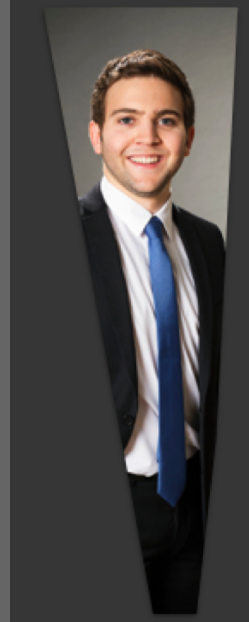
STRIPPED ENVELOPE SUPERNOVAE:

Looking for the hidden high-mass progenitors with iPTF



Emir Karamehmetoglu – PhD Thesis Work,

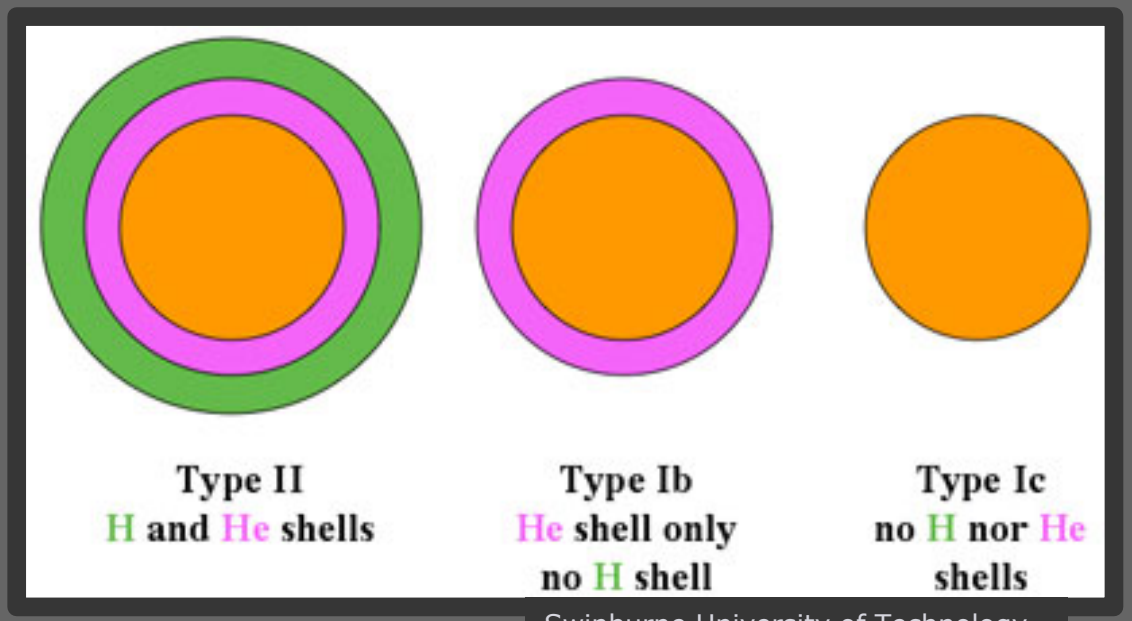
ZTF Team meeting, Stockholm. August 7 2018.

Oskar Klein centre

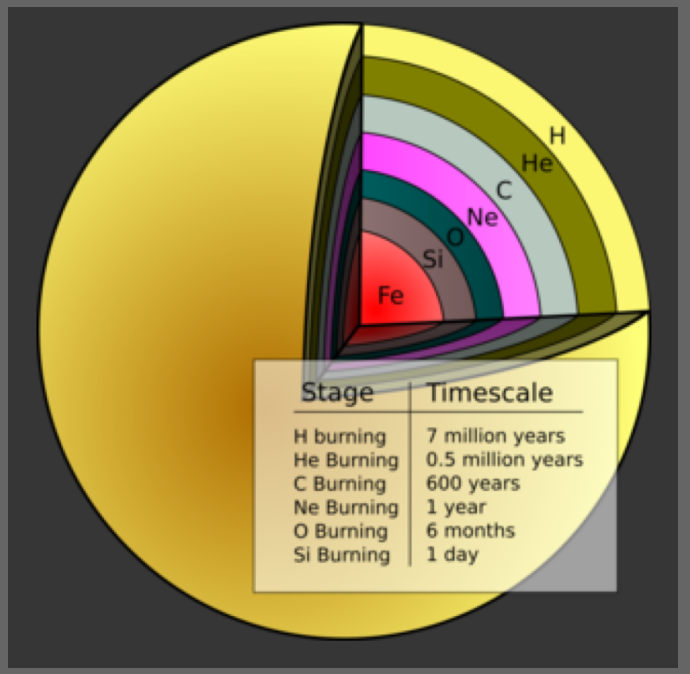
Stockholm University

Core-collapse stripped-envelope supernovae

Stripped Envelope Supernovae (SE SNe) are the core-collapse explosions of massive stars that do not show hydrogen (and/or helium).

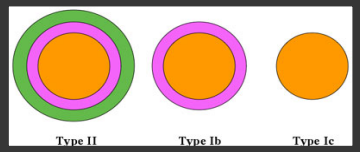


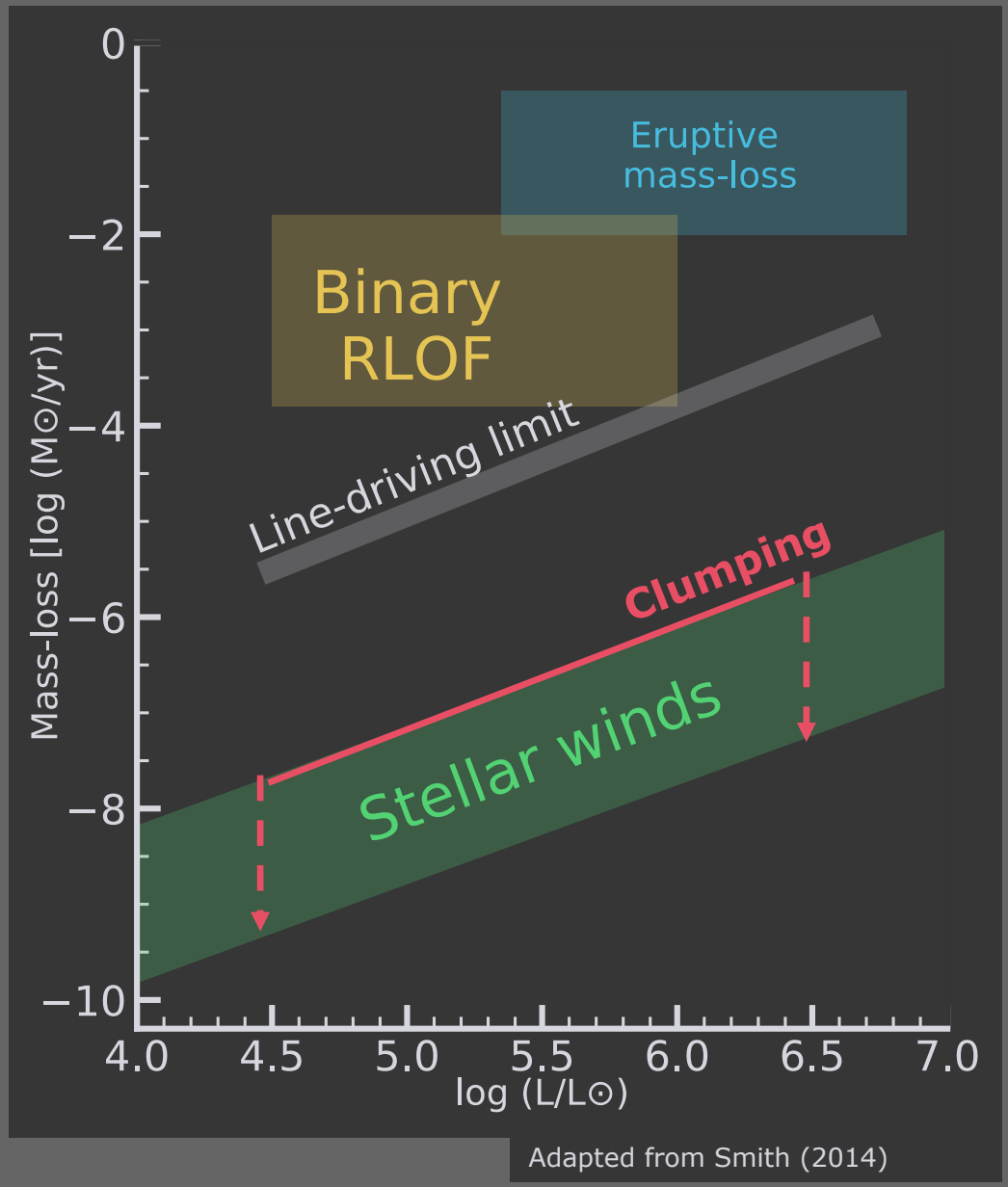
Swinburne University of Technology



Stockholm University

How to strip?





Adapted from Smith (2014)

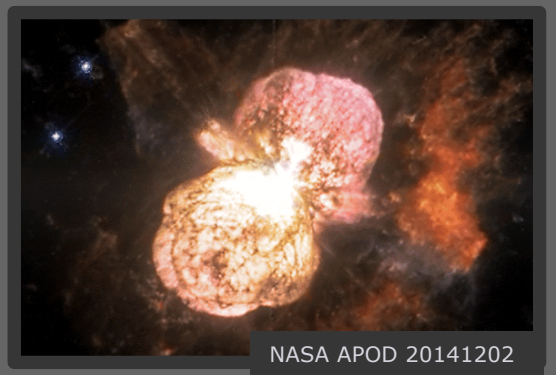
Stellar Winds

Young, C. Alex

Binary mass-transfer

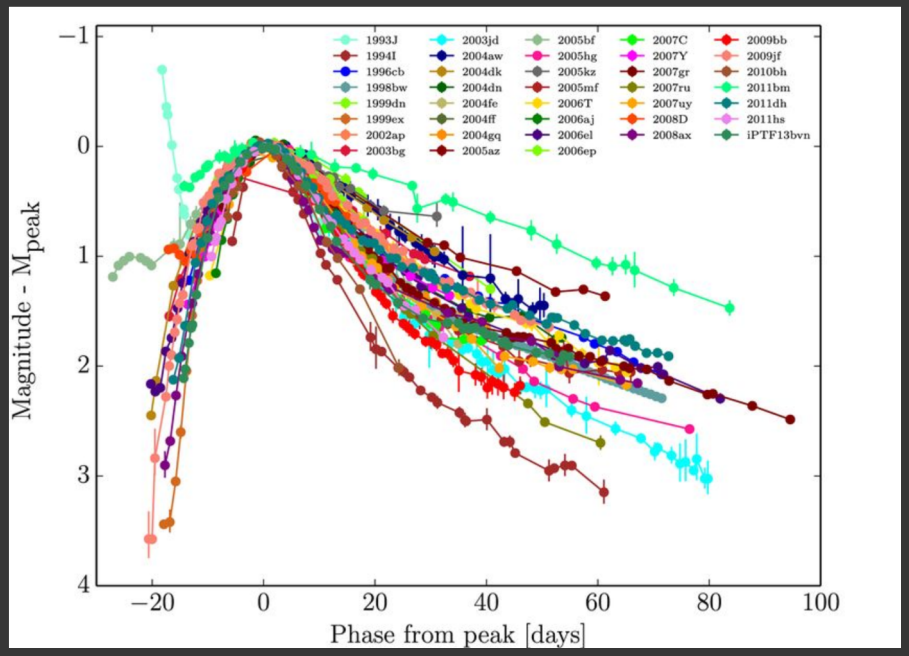
ESO Calcada, Kornmesser, De Mink

Eruptive mass-loss

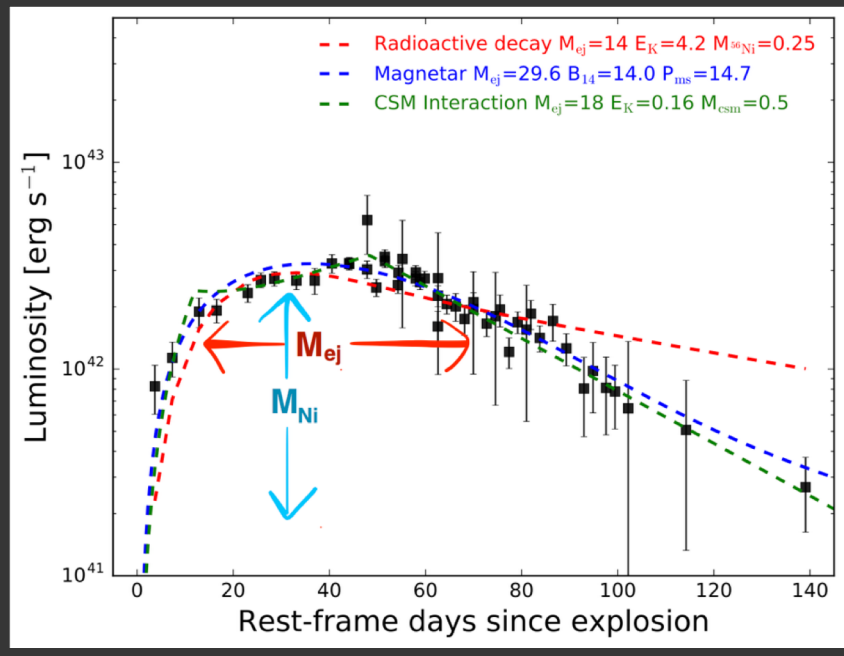


NASA APOD 20141202

Lightcurves



Lyman et al. (2016)



Karamehmetoglu et al. (2017)

Note that LC broadness is related to ejecta mass!

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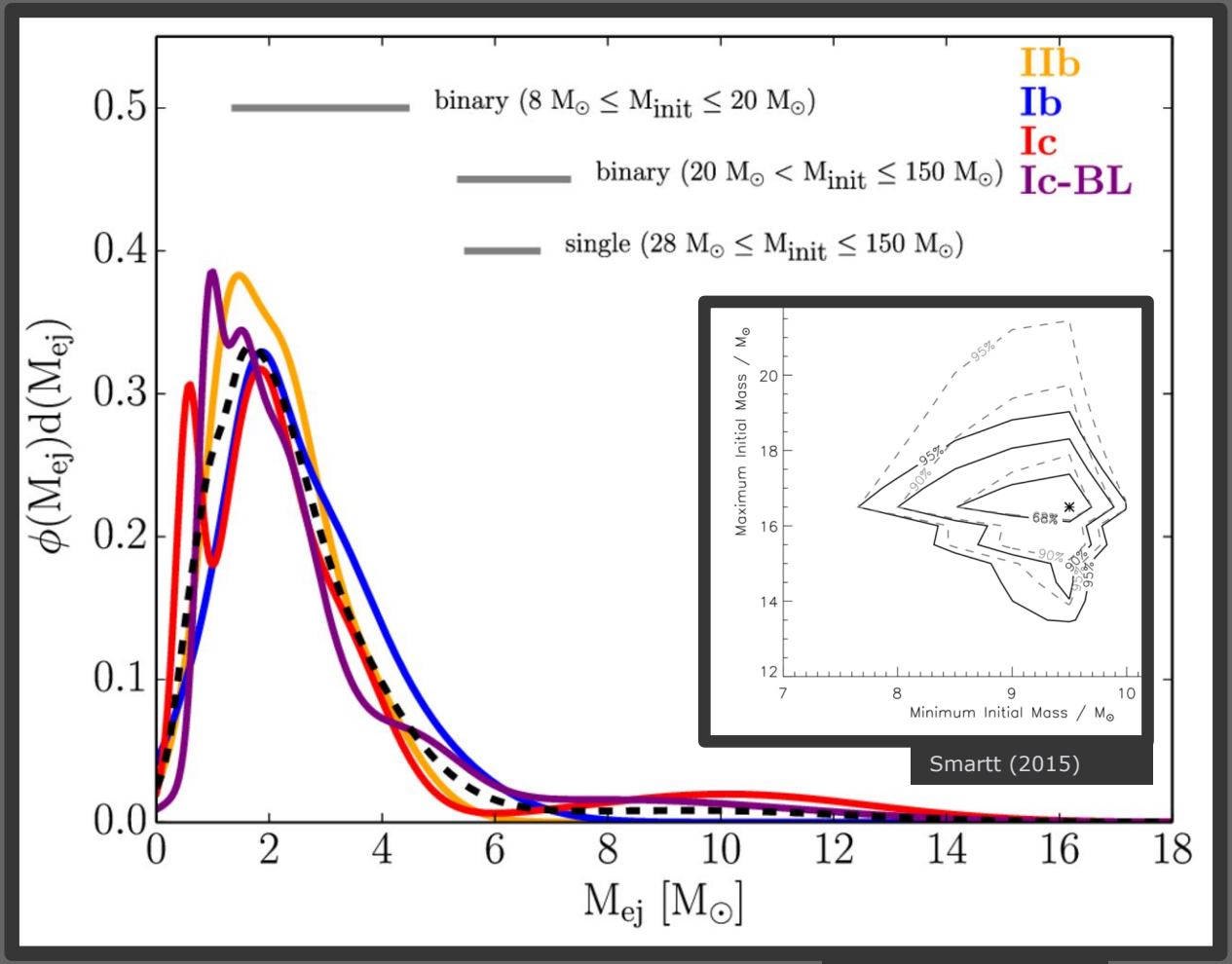
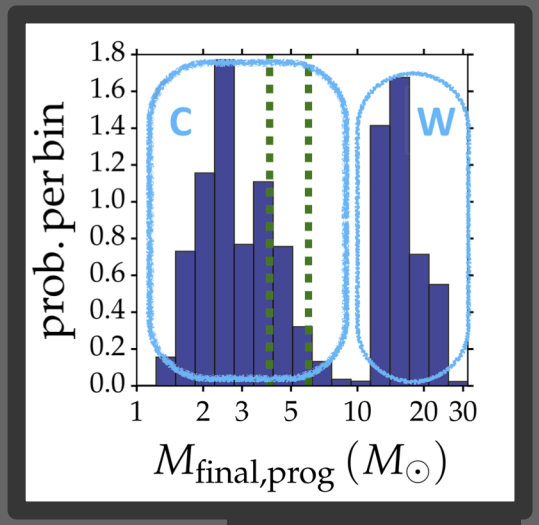
Ejecta mass distribution > lower-mass progenitors (probably formed in binaries)



Lyman et al. (2016)

Smartt (2015)



Zapartas et al. (2017)

Majority of SE SNe have low ejecta masses. Not massive stars!?

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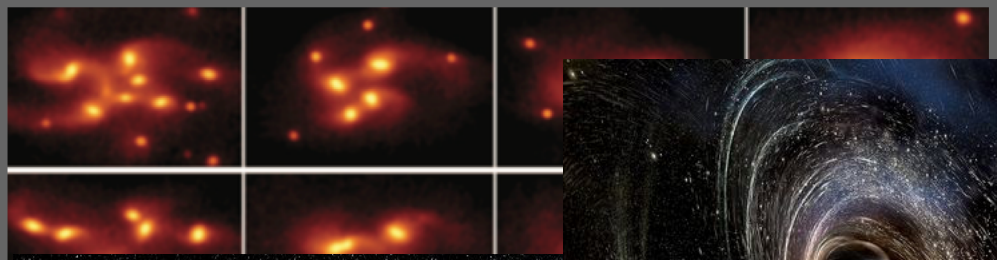
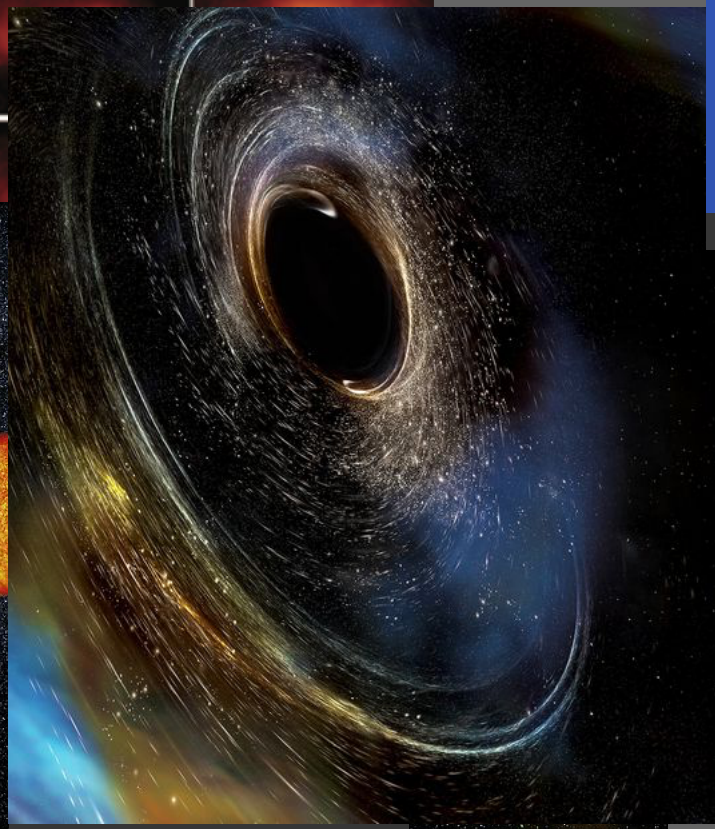
Summary (Case for the missing high-mass stars)

1. Mass-loss rates of single stars lower than previously assumed.
2. **<u>High-mass stars are not seen in the SN Record (too few).</u>**
3. Rates of SE SNe are too high.
4. Majority of massive stars in interacting binaries.

What happens to high-mass stars? (>20M⊙)

Missing massive stars, why does that matter?





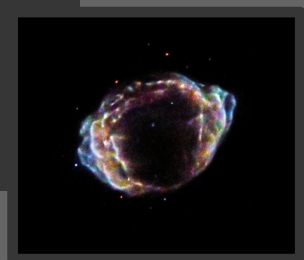
LIGO (Aurore Simonnet)

Alan Fincher

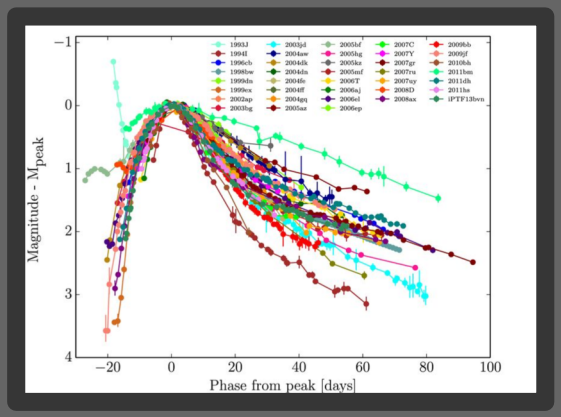
ESO/S. Steinhöfel

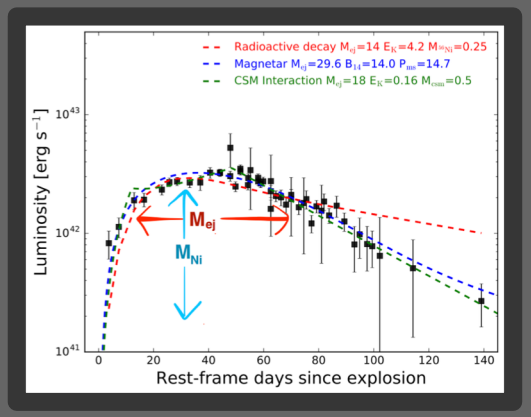
Stockholm University

My thesis work has been searching for SNe that may originate from high-mass stars > 20–25 M⊙



Clue: look for broad lightcurves!





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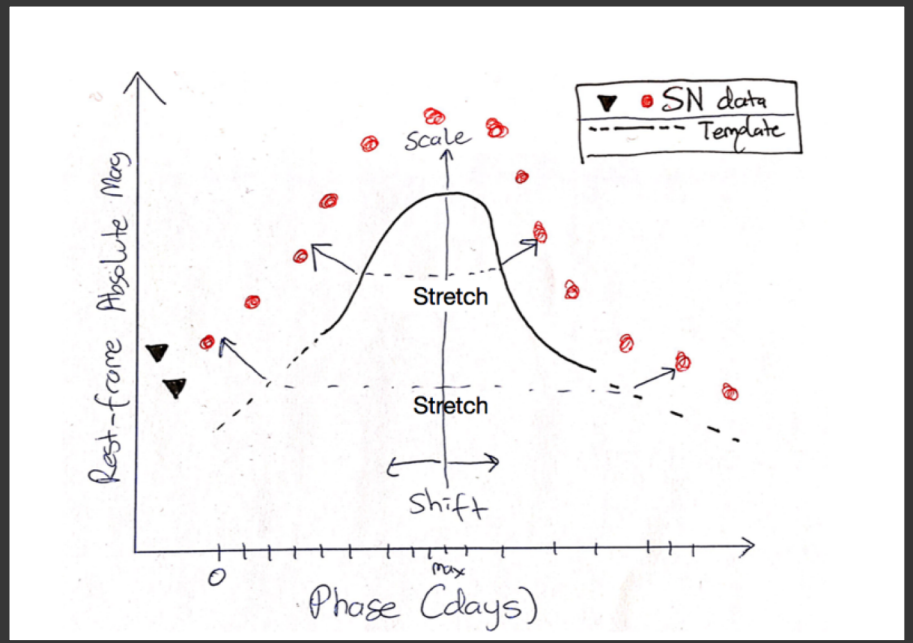
The first systematic search for SE SNe with massive progenitors.

New evidence in the case for missing high-mass stars

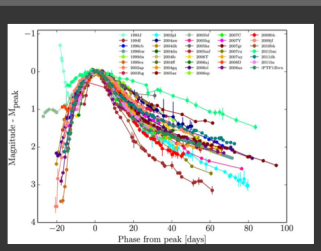
Karamehmetoglu et al. (in prep.)



Selection	# of SNe remaining
(i)PTF CC-SN sample	910
SE SNe	208
Only Type Ibc/IIb	173
Cut on templatability	92
Stretch > 1.5	11

Table 6.1: The number of SNe left after each step of the sample selection process.

Use the massive (i)PTF dataset to find SE SNe with broad lightcurves.



PALOMAR TRANSIENT FACTORY

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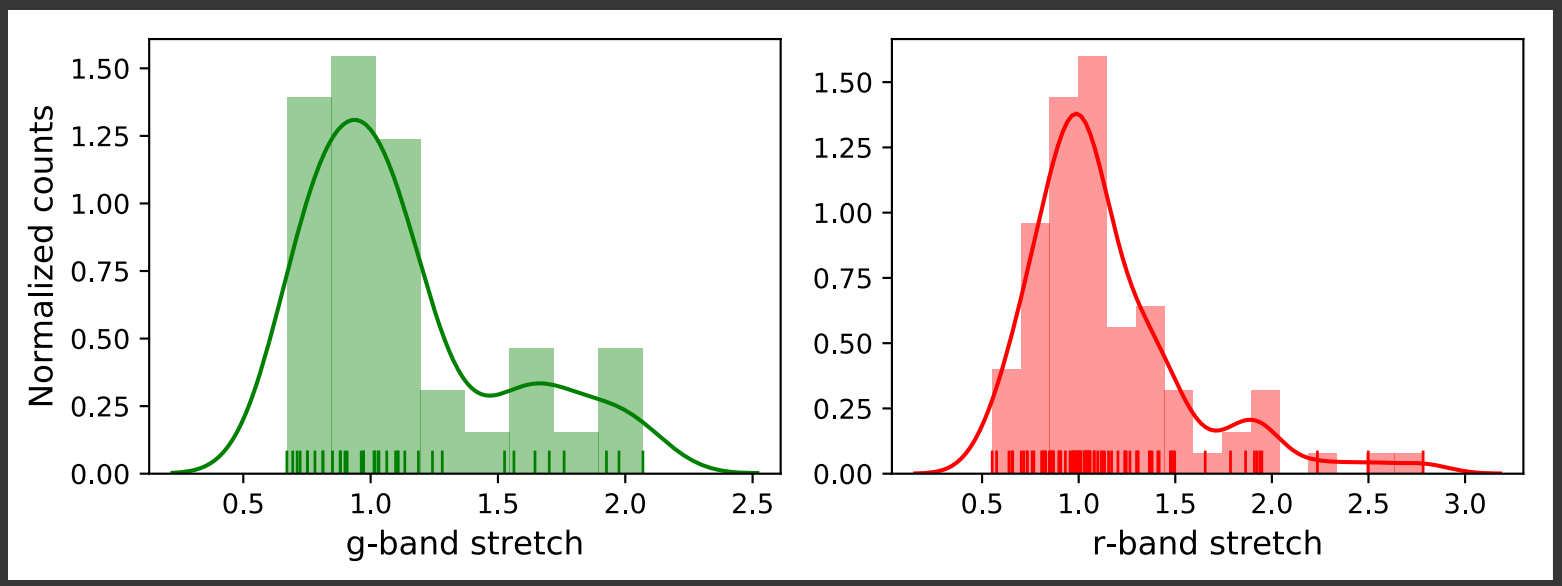
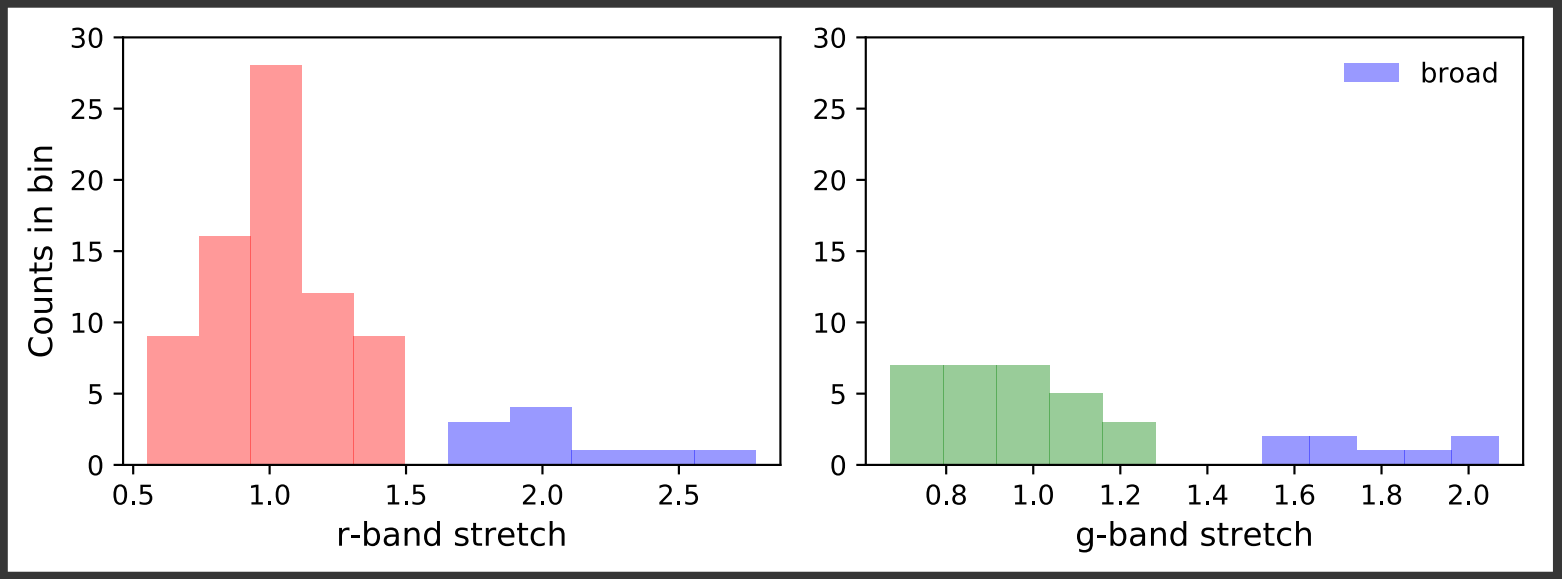
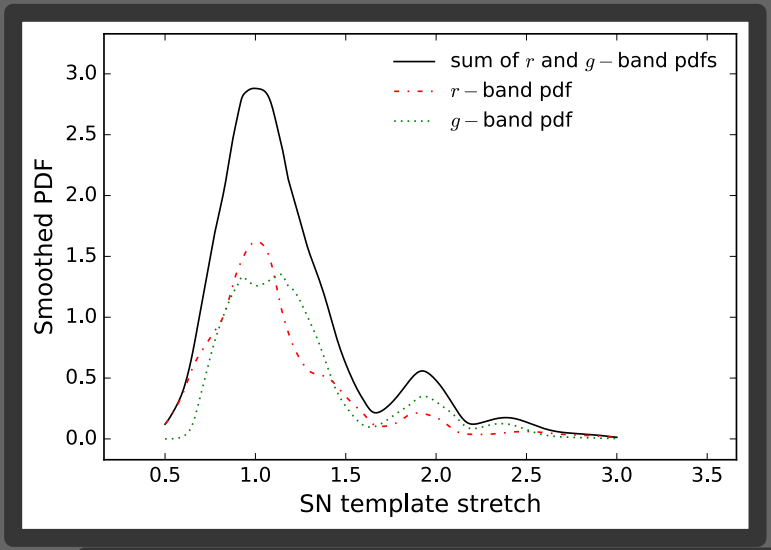
Fitting Results



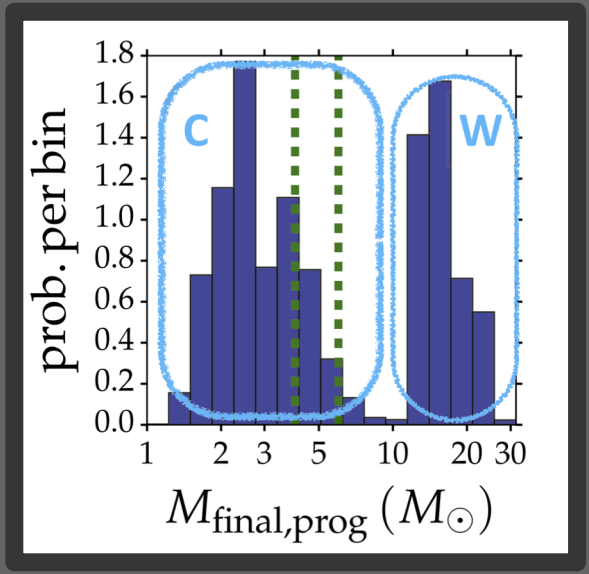


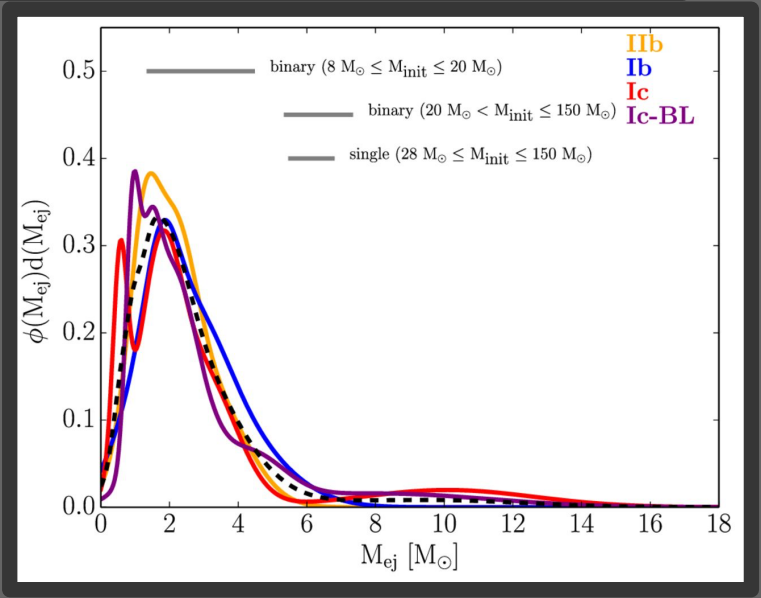
Fitting Results



Comparing distributions:

Hints of the second population?





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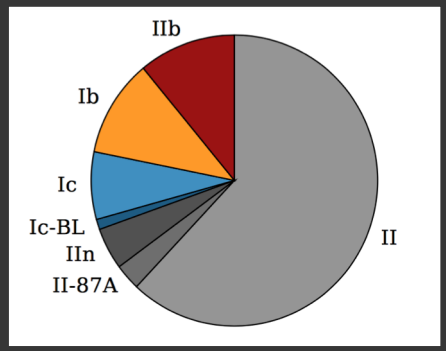
Preliminary Result:

~8% of (i)PTF SE SNe have broad lightcurves! (And potentially massive progenitor stars.)



Shivvers et al. (2017)

More than doubles the literature sample of spectroscopically ordinary SE SNe with broad lightcurves!

A&A 609, A106 (2018)
DOI: 10.1051/0004-6361/201629874
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Astronomy & Astrophysics

PTF11mnb: First analog of supernova 2005bf

Long-rising, double-peaked supernova Ic from a massive progenitor*

F. Taddia[1], J. Sollerman[1], C. Fremling[1,5], E. Karamehmetoglu[1], R. M. Quimby[2,3], A. Gal-Yam[4], O. Yaron[4], M. M. Kasliwal[5], S. R. Kulkarni[5], P. E. Nugent[6,7], G. Smadja[8], and C. Tao[9,10]

A&A 592, A89 (2016)
DOI: 10.1051/0004-6361/201628703
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Astronomy & Astrophysics

iPTF15dtg: a double-peaked Type Ic supernova from a massive progenitor

F. Taddia[1], C. Fremling[1], J. Sollerman[1], A. Corsi[2], A. Gal-Yam[3], E. Karamehmetoglu[1], R. Lunnan[4], B. Bue[5], M. Ergon[1], M. Kasliwal[6], P. M. Vreeswijk[3], and P. R. Wozniak[7]

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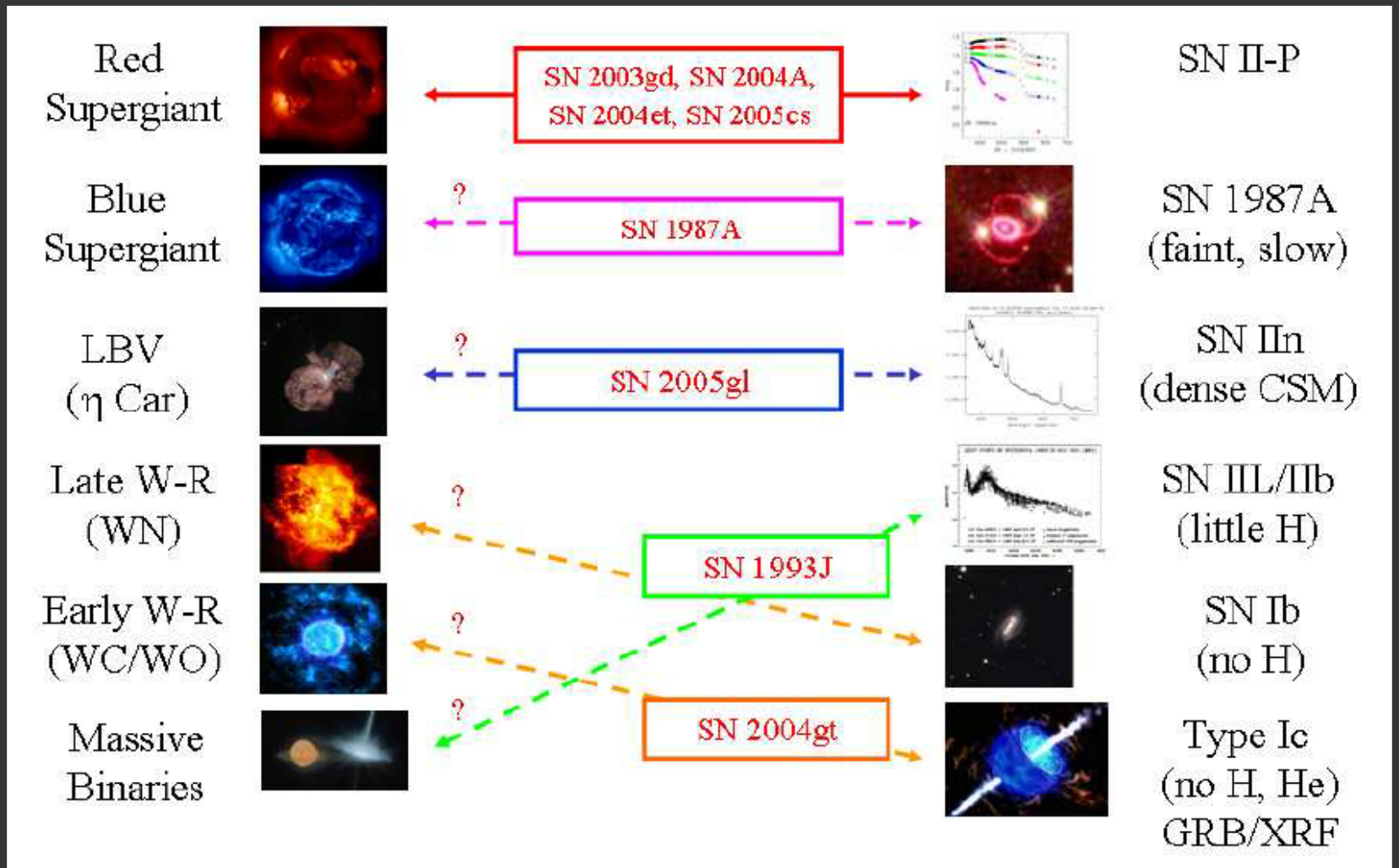
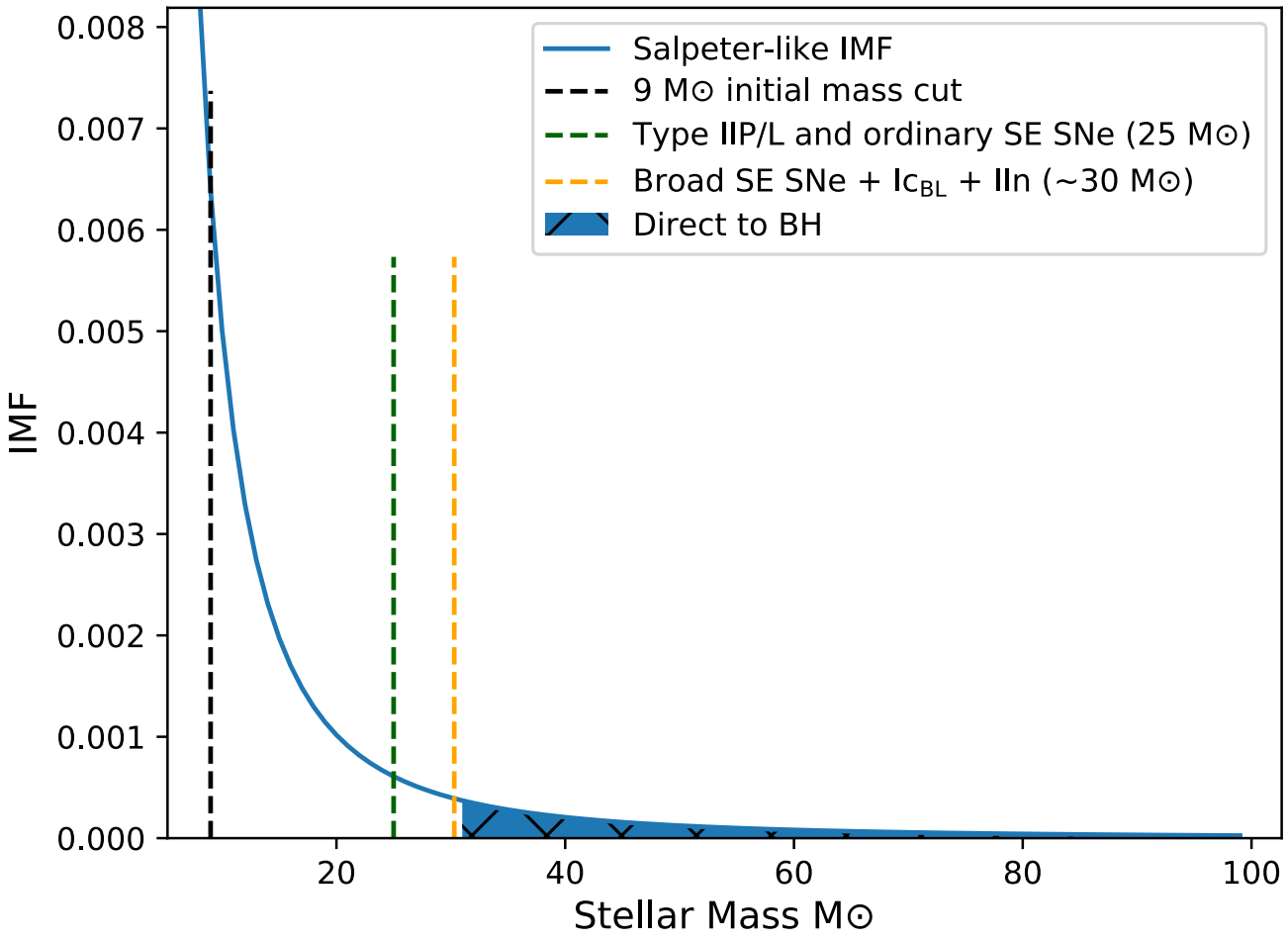
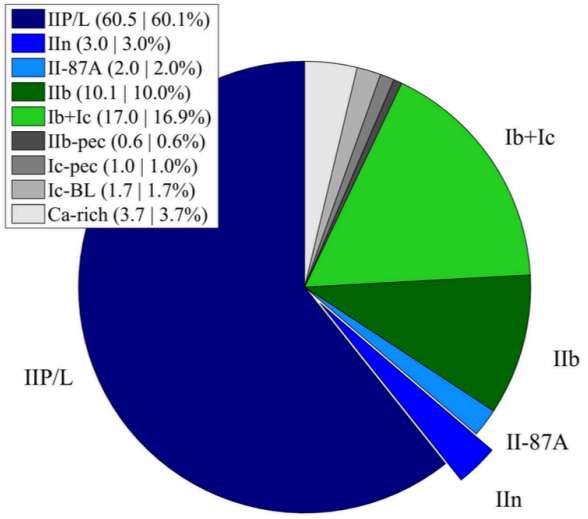
What can we do with this info?

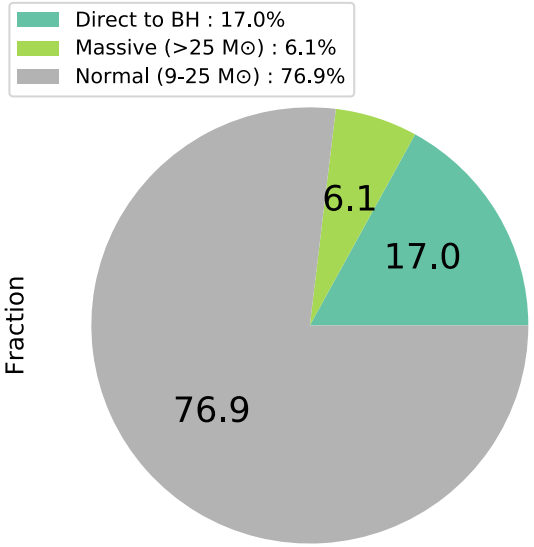


Gal-Yam et al 2008

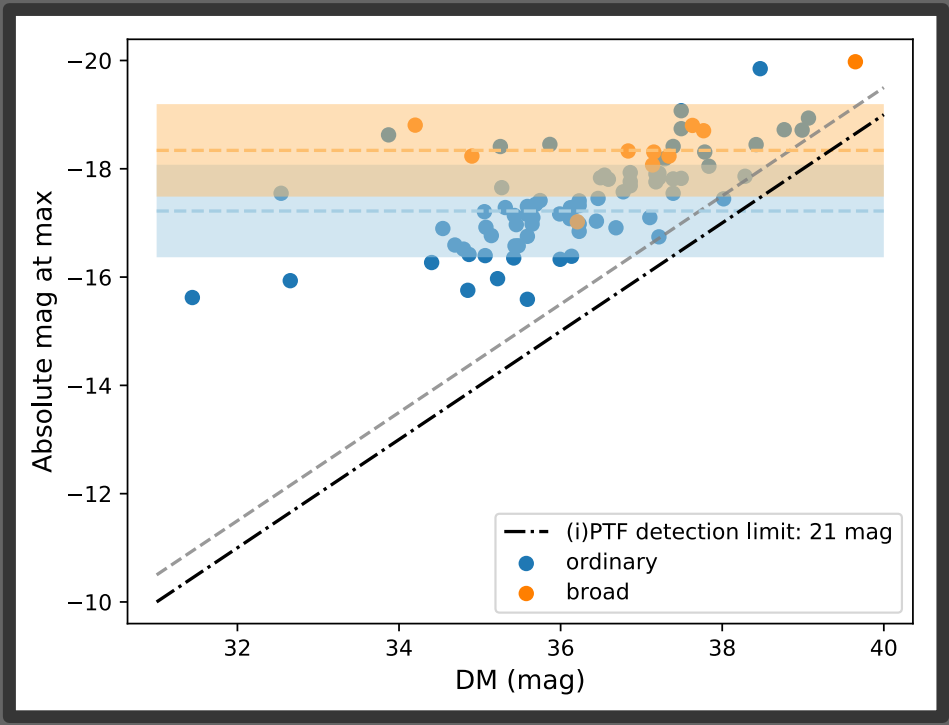




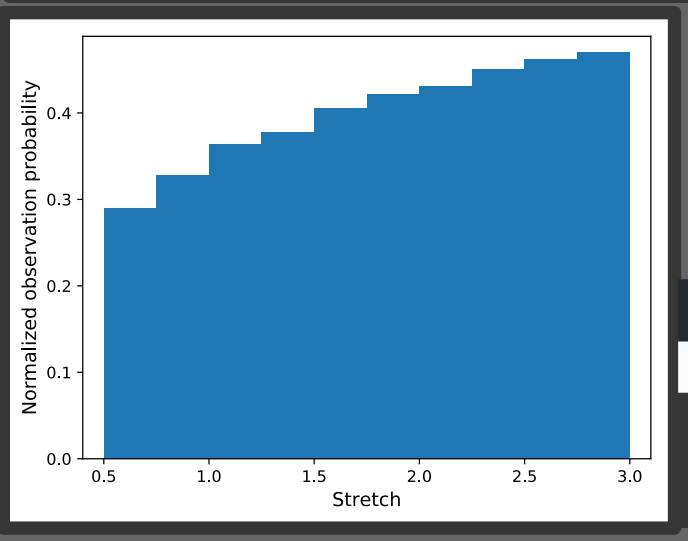
$(N = 100.6,\ M_\star > 3 \times 10^9\ \mathrm{M}_\odot)$



Caveats: Biases!



- **Malmquist bias**
- **Observability bias**
- **Survey selection bias**
- Follow-up bias
- PTF/iPTF survey biases
- …



Band	Estimate ($\hat{\pi}_1$)	95% C.I.
r	$10/84 = 0.119$	$(0.050, 0.188)$
g	$9/37 = 0.216$	$(0.084, 0.349)$

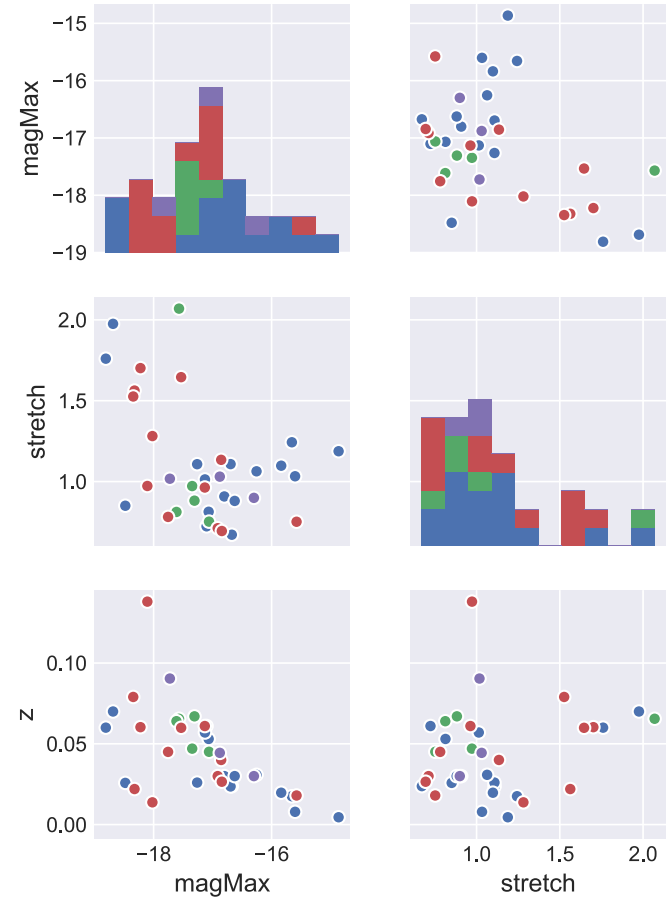
Band	Estimate ($\hat{\pi}_1$)	95% C.I.
r	0.041	$(0.022, 0.077)$
g	0.050	$(0.024, 0.104)$

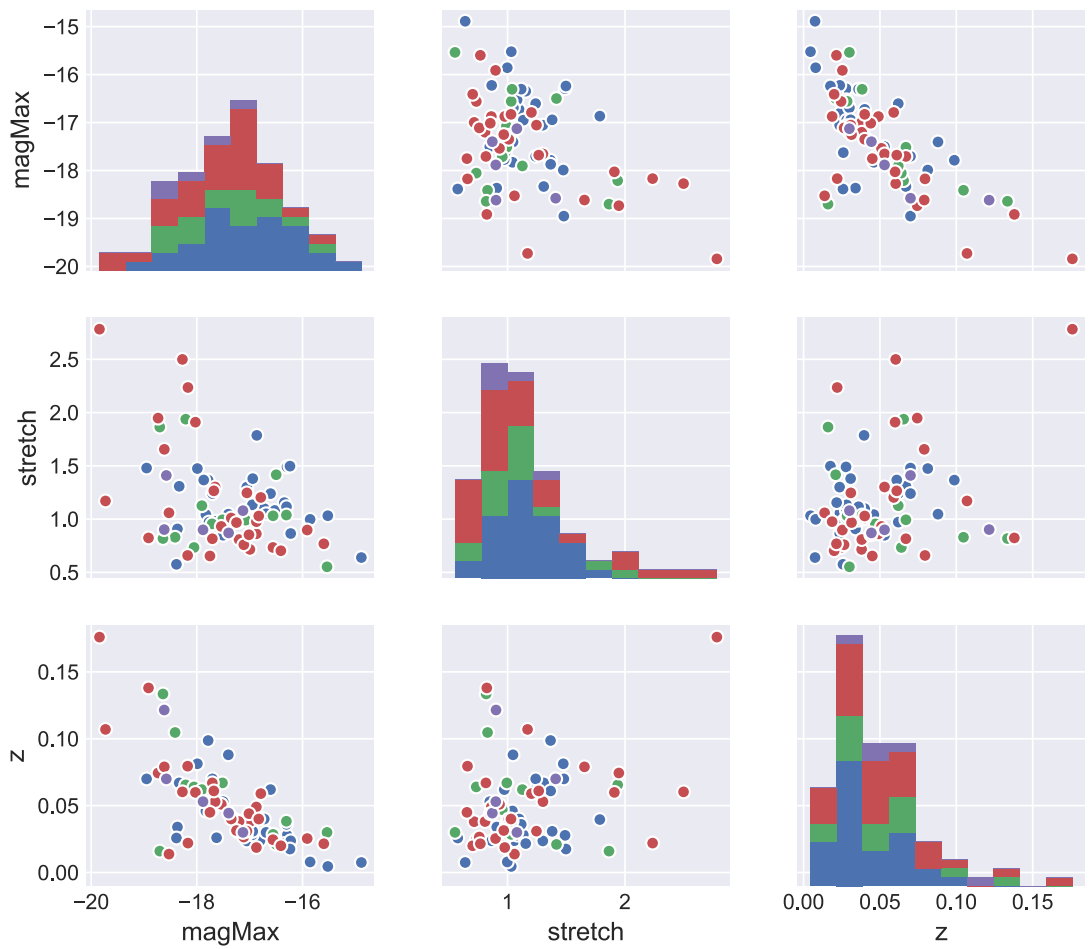
MickaelRigault / simsurvey

Simsurvey: Feindt et al (in prep)

Stockholm University

Can do much more with measured parameters!





R band

g band

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