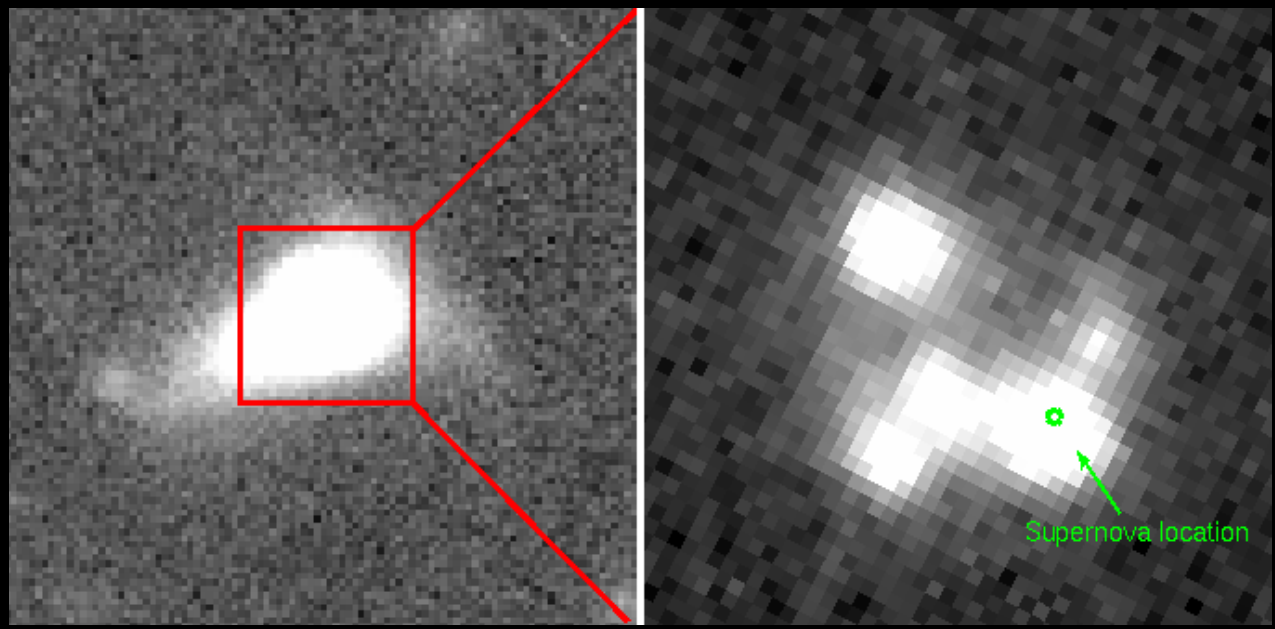
(SLSN) Hosts in PTF

Daniel Perley

Caltech / Dark Cosmology Centre



Motivations

Host galaxies provide a route to understanding SLSN progenitors and origins.

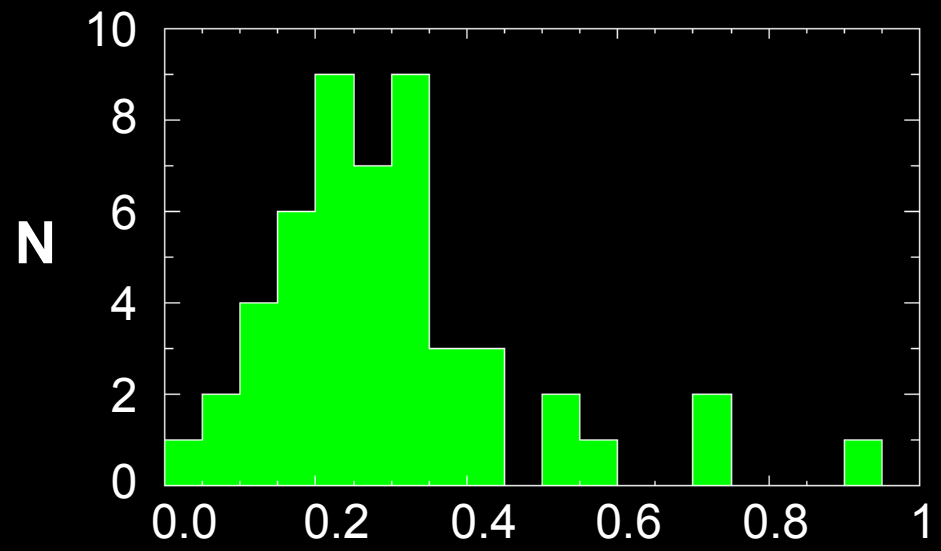
Progenitor age and (approximate) mass
Progenitor metallicity dependence (PI-SN?)
Variable IMF in the local universe? What conditions?
Other exotic influences affecting massive stellar evolution?

→ Assess suitability as a higher-redshift tracer.

PTF and SLSN hosts

PTF represents a nearly-ideal survey for SLSN hosts because:

* Untargeted
* Lots of them (~half of SLSNe discovered to date)
* Reasonably high spec. completeness, fewer biases
* Shallow (low-z)



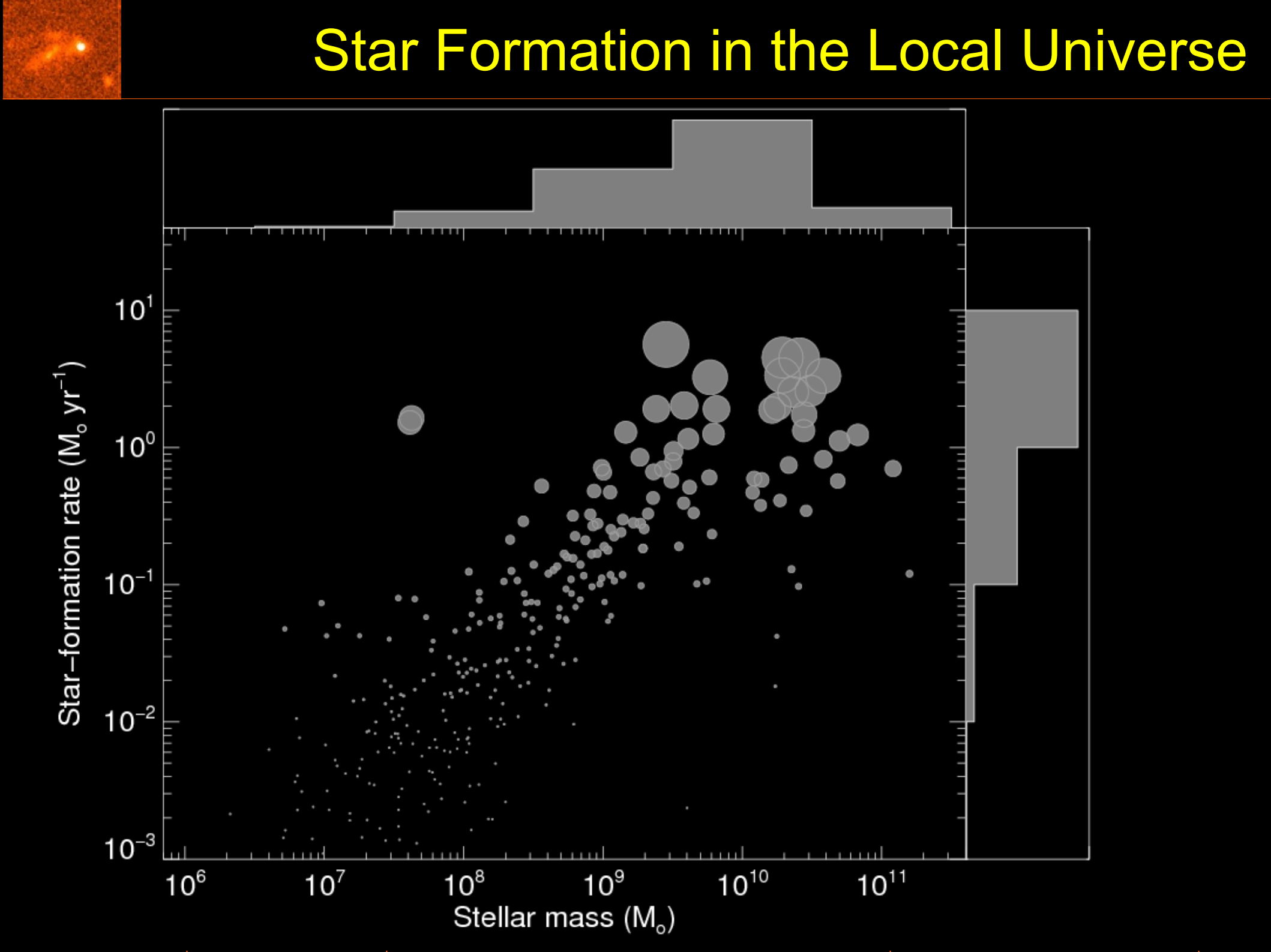
SLSN hosts in PTF

Have to wait for the SN to disappear to fully study the host!

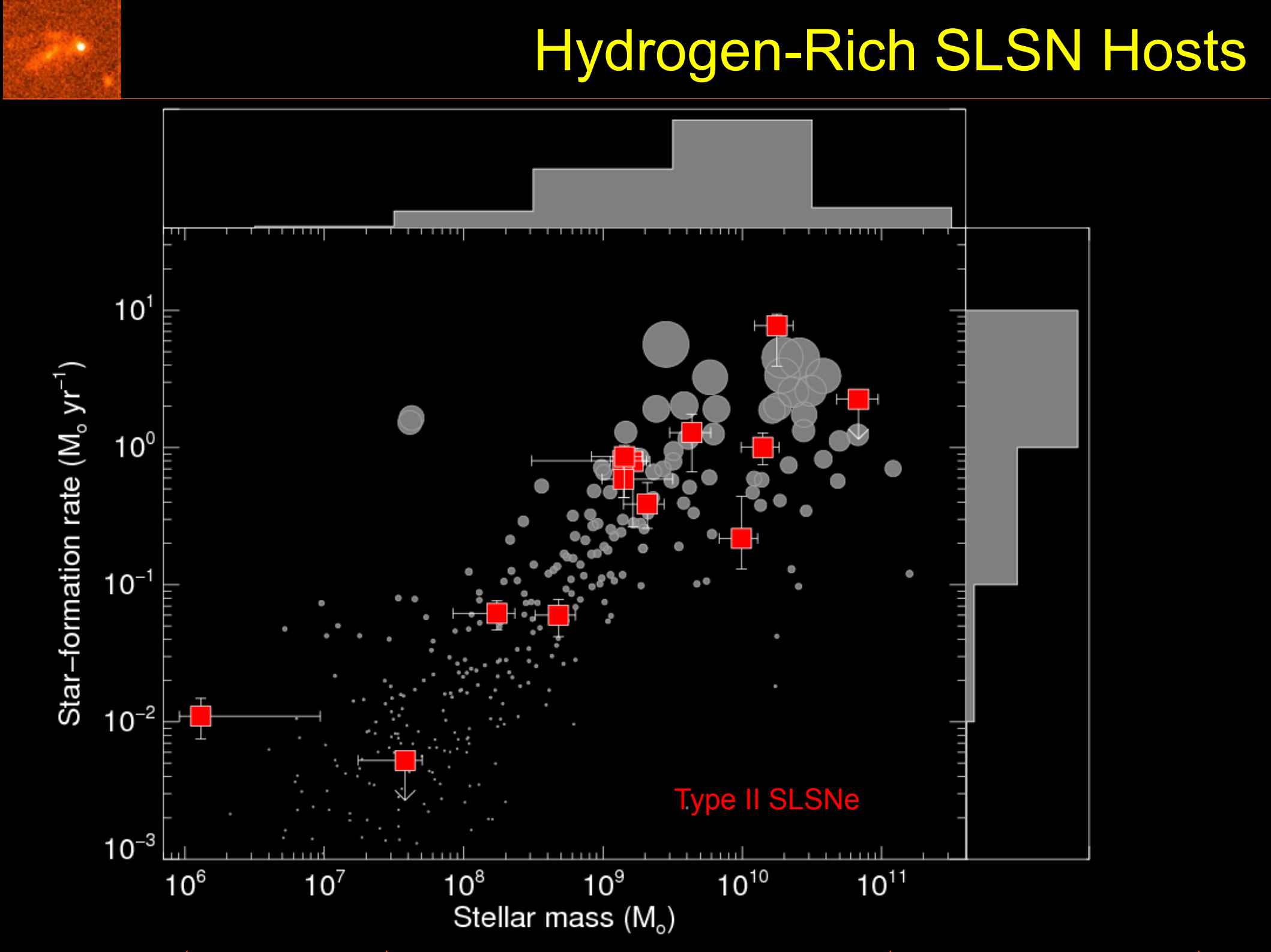
Only events from 2009-2012 (non-i PTF) studied in detail
17 SLSNe-I and 15 SLSNe-II

Multi-filter photometry (P200) + spectroscopy (Keck)
(Measure multiple observational properties –
mass, SFR, metallicity, etc.)

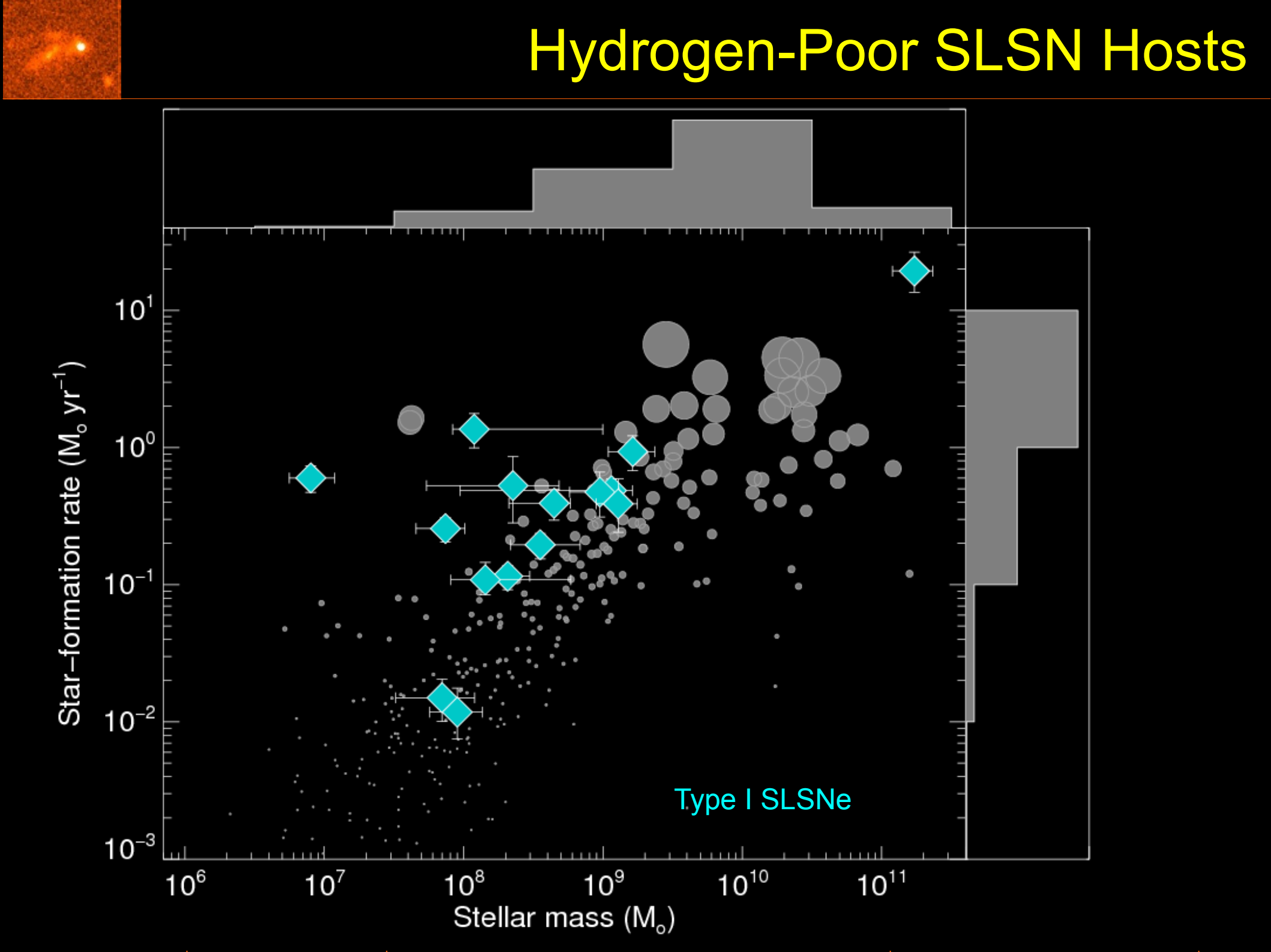
Star Formation in the Local Universe



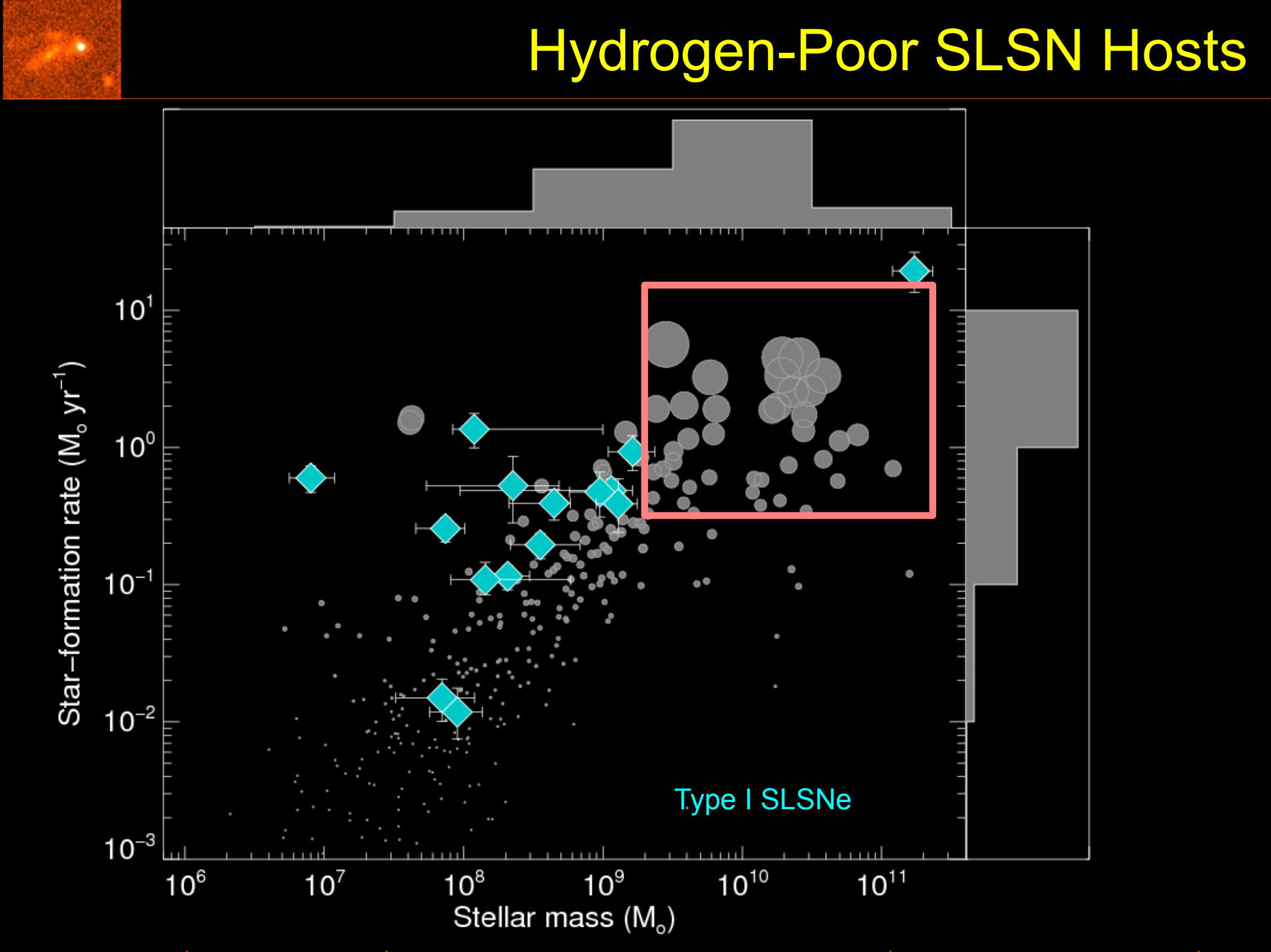
Hydrogen-Rich SLSN Hosts



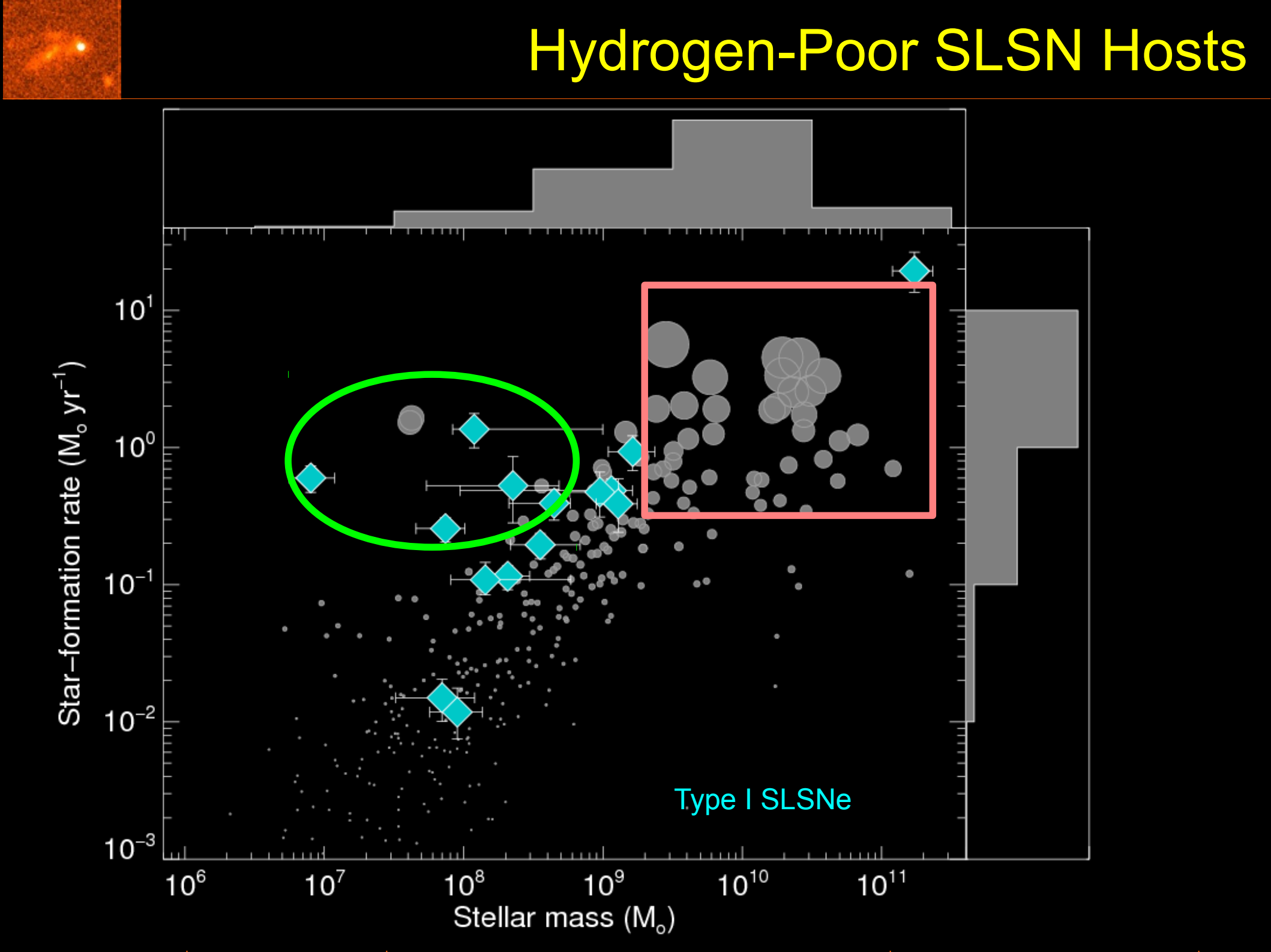
Hydrogen-Poor SLSN Hosts



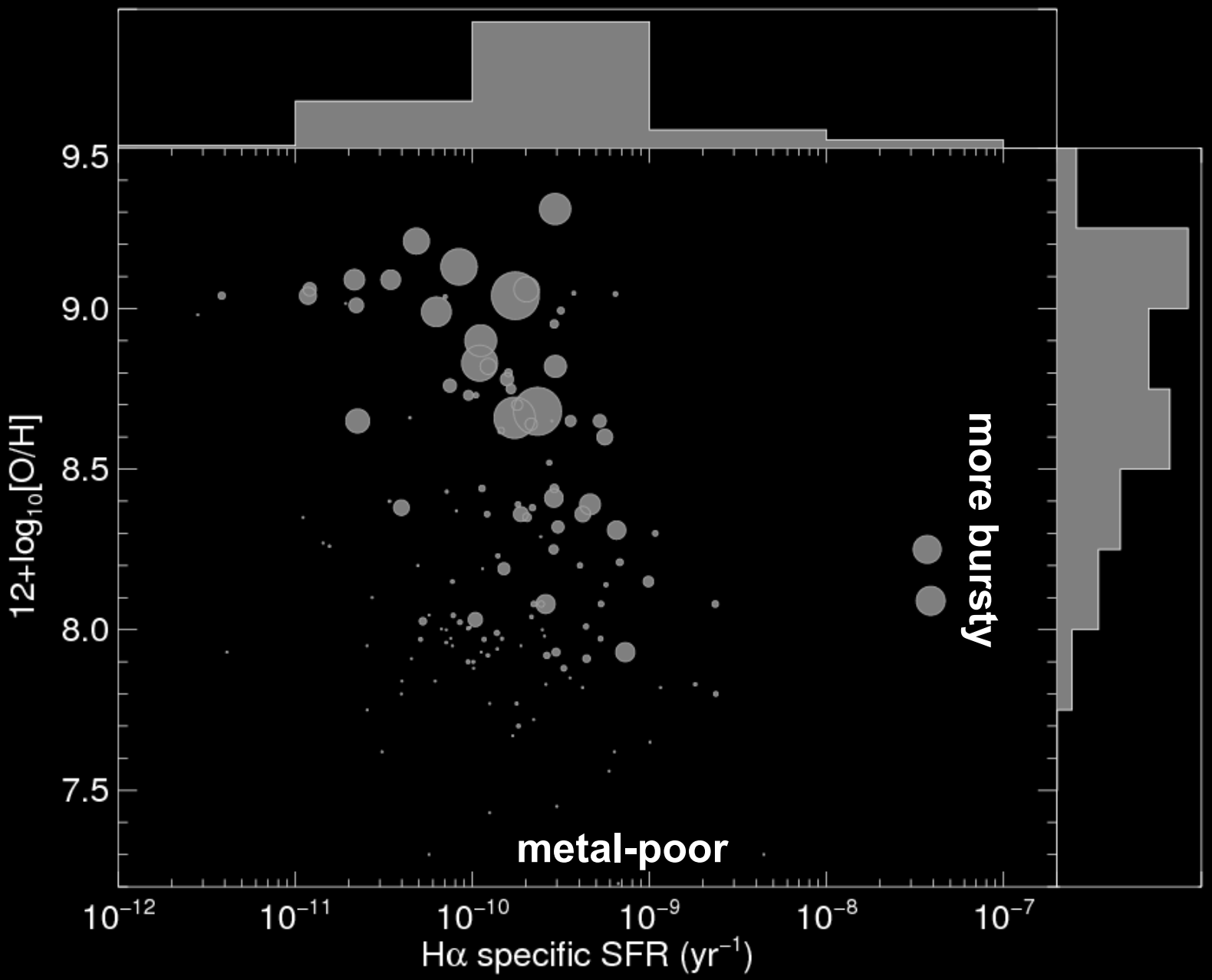
Hydrogen-Poor SLSN Hosts



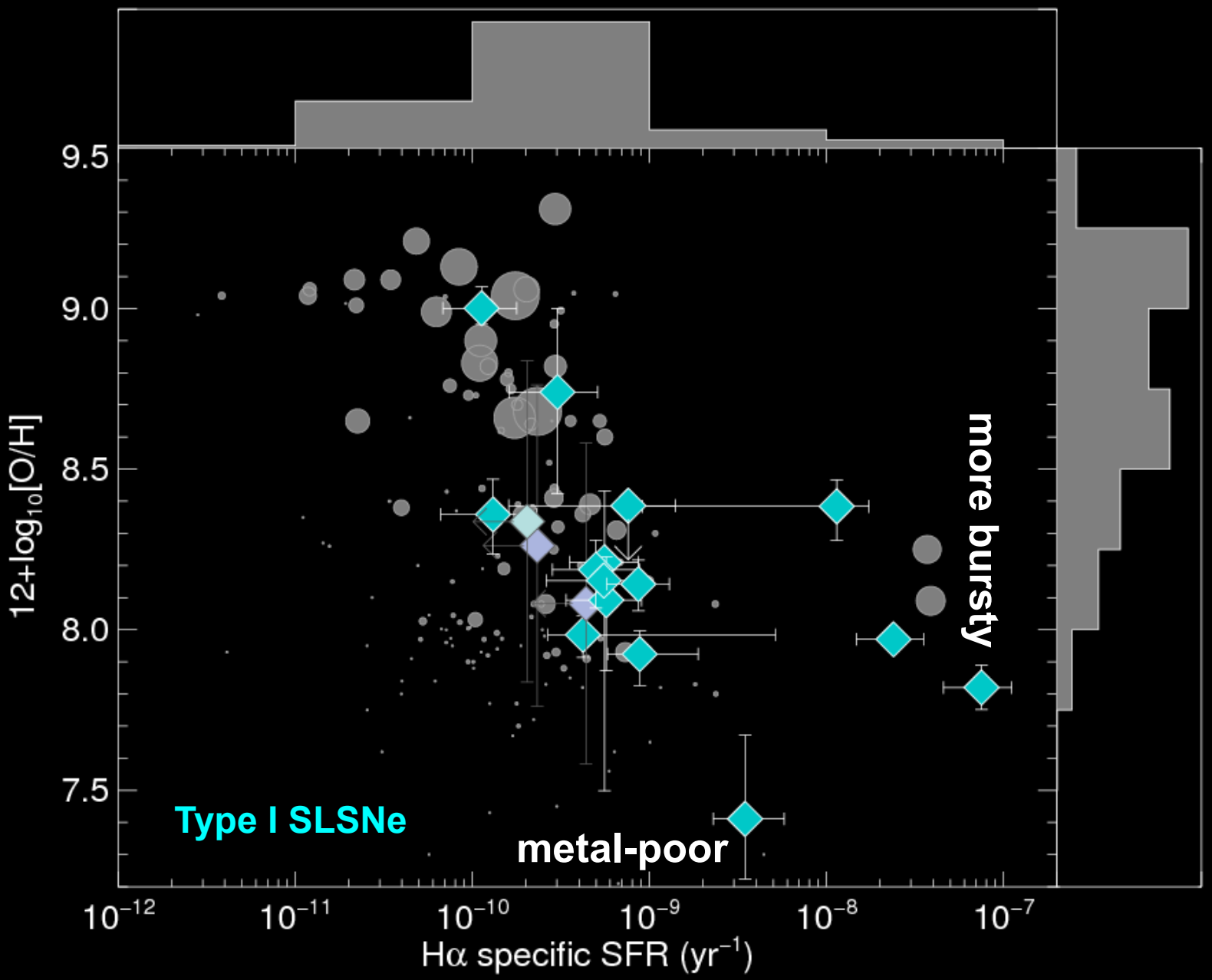
Hydrogen-Poor SLSN Hosts



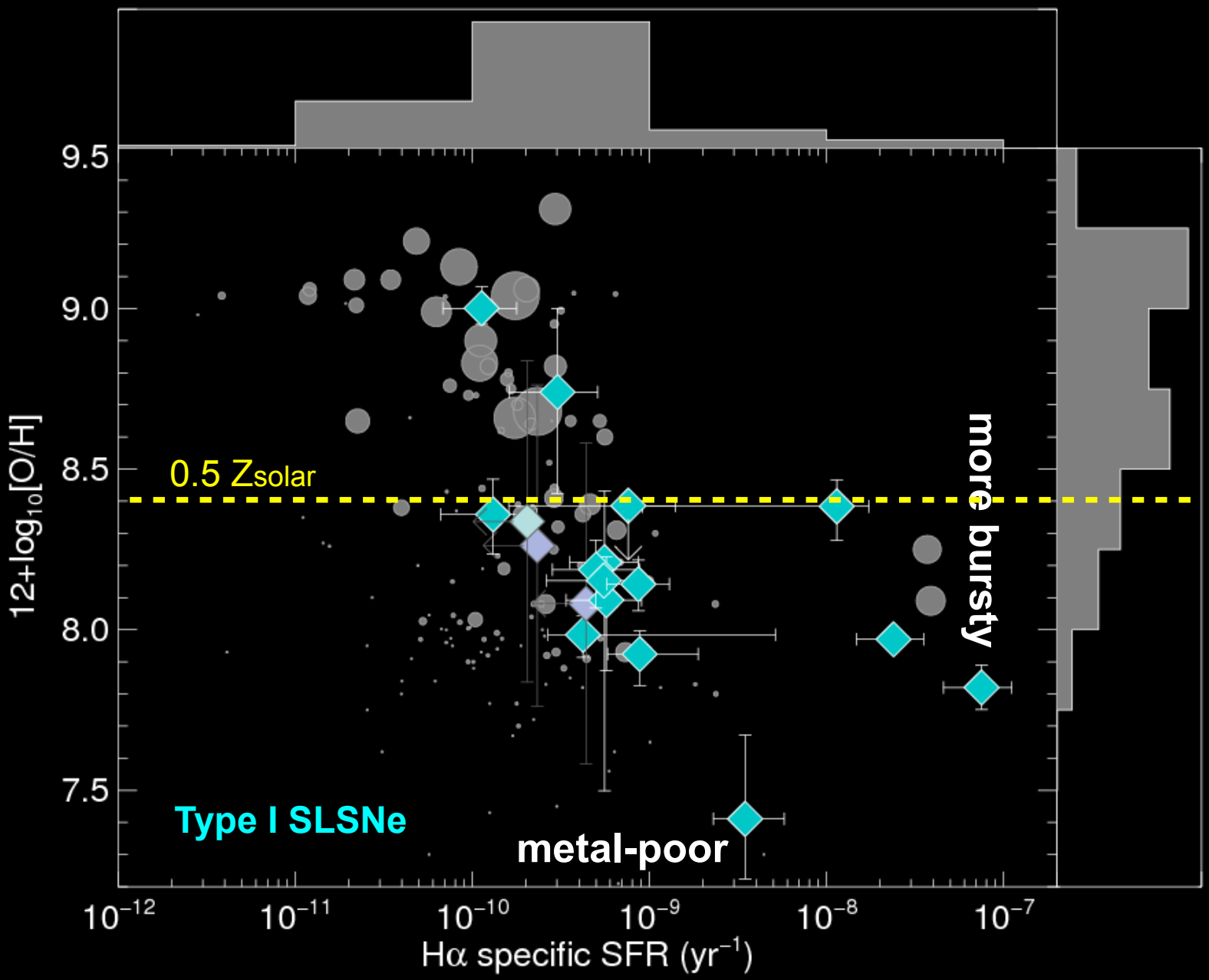
Burstiness-Metallicity Relation



Hydrogen-Poor SLSNe



Hydrogen-Poor SLSNe



Conclusions from PTF

SLSNe-II : Occur in all galaxies
(No **strong** differences from locations of star-formation)

SLSNe-I: Exclusively in $M^* < 10^{9.2}$, $Z < 0.5\ Z_{sun}$ galaxies

Abundance of starbursts partially (entirely?)
a side effect of metallicity bias

SLSN hosts in iPTF

	2009	2010	2011	2012	2013	2014	2015	2016	**TOTAL**
Type I	3	11	4	4	8	3	5	3	**28**
Type II	1	8	1	4	1	1	0	0	**16**

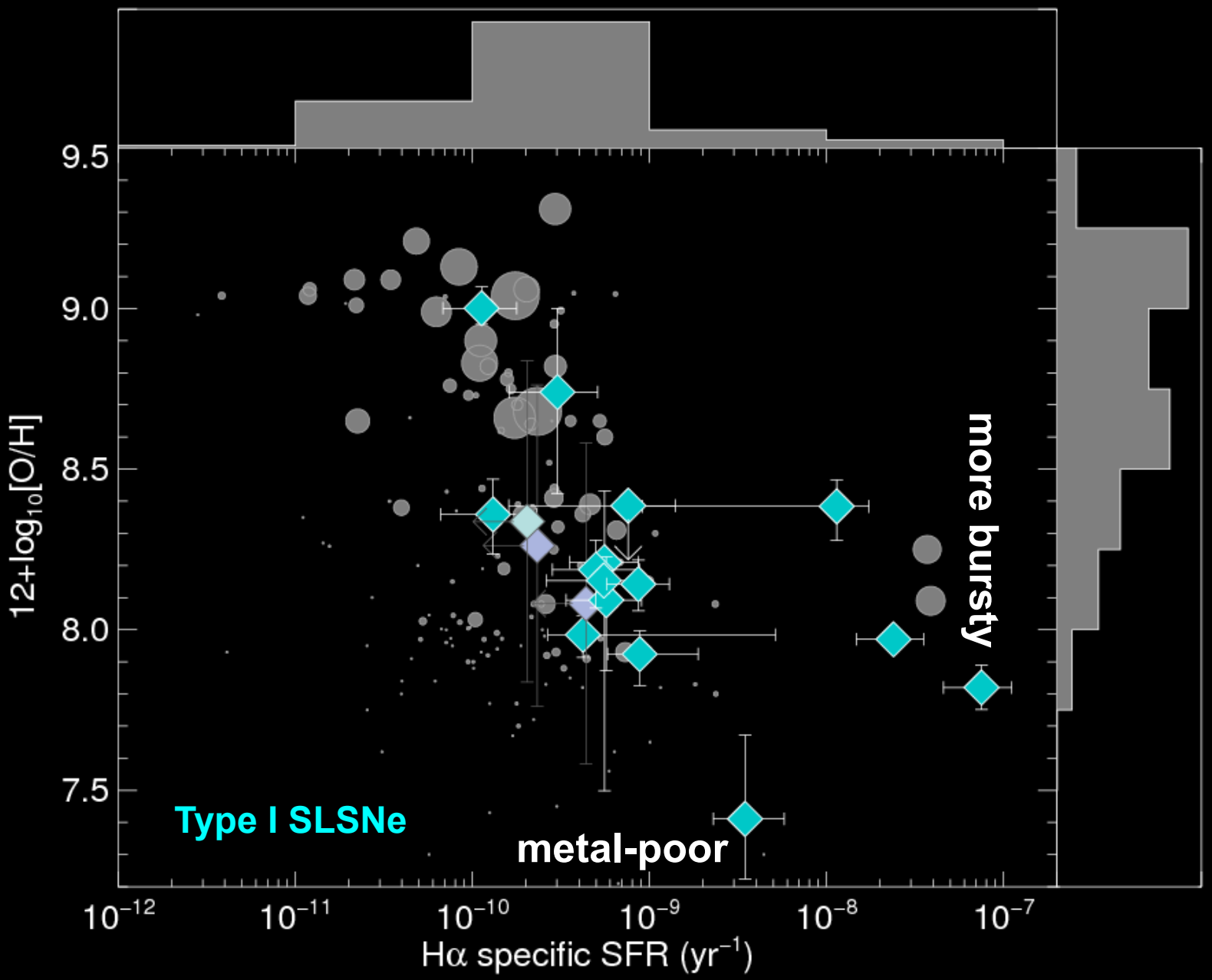
~ doubling of (SLSN-I) sample size

Oddballs, high-Z hosts, etc

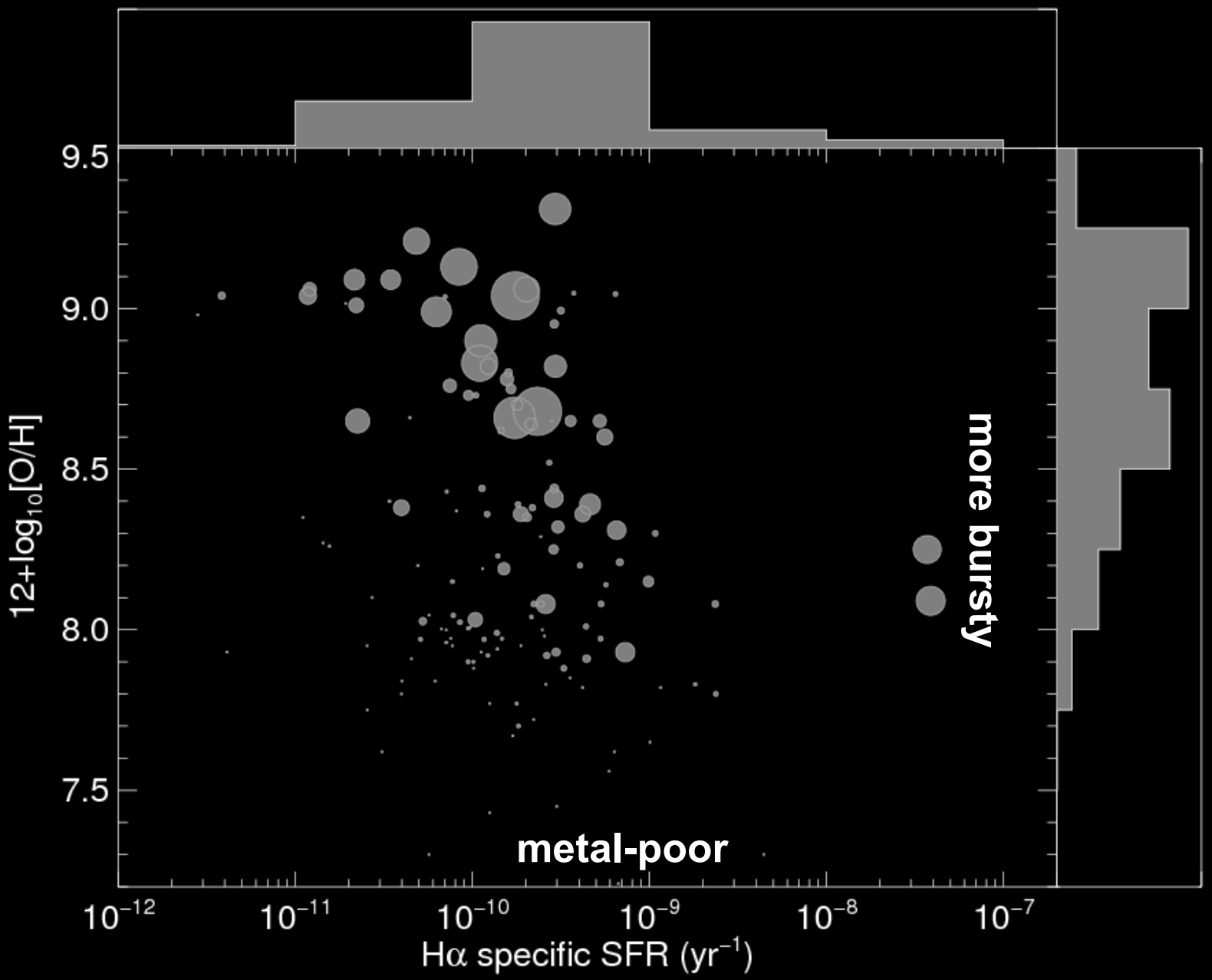
Measurement of starburst fraction (excess?)

HST / resolved observations

(SL)SN hosts in ZTF



(SL)SN hosts in ZTF

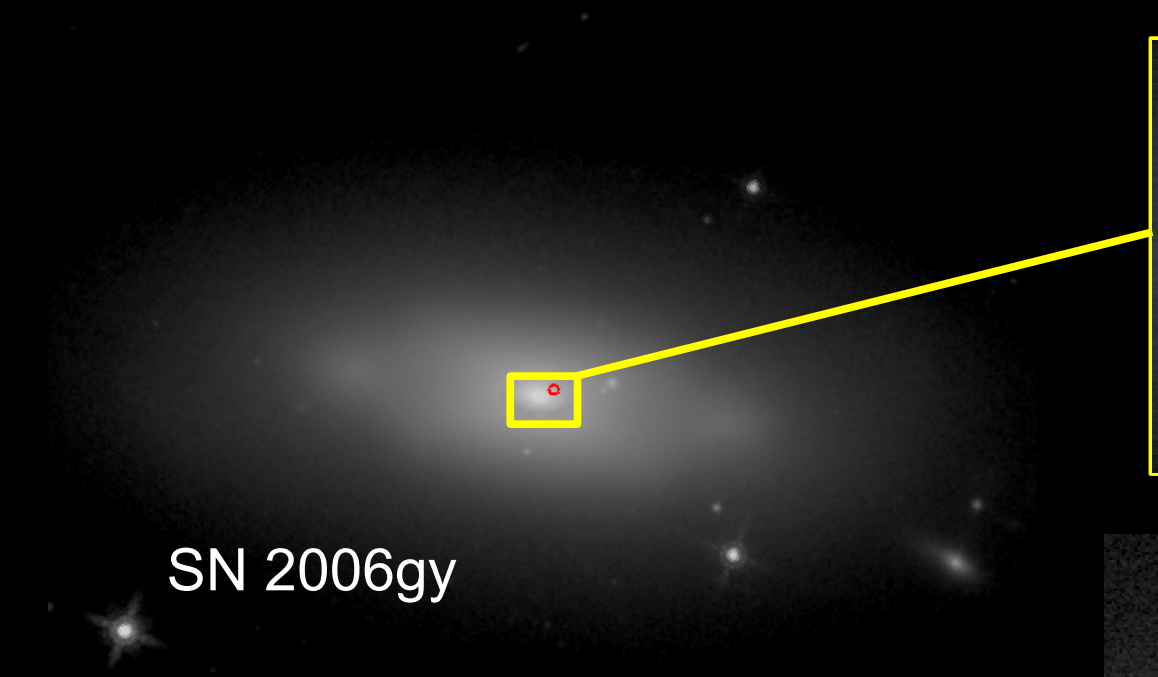


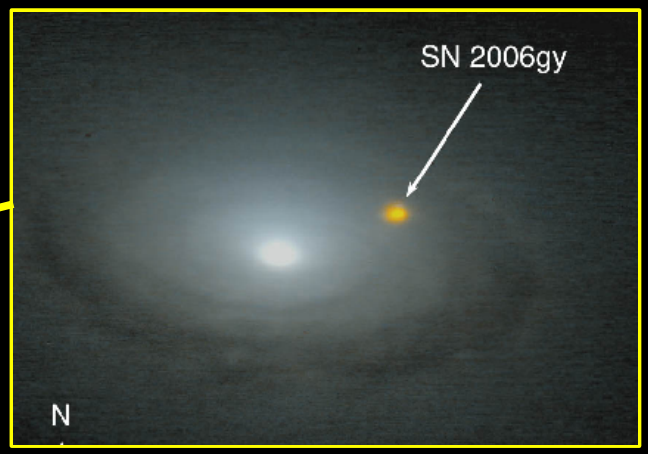
ZTF: Complete & Control Samples

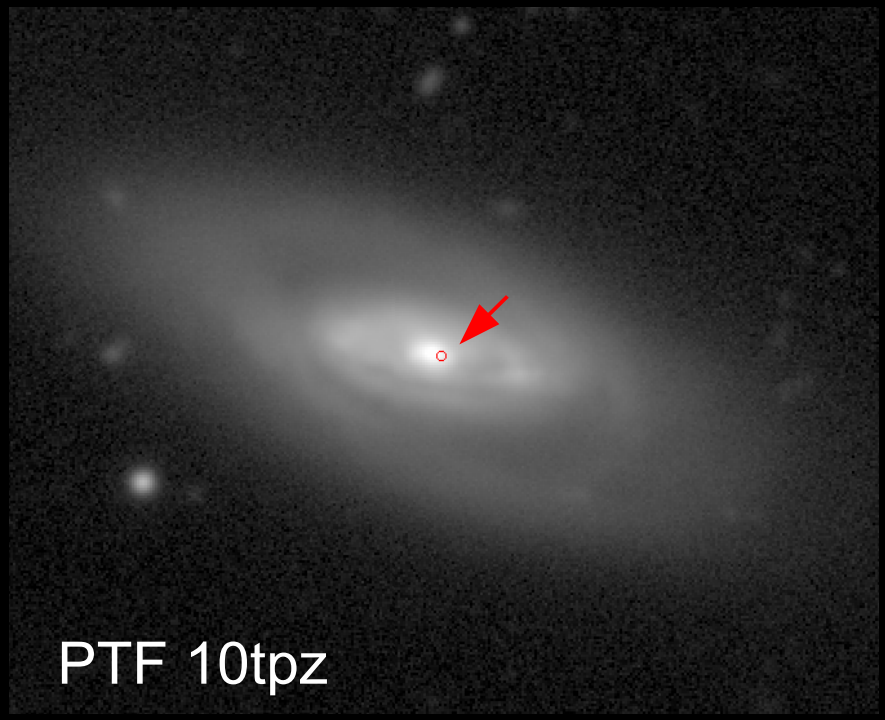
ZTF will find 10s of nearby SLSNe per year (coadding will find many more at higher-z) – **but,** already in an era where host galaxy study uncertainties dominated by comparison catalog systematics.

Establish and enforce magnitude cut for classification for all SLSNe (public release? Will overlap ATLAS/ASAS-SN)

SN 2006gy, PTF10tpz & Nuclear SLSNe

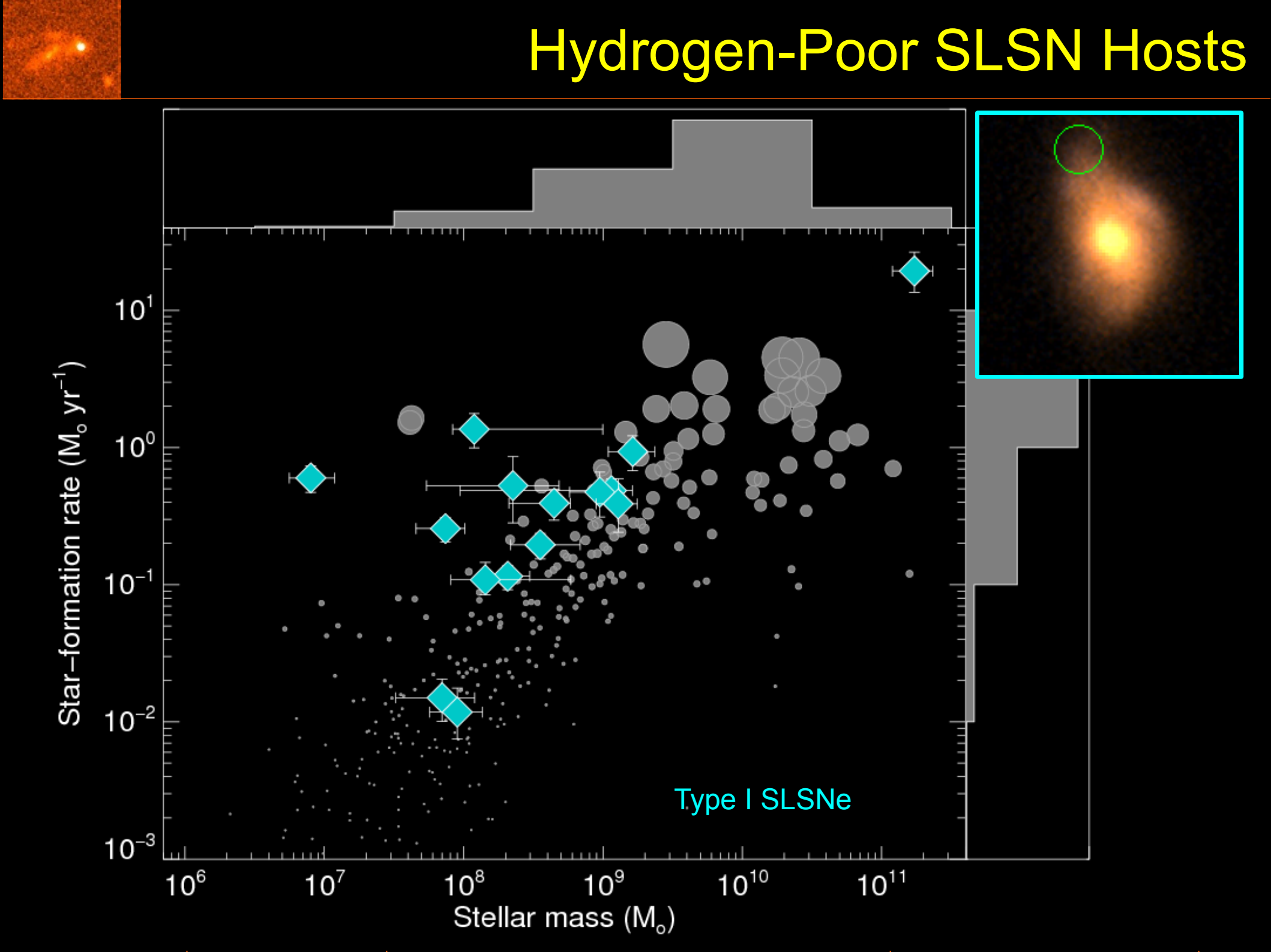




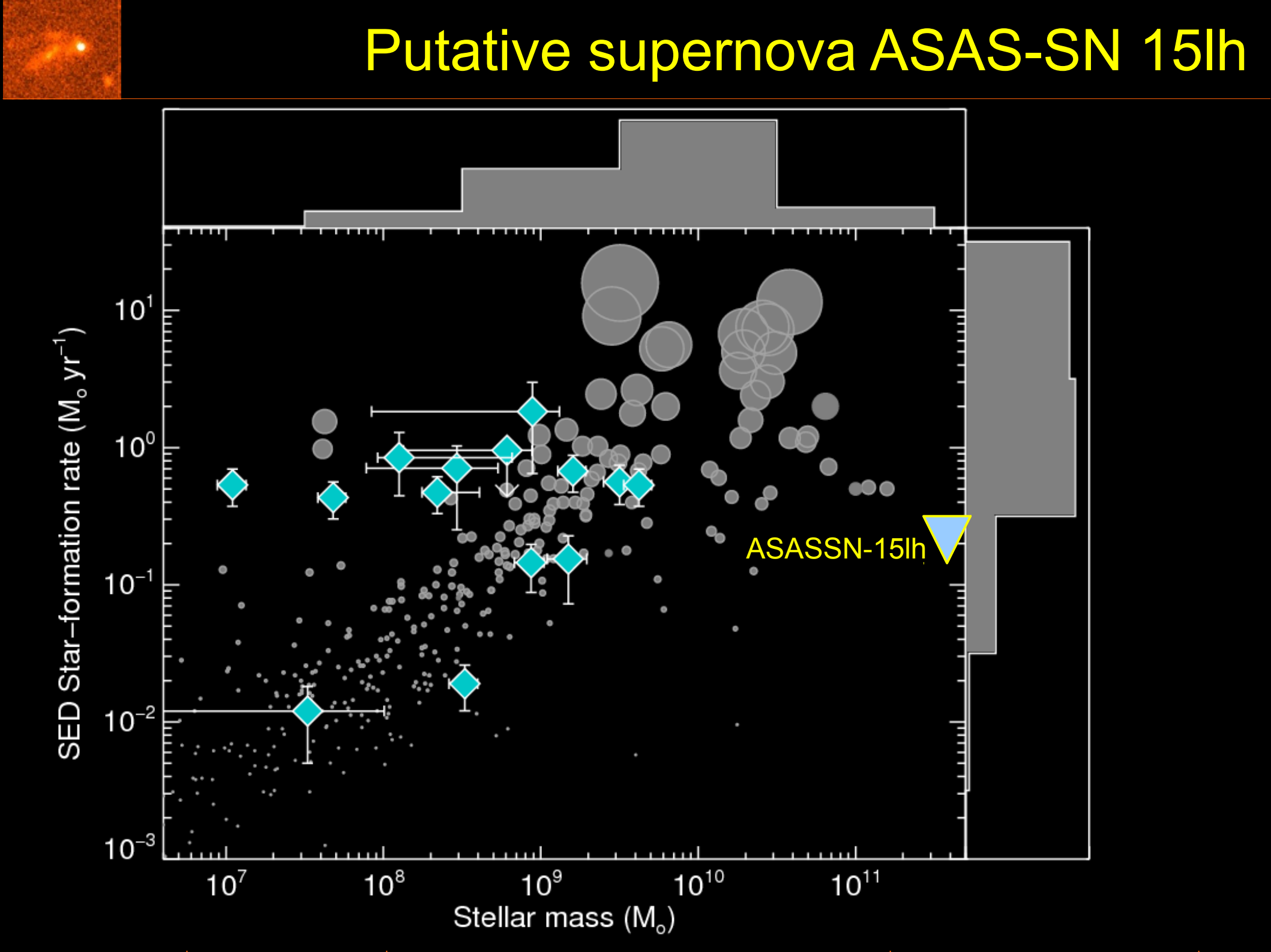


Something very curious about galaxy inner cores...

Hydrogen-Poor SLSN Hosts



Putative supernova ASAS-SN 15lh



Origins of Low-z Extreme Transients

SLSNe with hydrogen:
No obvious environmental preferences.
→ A very massive star that happened to undergo major **eruptions/instabilities** before exploding.

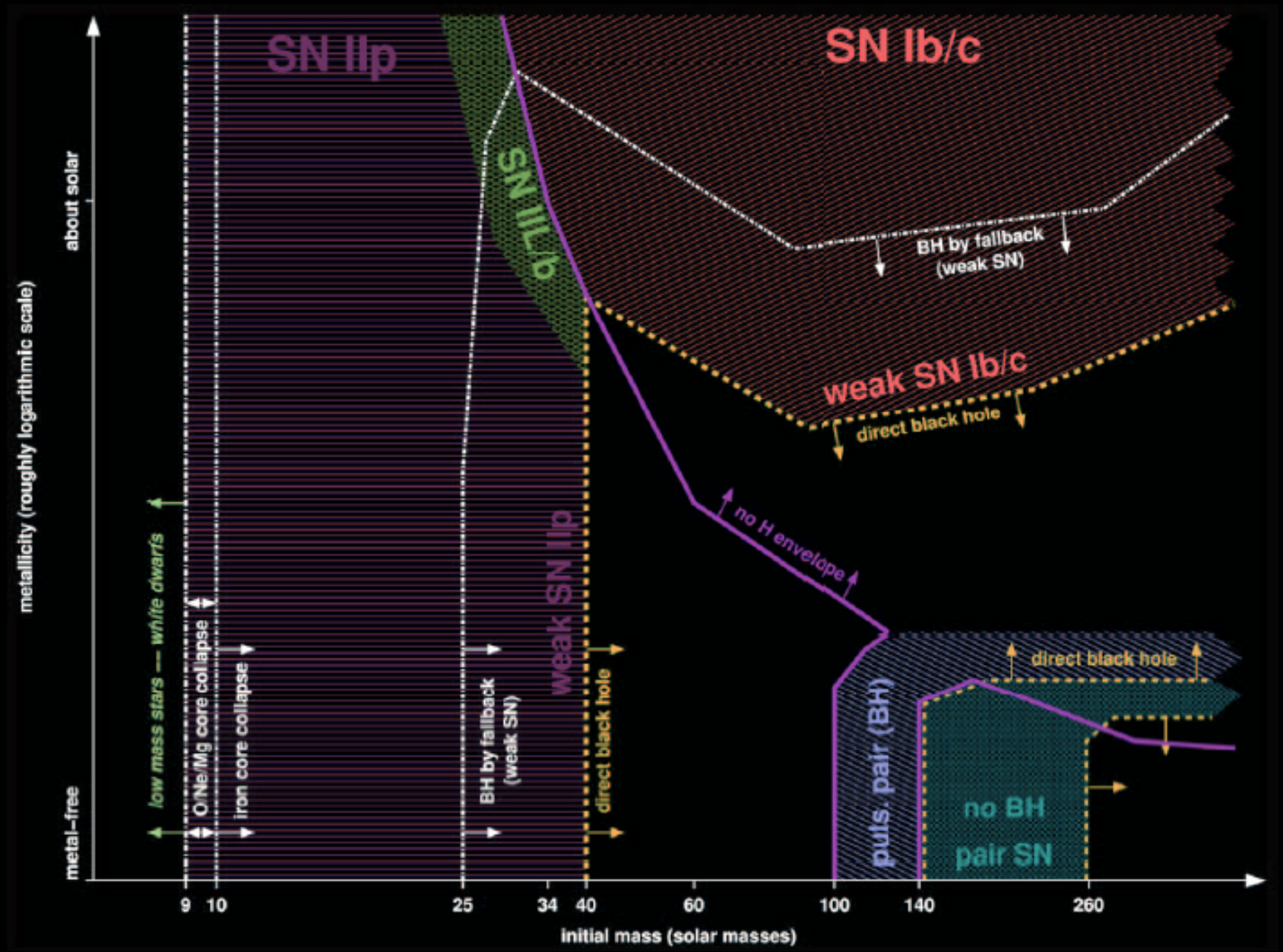
+ a class of exclusively circumnuclear SNe?

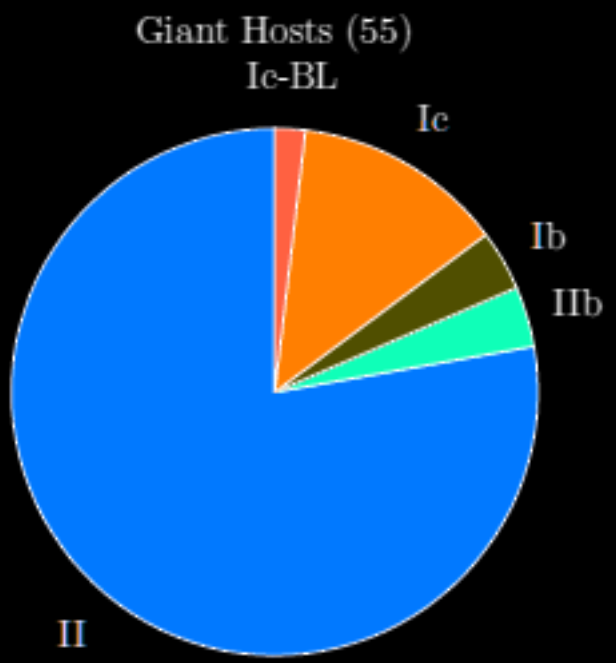
SLSNe without hydrogen:
Almost never in massive & metal-rich galaxies.
~0.5 Solar metallicity cutoff.
Excess in starbursts? (May just be nature of low-mass galaxies.)

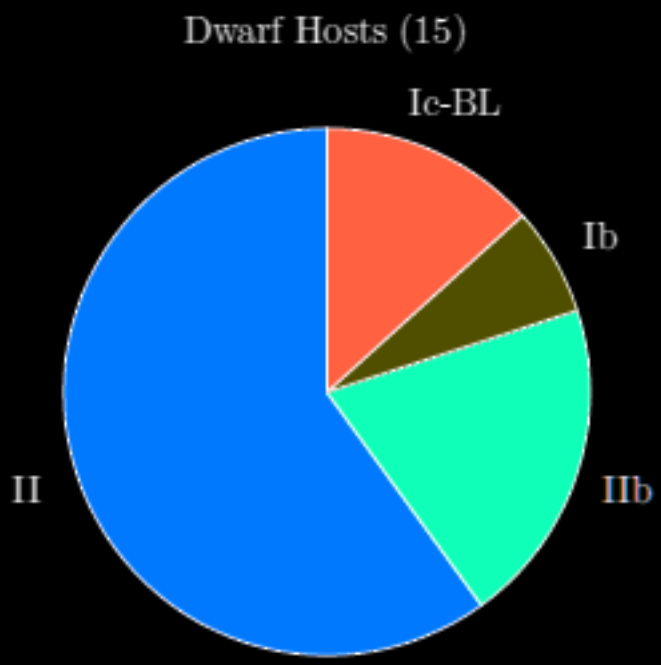
Gamma-ray bursts:
Almost never in massive galaxies (but plenty at intermediate mass)
~1 Solar metallicity cutoff. No starburst excess.

⇒ Combination of factors: mass, binarity, stochastic effects.
Boosting due to variations in IMF (etc.) is minor or nonexistent.
SLSNe require lower metallicites than GRBs. Why?

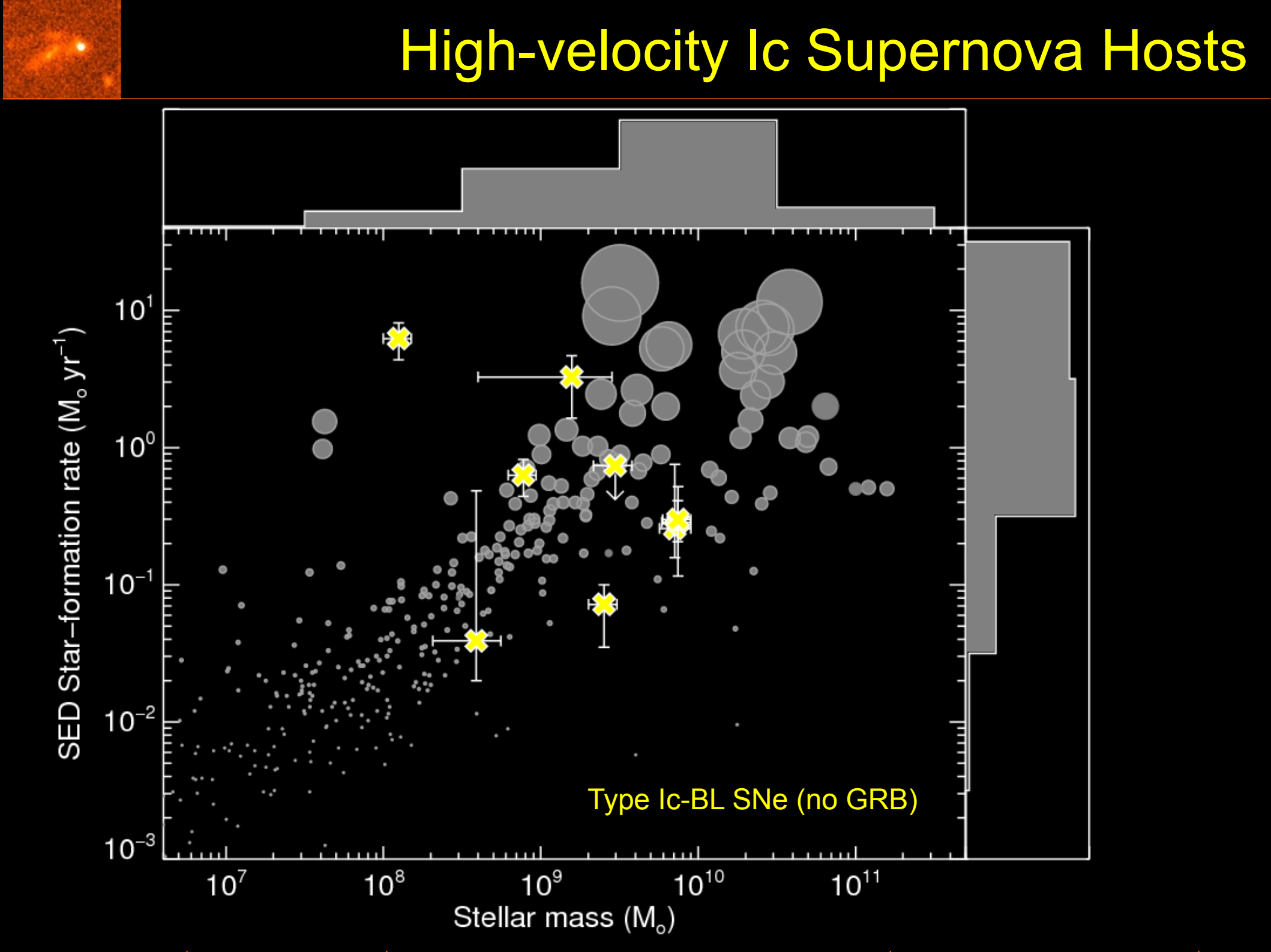
Hosts and Massive Stellar Evolution




Giant Hosts (55)
Ic-BL
Ic
Ib
IIb
II


Dwarf Hosts (15)
Ic-BL
Ib
II
IIb

High-velocity Ic Supernova Hosts



What can a star care about?

Mass	If IMF varies
Composition	YES
Rotation speed	Probably stochastic (could vary with IMF)
Binary companion	Yes if binarity varies with environment
Heirarchial companion	Only in extreme starbursts

Dependence on metallicity?
Does a dependence on metallicity alone explain everything?
(Z-dependence is fundamental or a side-effect; need for other factors?)