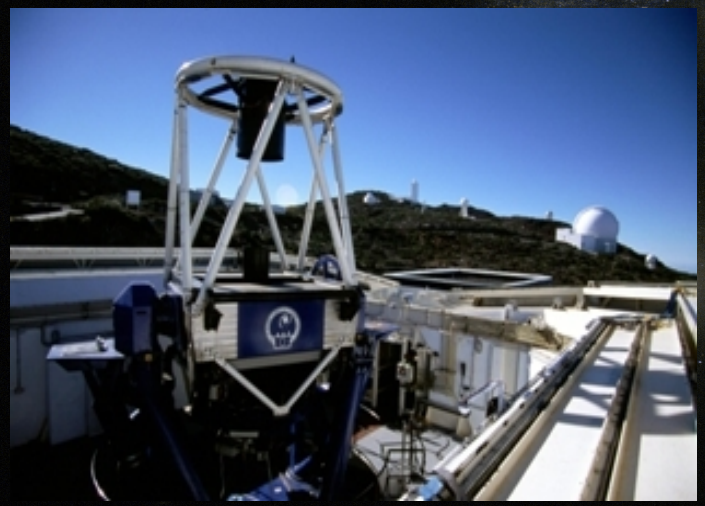
- Fractional *R*-band light: Fr*(R)*
  - Fraction of galaxy *R*-band emission lying within the ellipse containing the SN
    - *See Anderson & James 2009 for a full explanation*

- Implicitly normalises to the measured distributions of different stellar populations



Our Sample

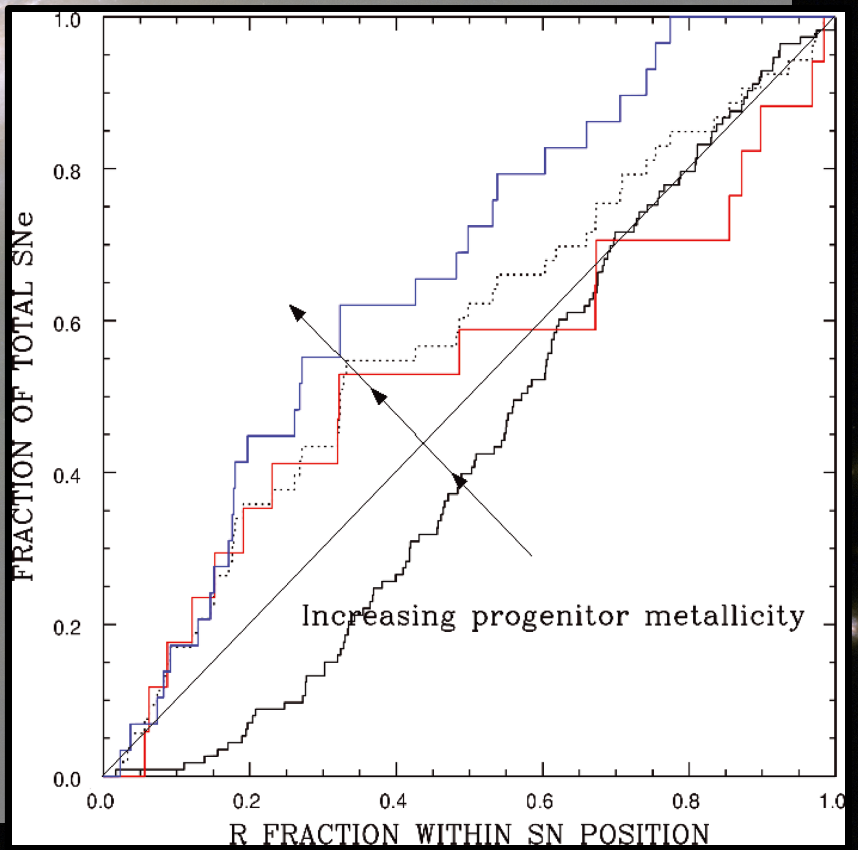
- 140 Local spiral galaxies (<6000 kms^{-1})
- 178 CCSNe
  - 110 SNII
  - 68 SNIbc



Investigations

Anderson & James (2009)

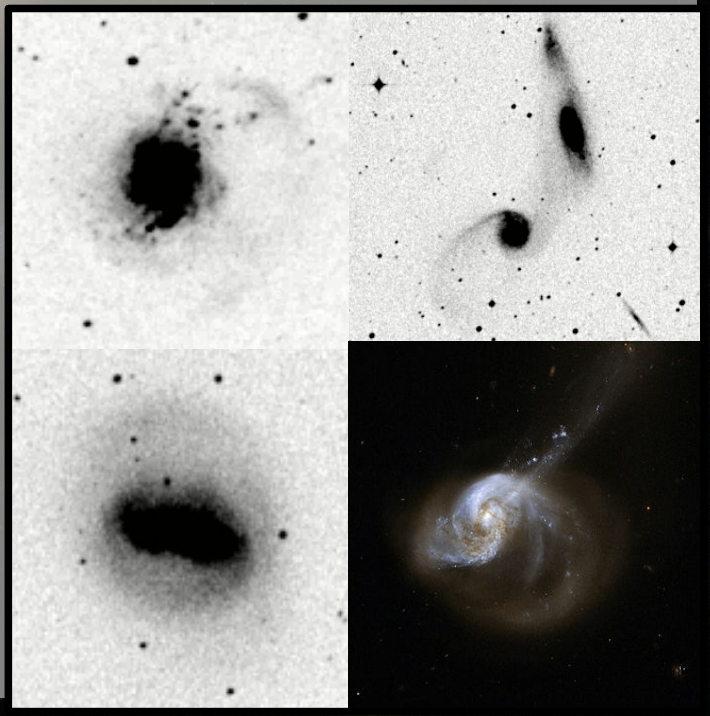
- Radial distributions wrt young and old stellar populations
- Hα and *R*-band light
- CCSNe follow Hα emission
- Central deficit of SNII
- Central excess of SNIbc
- Interpreted as metallicity sequence II→Ib→Ic



Investigations

Disturbance

- Split sample by galaxy disturbance
- Tidal tails
- Interaction
- Double nuclei
- Strong asymmetry



Results

Undisturbed (112):

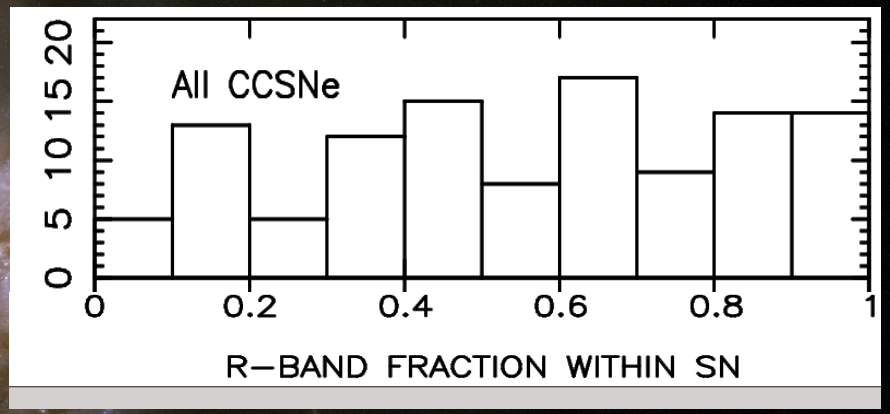
- SNII 65% & SNIbc 35%
- 45% occur within the central half of the galaxy light

Disturbed (64):

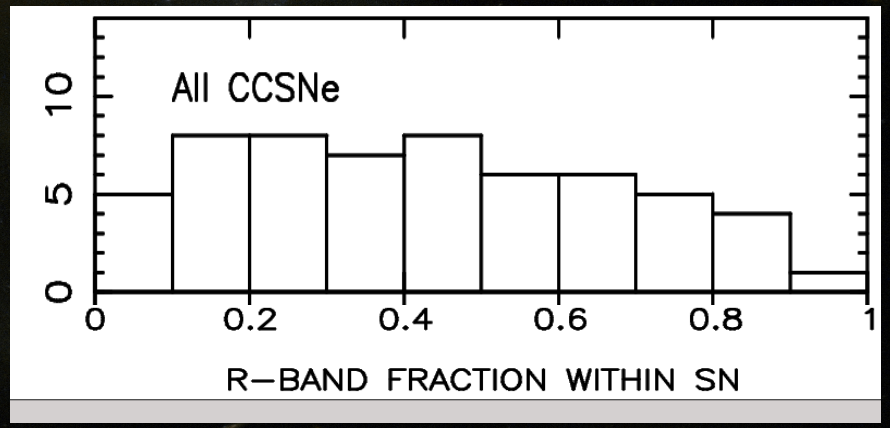
- SNII 56% & SNIbc 44%
- 62% occur within the central half of the galaxy light

KS: P = 0.037

Undisturbed



Disturbed



Results

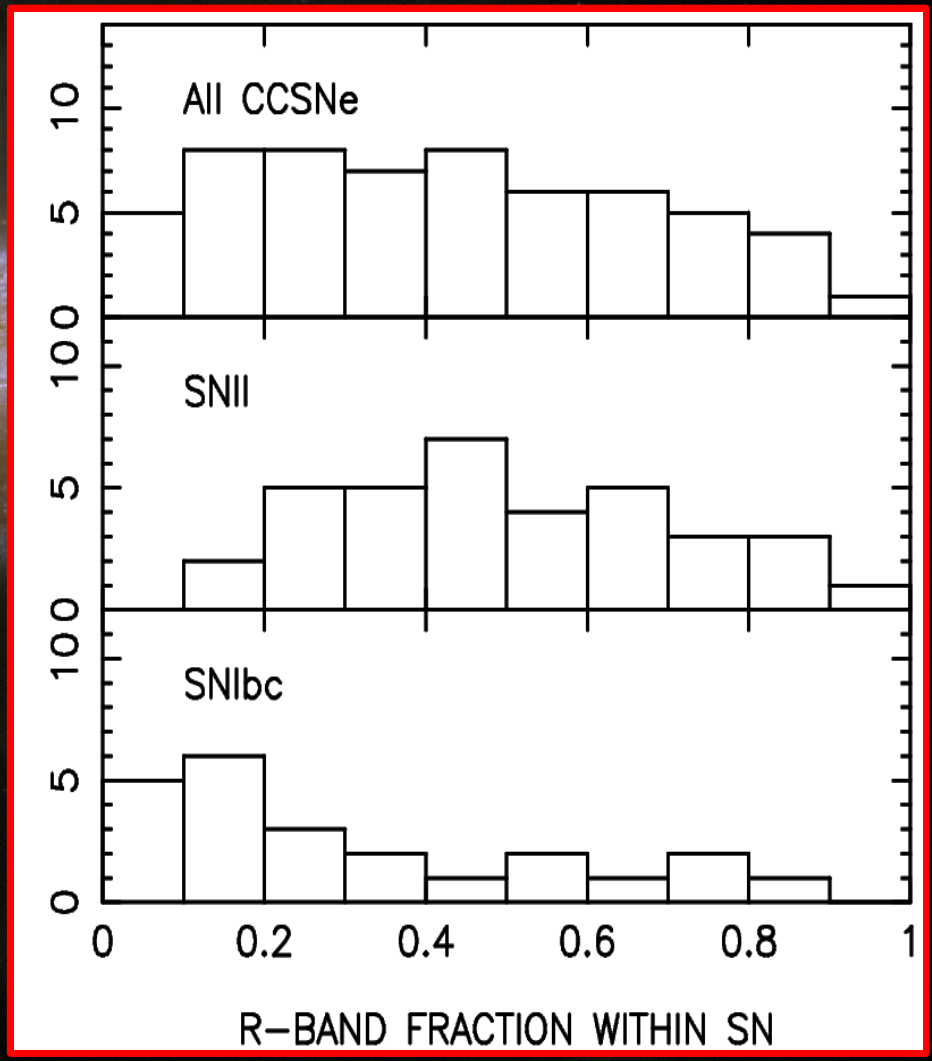
Disturbed:

100% of the SNe within the central 10% of the galaxy light are type Ibc

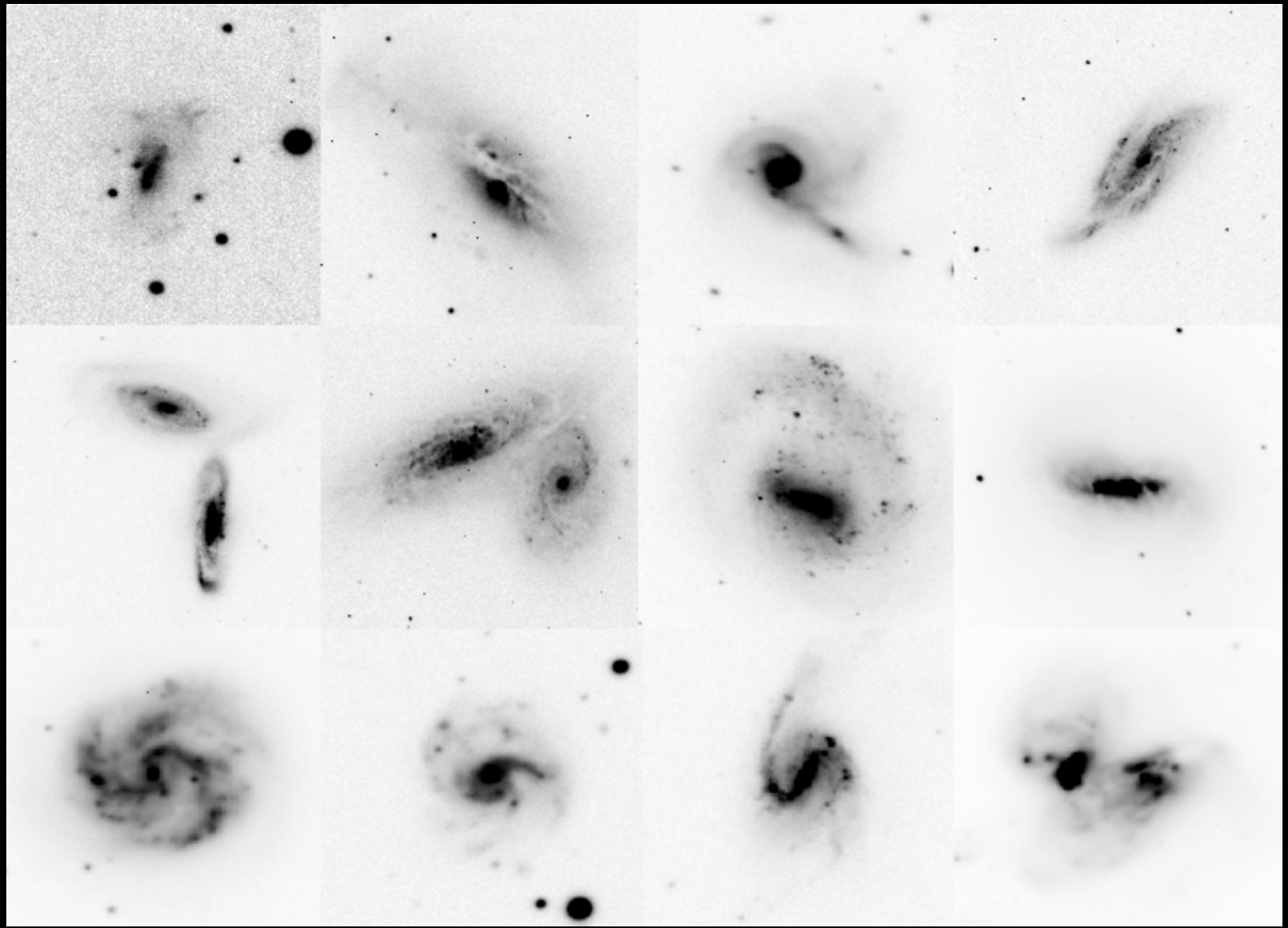
~85% within 20%

SNII vs SNIbc

KS: P = 0.003

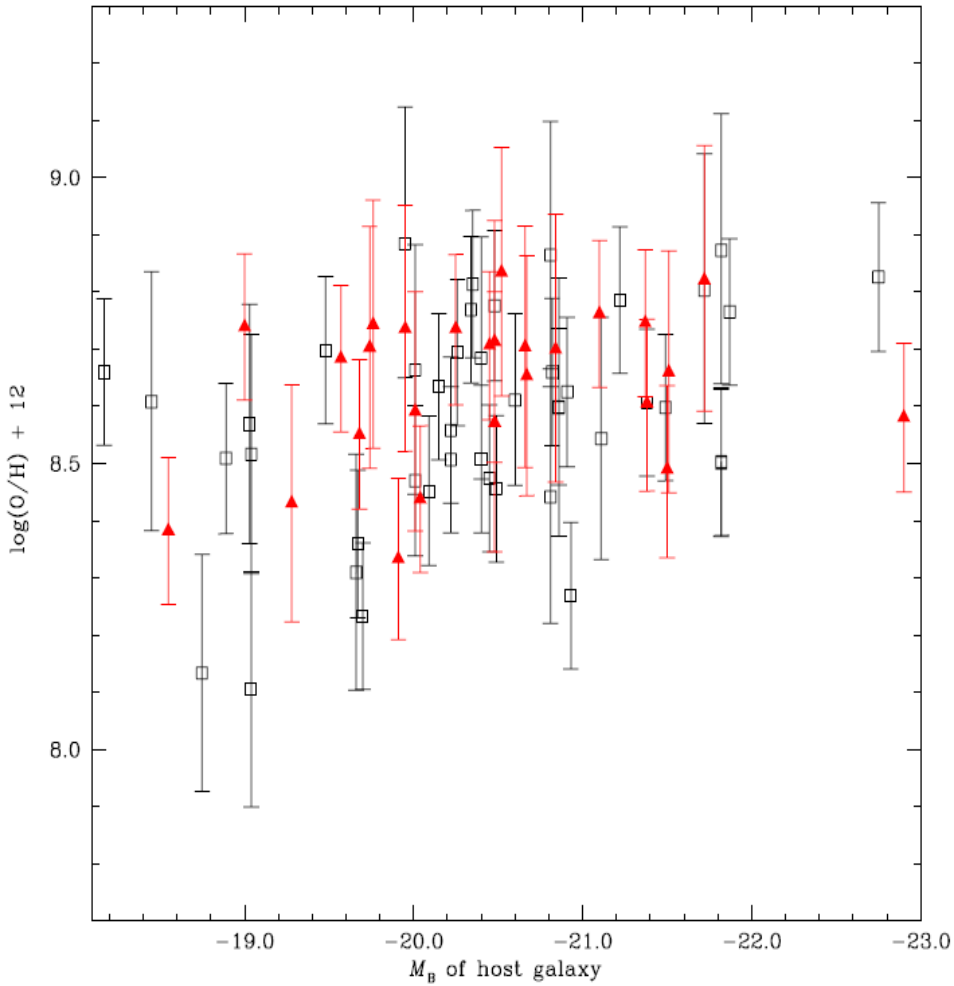


Results



Possible Interpretations

- Previous studies have interpreted central SNIbc distribution as a **metallicity** effect:
  - Indirect methods
  - Derived global metallicities
  - Derived local metallicities show presence of SNII at all metallicities



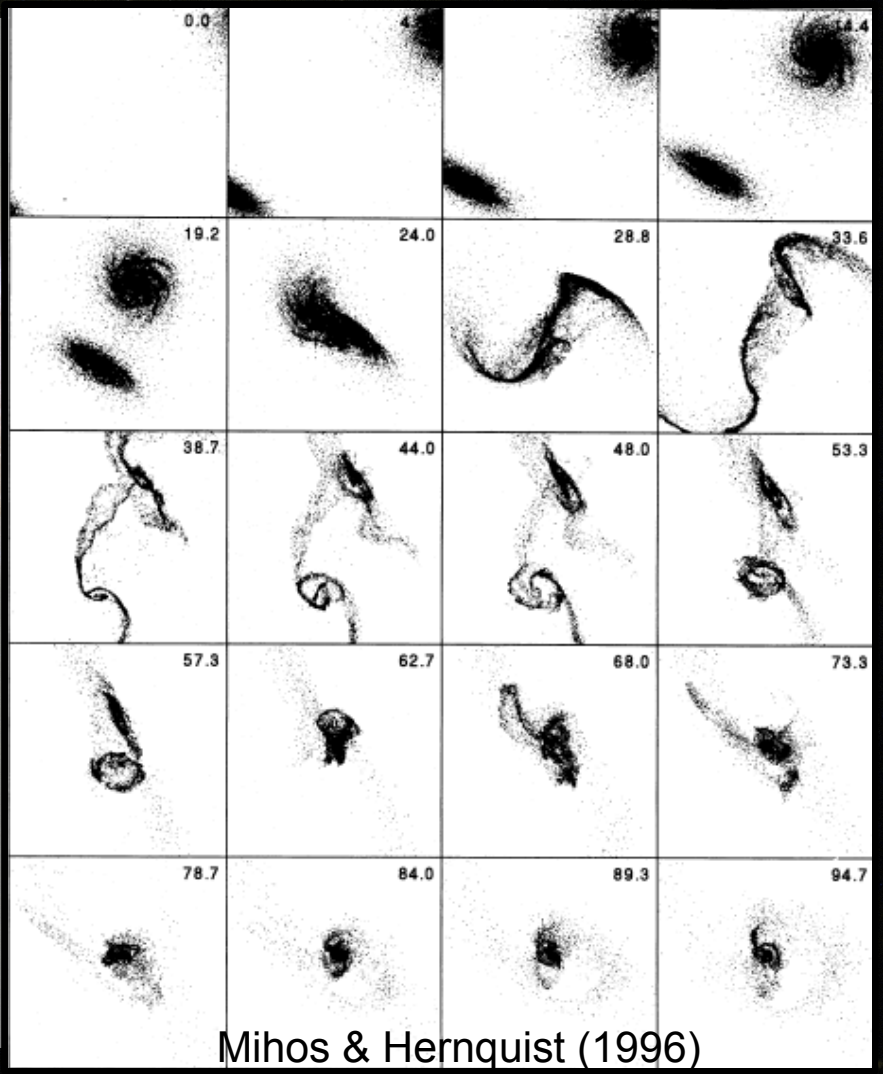
Anderson et al. (2010)

Possible Interpretations

Metallicity

Metallicity gradients in galaxies undergoing mergers should be smoothed out through the in-fall of unenriched gas.

(e.g. Michel-Dansac et al. 2008; Ellison et al. 2008)



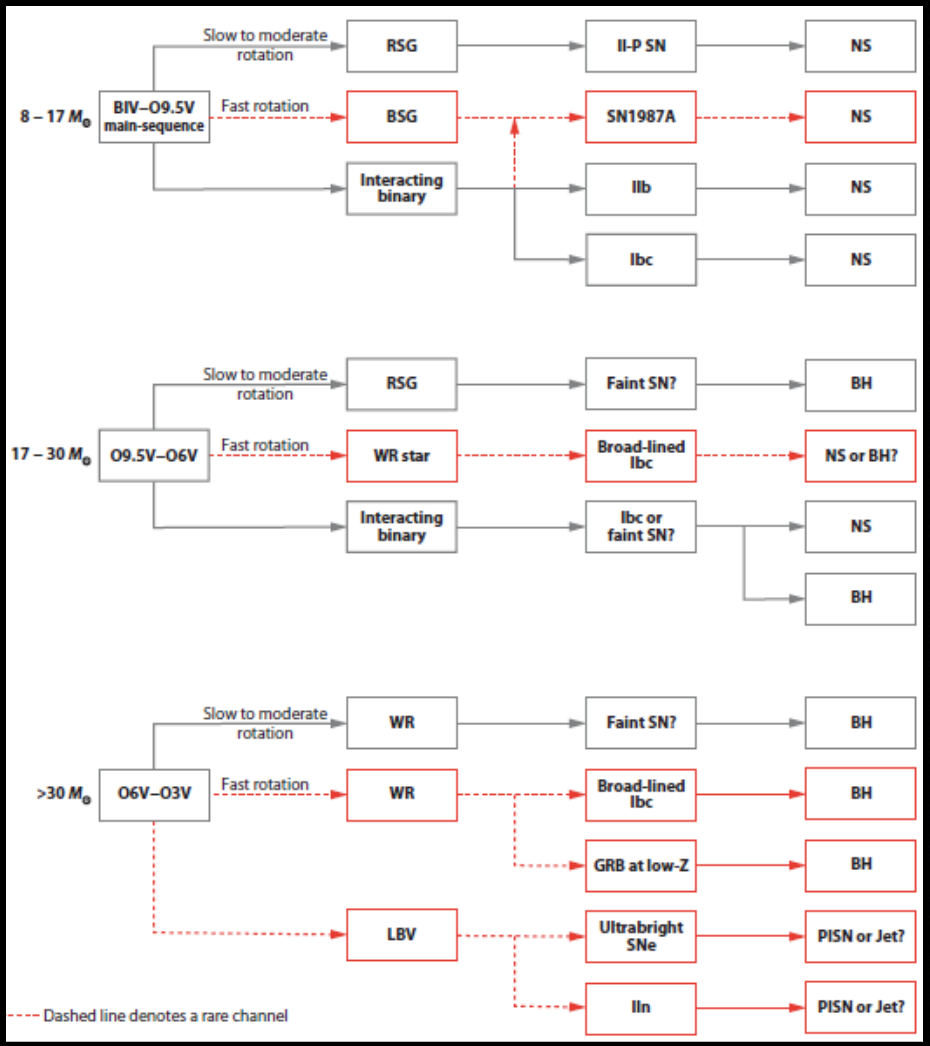
Mihos & Hernquist (1996)

Possible Interpretations

Contributions from:

- Stellar rotation
- Binarity

Can the increased densities in these environments lead to enough stellar mergers and binary interactions to explain this result?



Smartt (2009)

Possible Interpretations

Top-heavy IMF in nuclear starburst regions

Illustrative calculations require a positive index for the IMF slope of ~1
(Salpeter = -1.35)

- Support from early studies
  (e.g. Rieke et al. 1980)
- Simulations
  (e.g. Krumholz et al. 2010)
- Studies of starburst galaxies
  (e.g. Doyon et al. 1994)
- Galactic centre observations
  (e.g. Bartko et al. 2010)

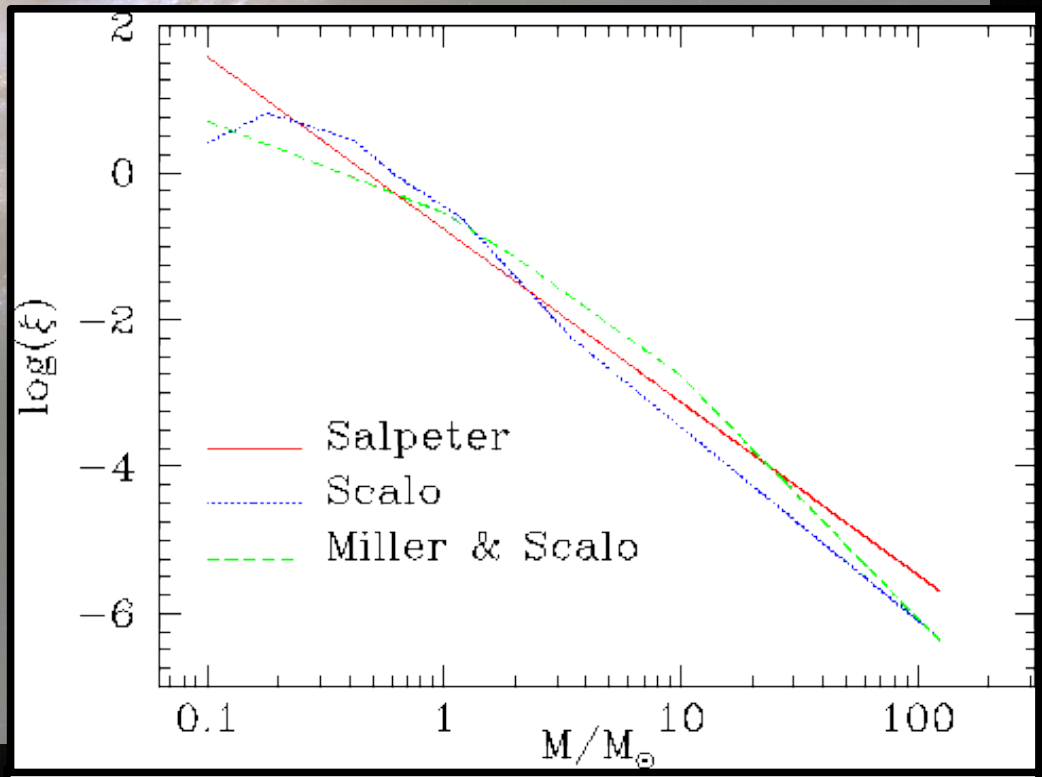
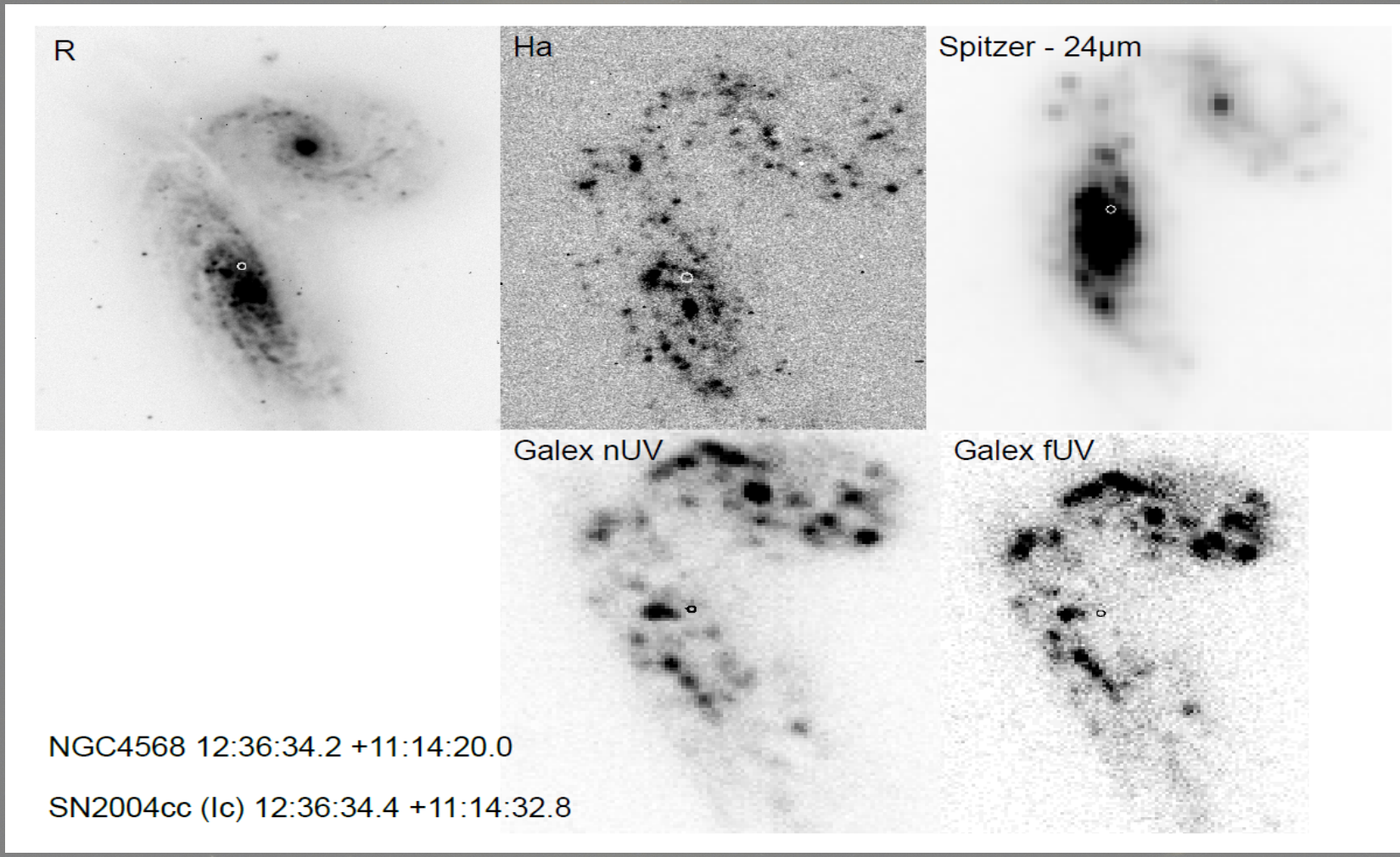


Image from Bolzonella (2000)

Future Work

- Extend study to new observations
- Investigate non-disturbed starbursts
- Explore starbursts using the mid-IR
- Spectroscopy of hosts

Comparisons to Spitzer and Galex



Conclusions

- CCSNe of all types show a **strong** degree of **central concentration** in the **disturbed** galaxies, probably as a result of **nuclear starbursts**.

- This central excess is **dominated** by **SNIbc**.

- The SNIbc excess cannot easily be explained in terms of metallicity effects, extinction, or central incompleteness of SNe.

- Our preferred explanation of the SNIbc excess is that the central regions of the disturbed galaxies are dominated by nuclear starbursts with IMFs biased towards high mass stars.

Conclusions

This investigation has demonstrated how **powerful CCSNe** can be in **tracing star formation properties** within host galaxies, a technique which is yet to be fully exploited

Biases

➔ Subjective classification of disturbance

➔ The Shaw effect (1979)

➔ Bias within the Asiago (Barbon et al. 2009) and IAUSN catalogues

➔ Dust extinction in the central regions

Undisturbed Sample Results

Undisturbed:

80% of SNe within 10% of galaxy light are type Ibc

~56% within 20%

SNII vs SNIbc

KS: P = 0.082

SNIbc: disturbed vs undisturbed

KS: P = 0.060