A SEARCH FOR SUPERNOVAE IN THE *BUFFALO* FIELDS

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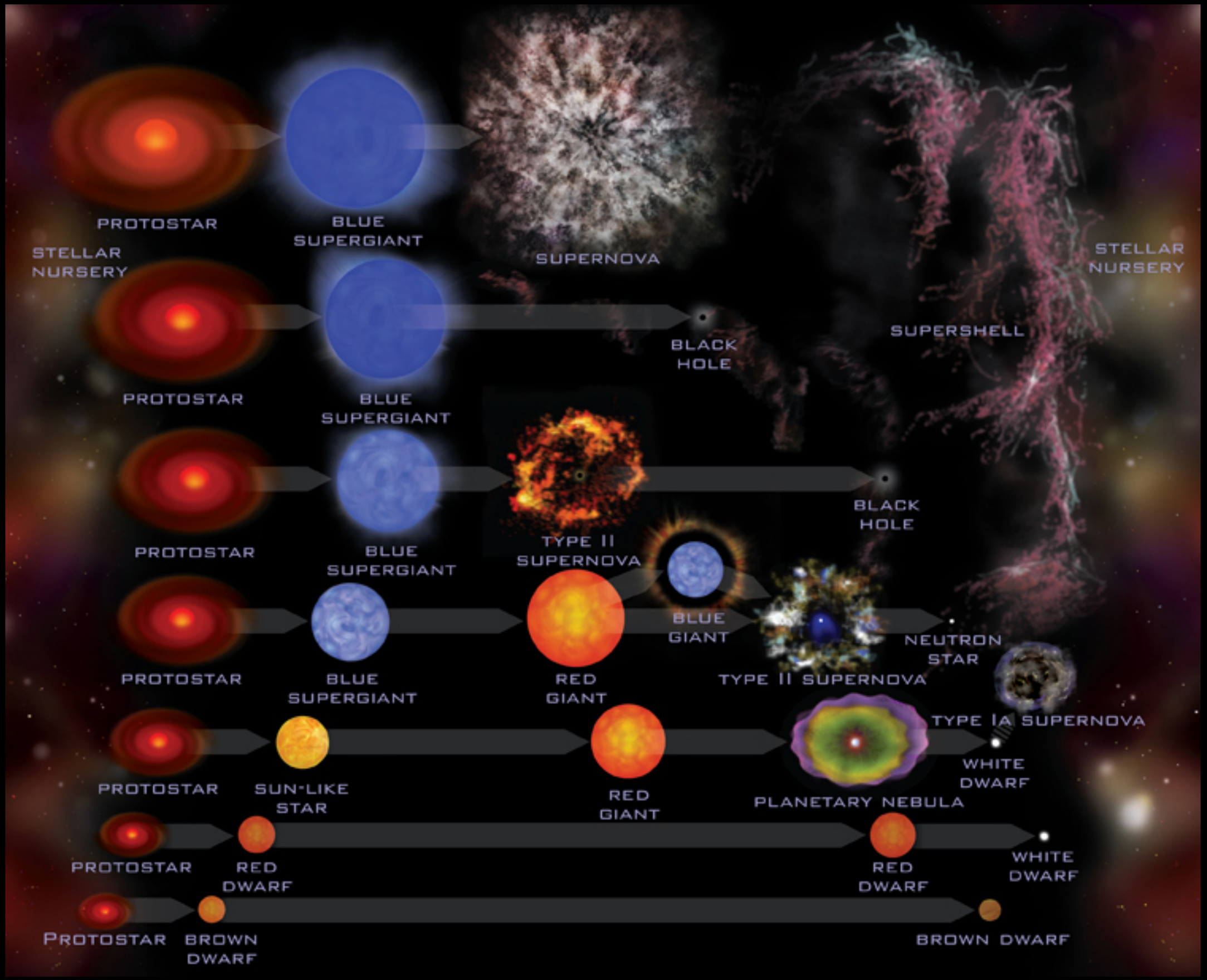
SPACE TELESCOPE SCIENCE INSTITUTE

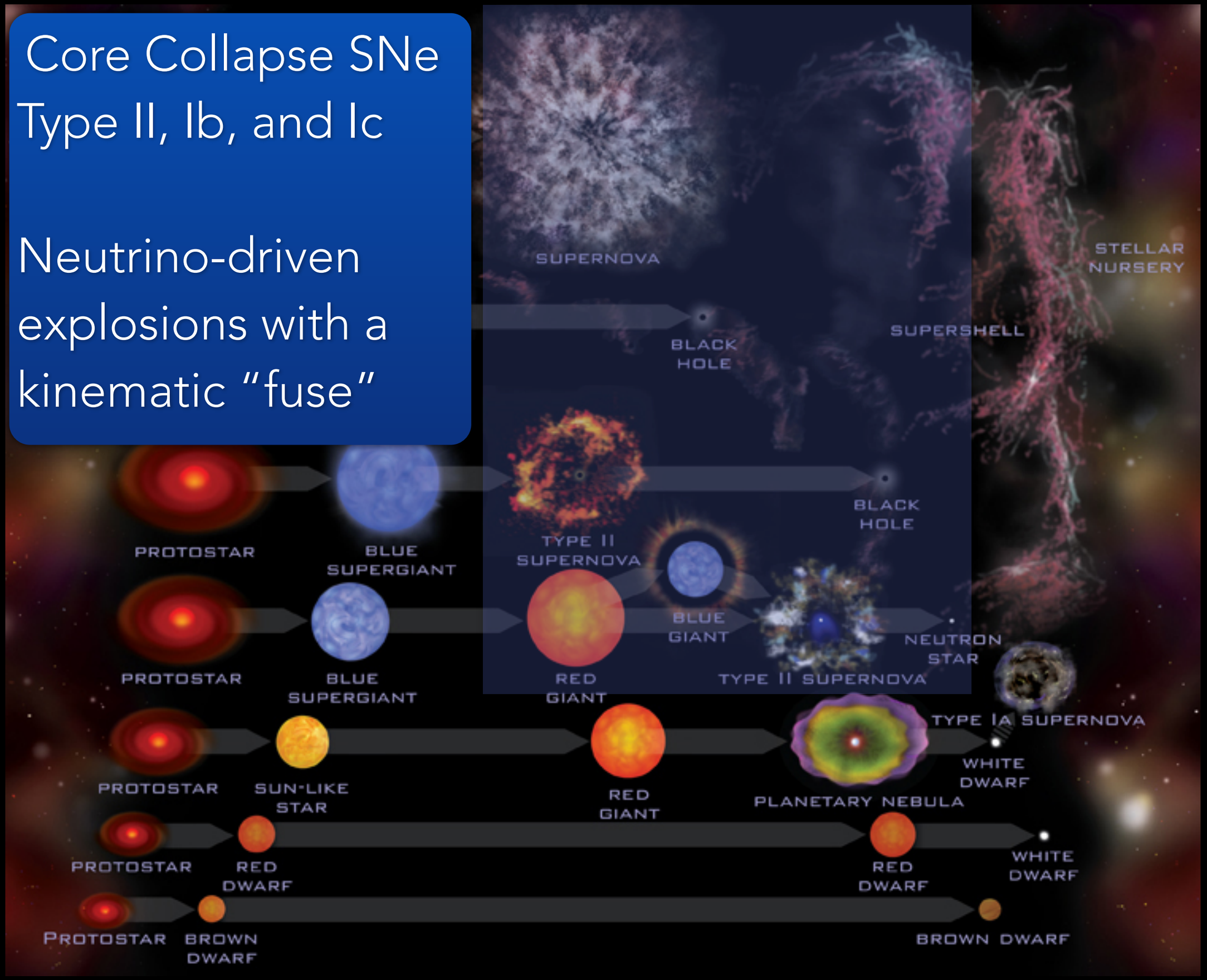
SUMMARY OF STELLAR EVOLUTION



SUMMARY OF STELLAR EVOLUTION

Core Collapse SNe
Type II, Ib, and Ic

Neutrino-driven explosions with a kinematic “fuse”



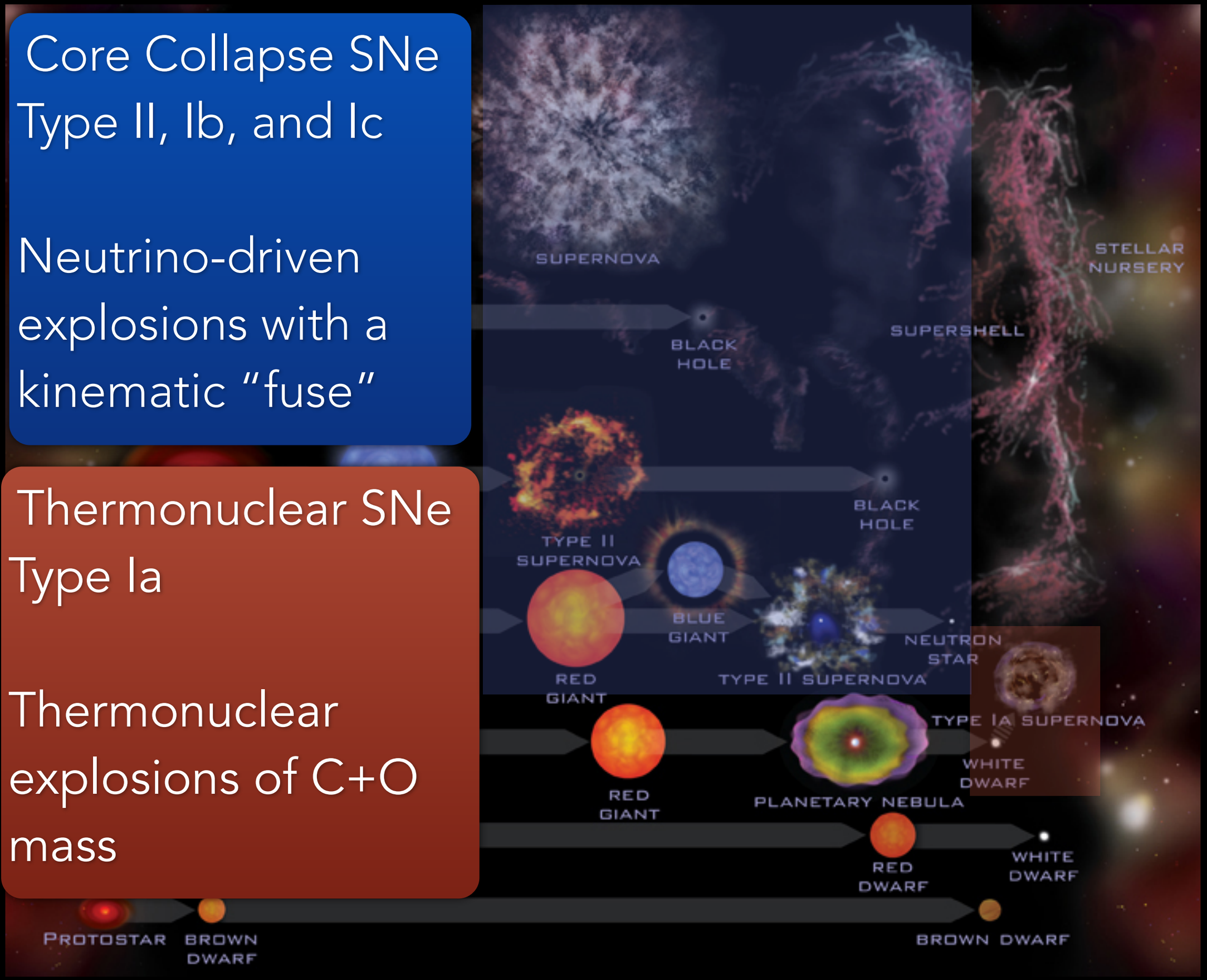
SUMMARY OF STELLAR EVOLUTION

Core Collapse SNe
Type II, Ib, and Ic

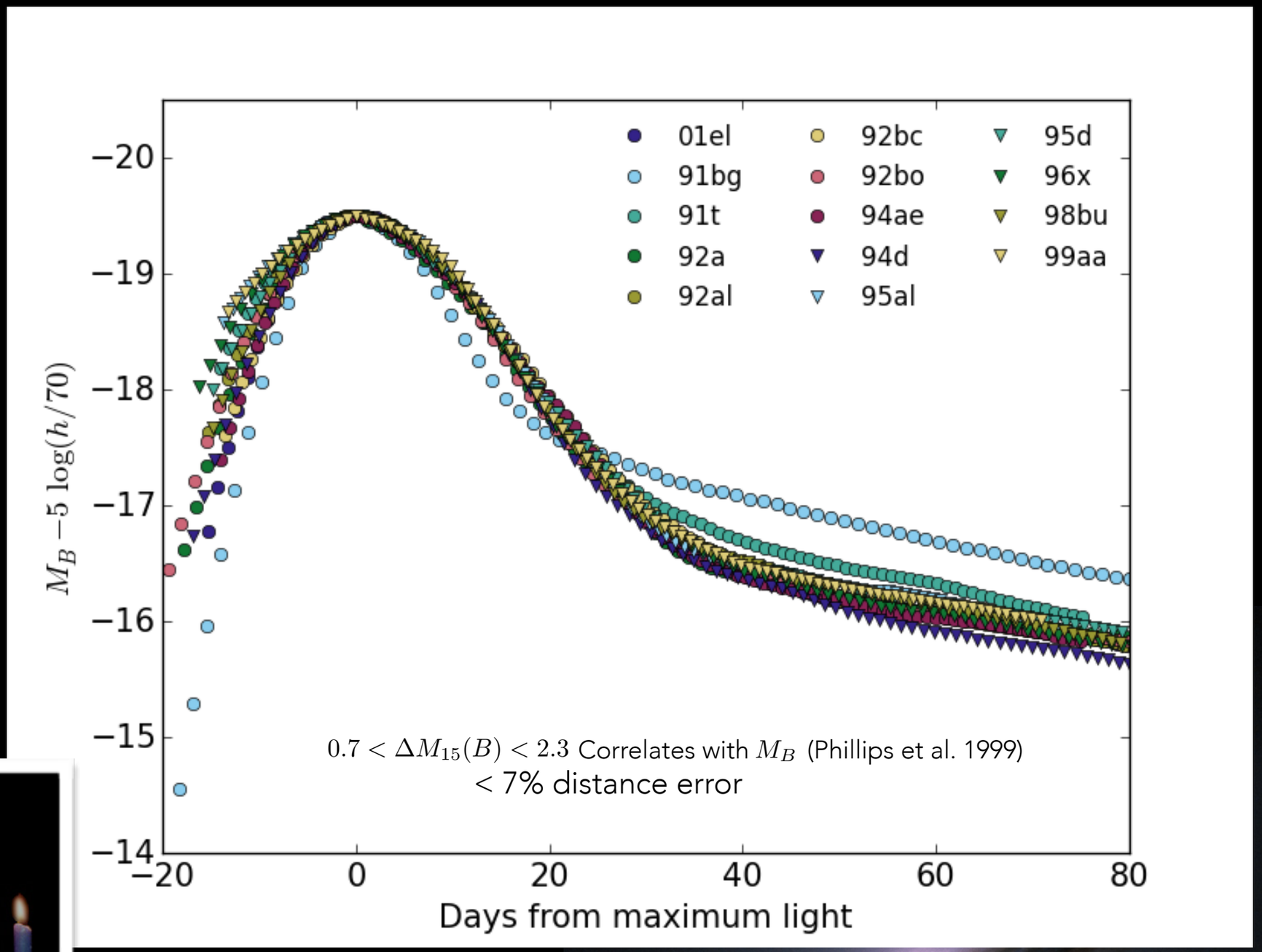
Neutrino-driven explosions with a kinematic "fuse"

Thermonuclear SNe
Type Ia

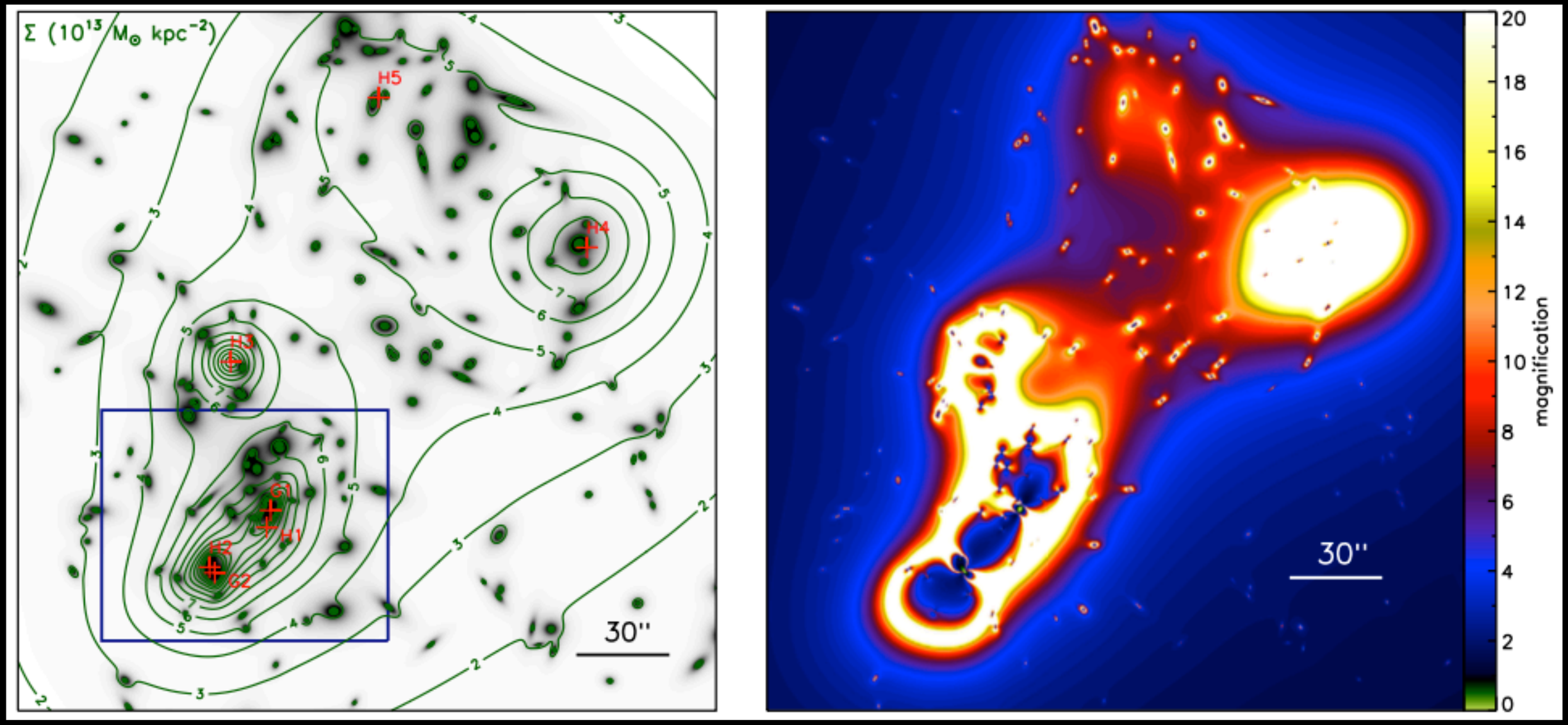
Thermonuclear explosions of C+O mass



SUPERNOVAE AS STANDARD CANDLES

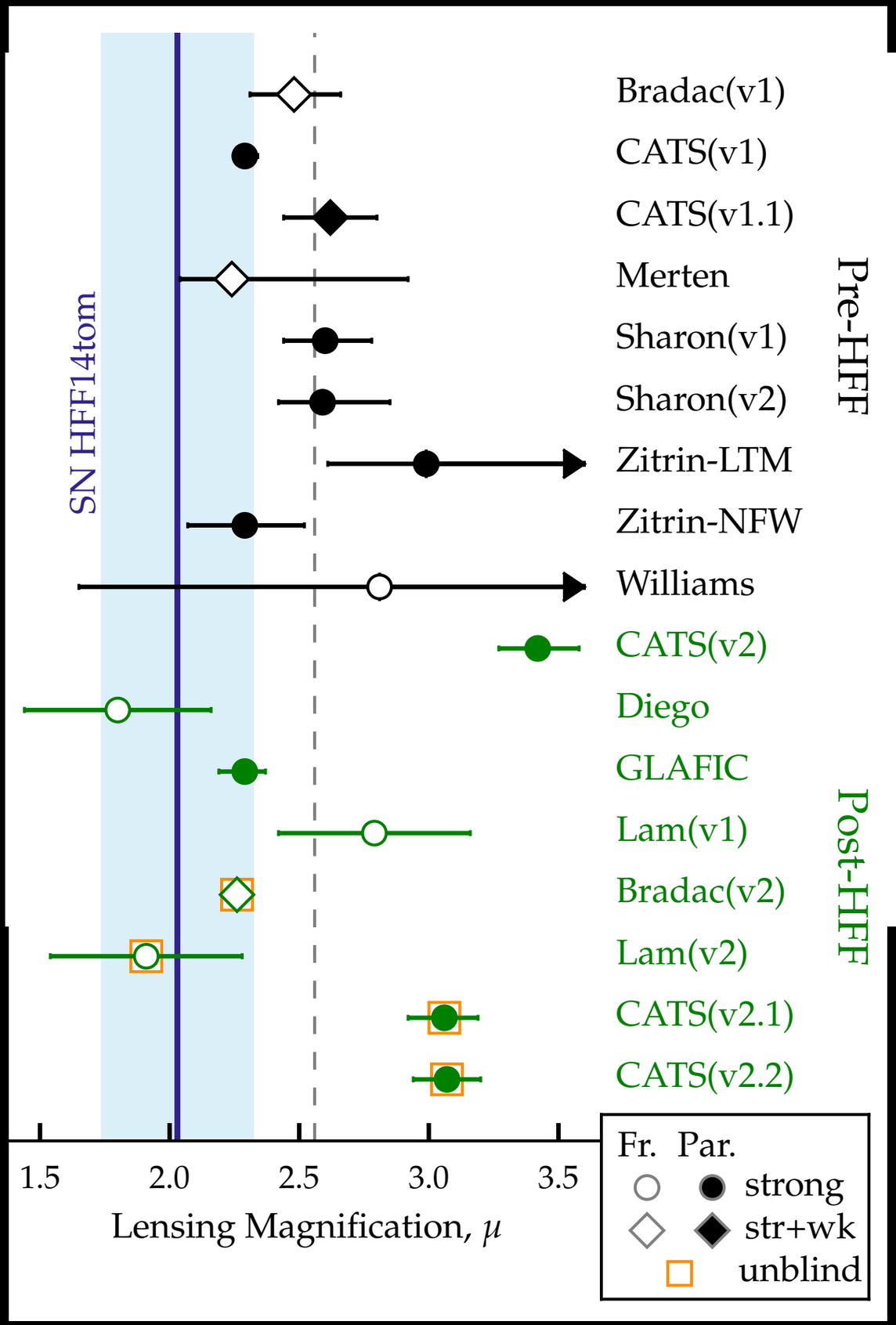


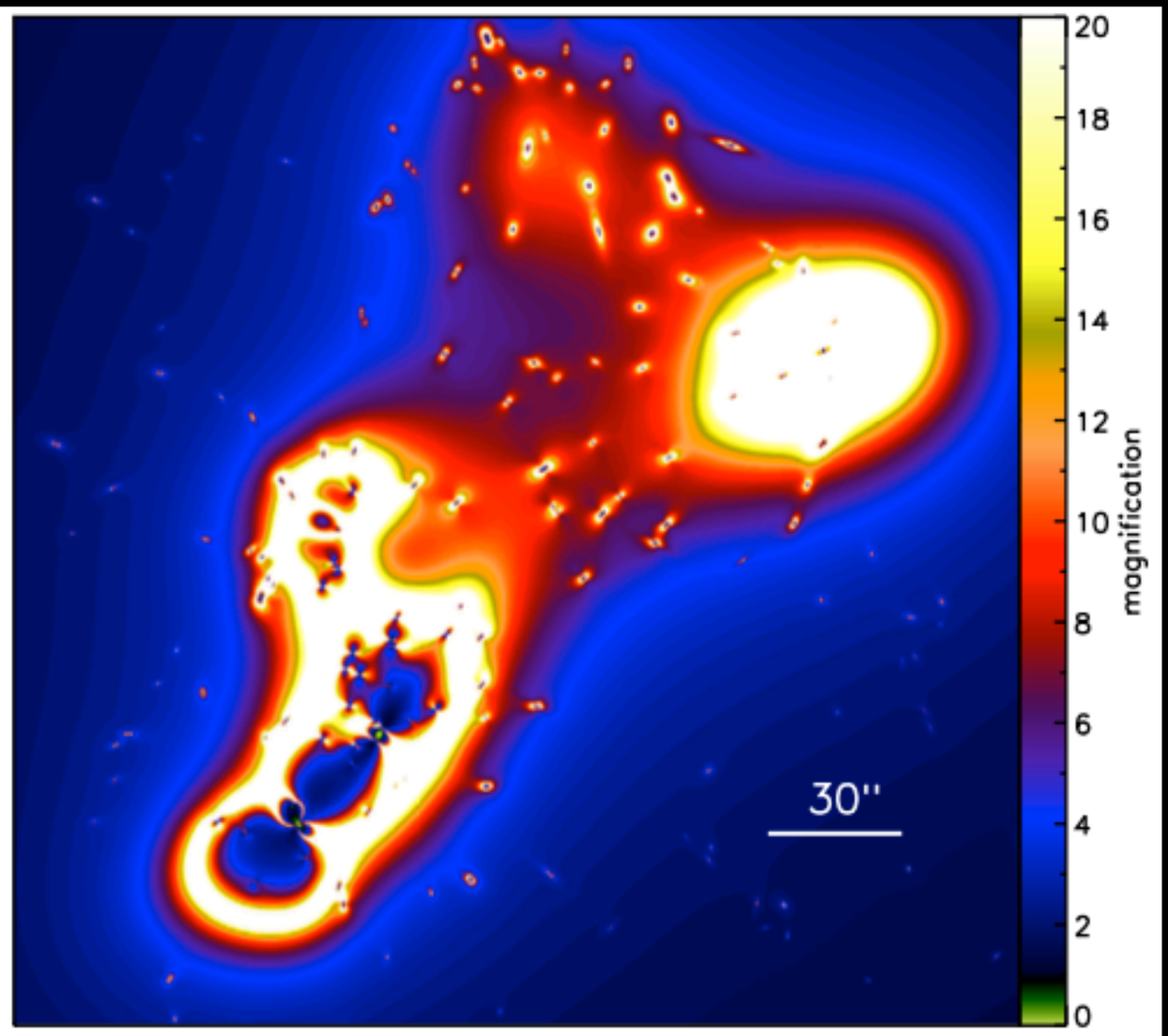
SUPERNOVAE MAGNIFICATION



Johnson et al. 2014

SUPERNOVAE MAGNIFICATION

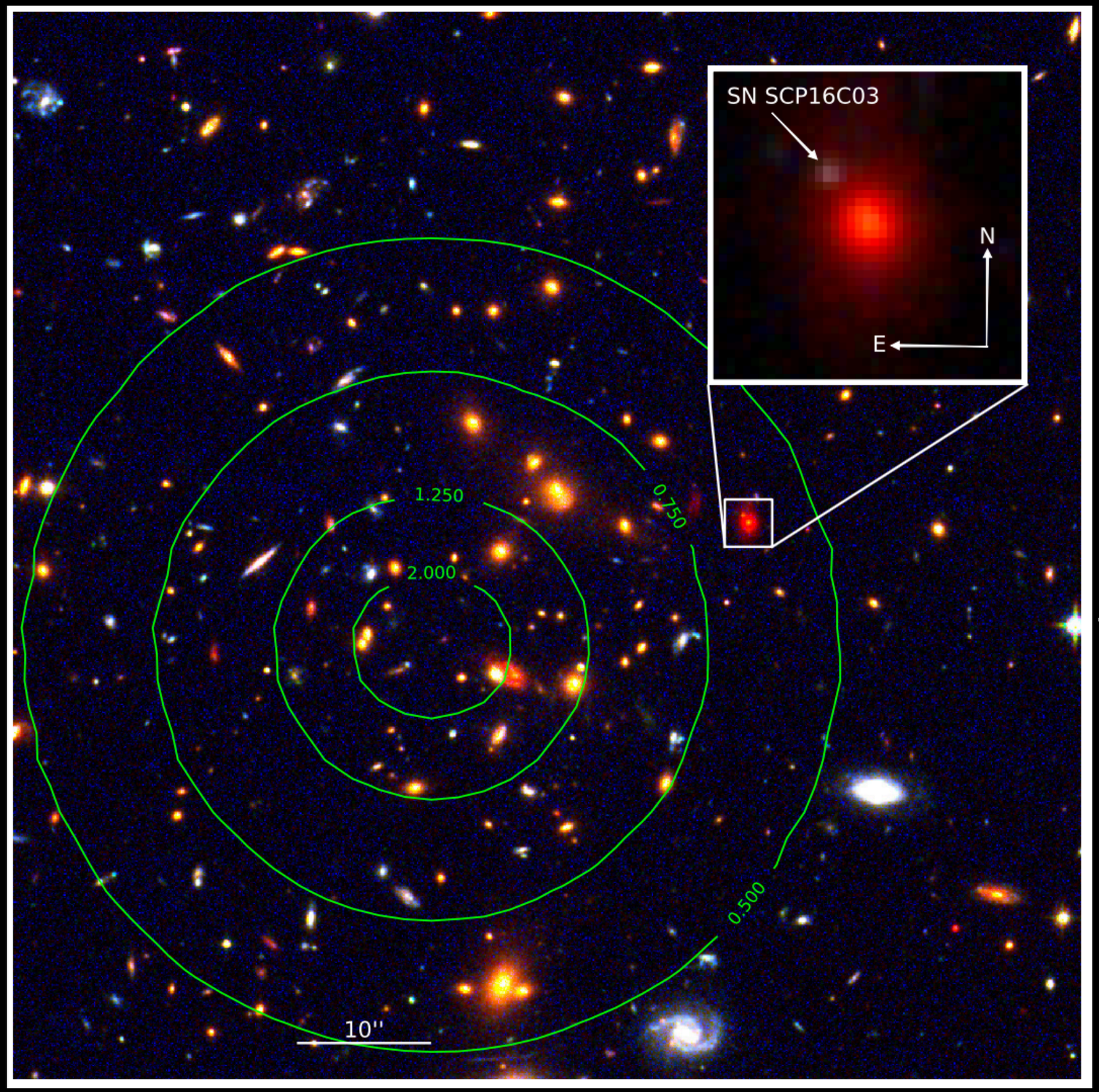




Johnson et al. 2014

Rodney et al. 2015

LENSING AS AN ODD EVENT DETECTOR

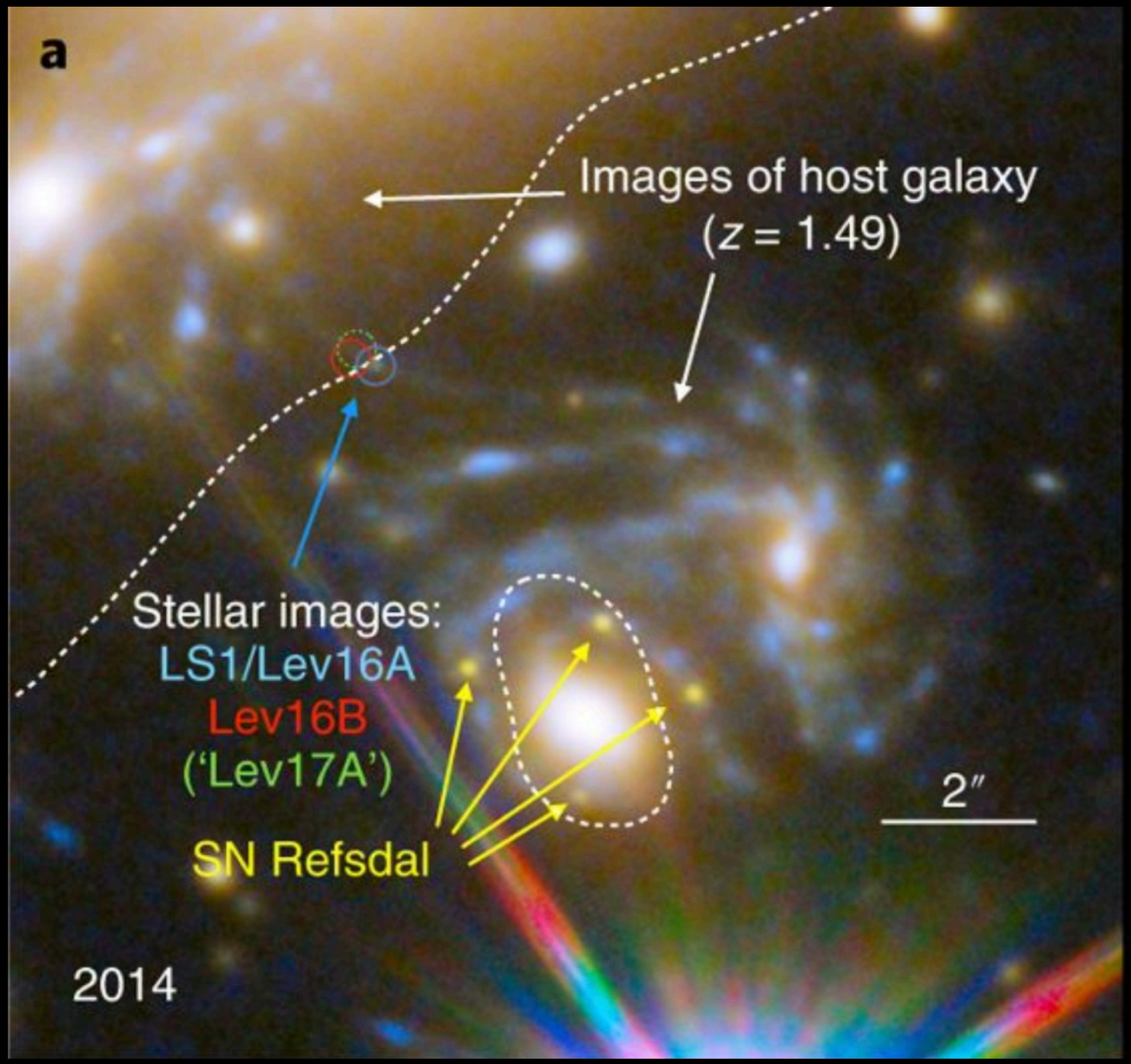


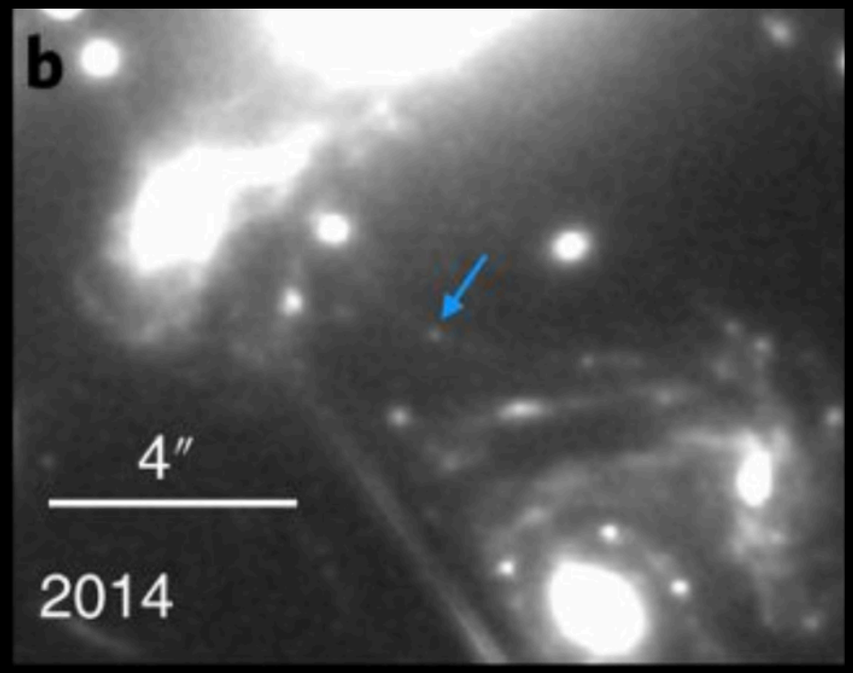
Rubin et al. 2017

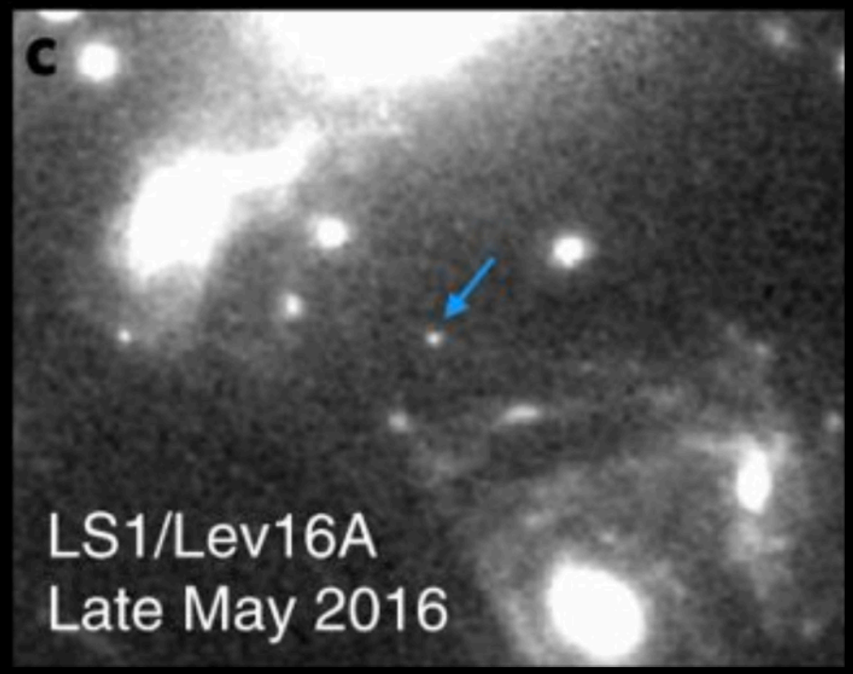
Sn Ia, z = 2.2

Magnified 2.8x by foreground lensing cluster, z = 1.23

LENSING AS AN ODD EVENT DETECTOR

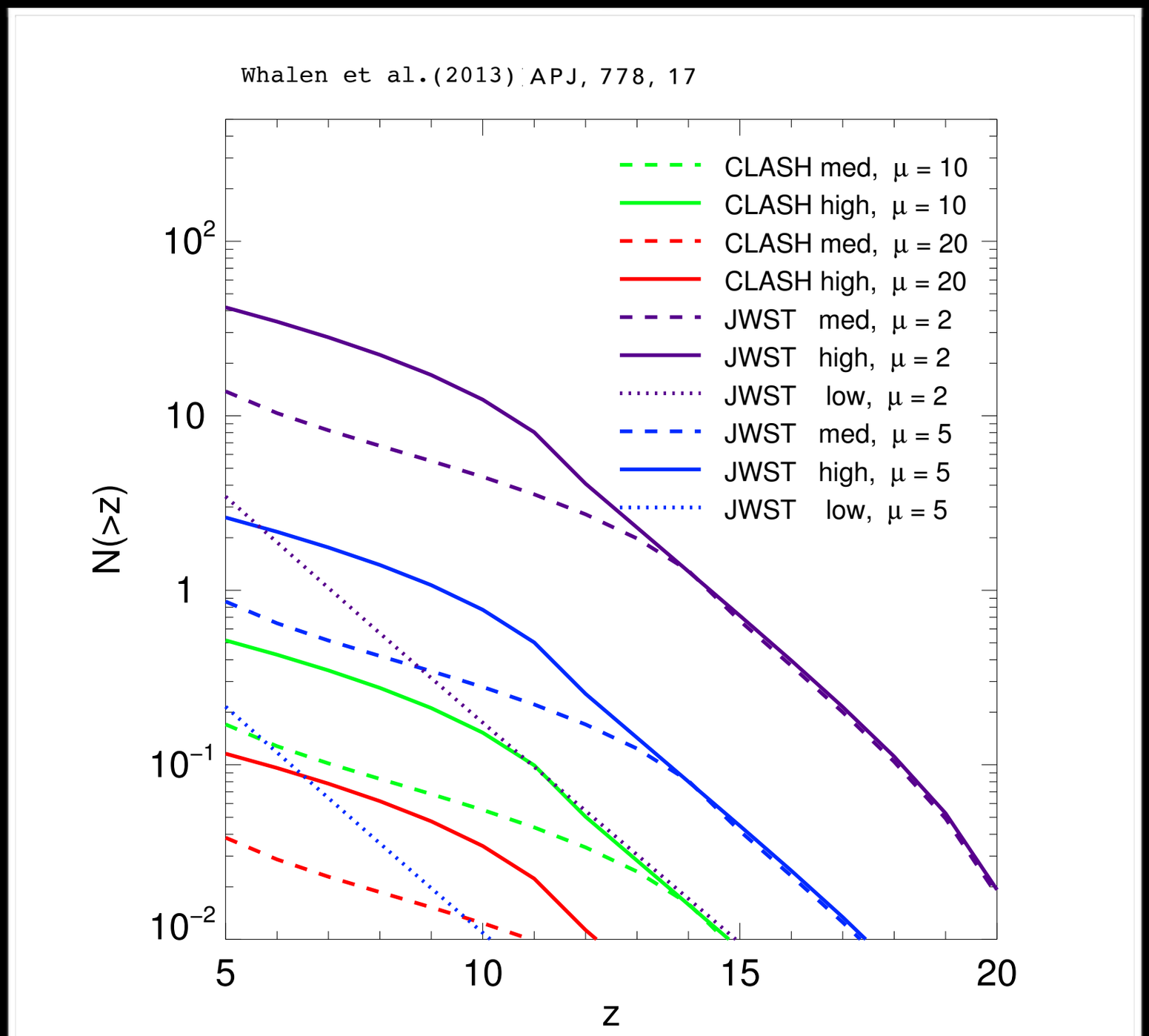






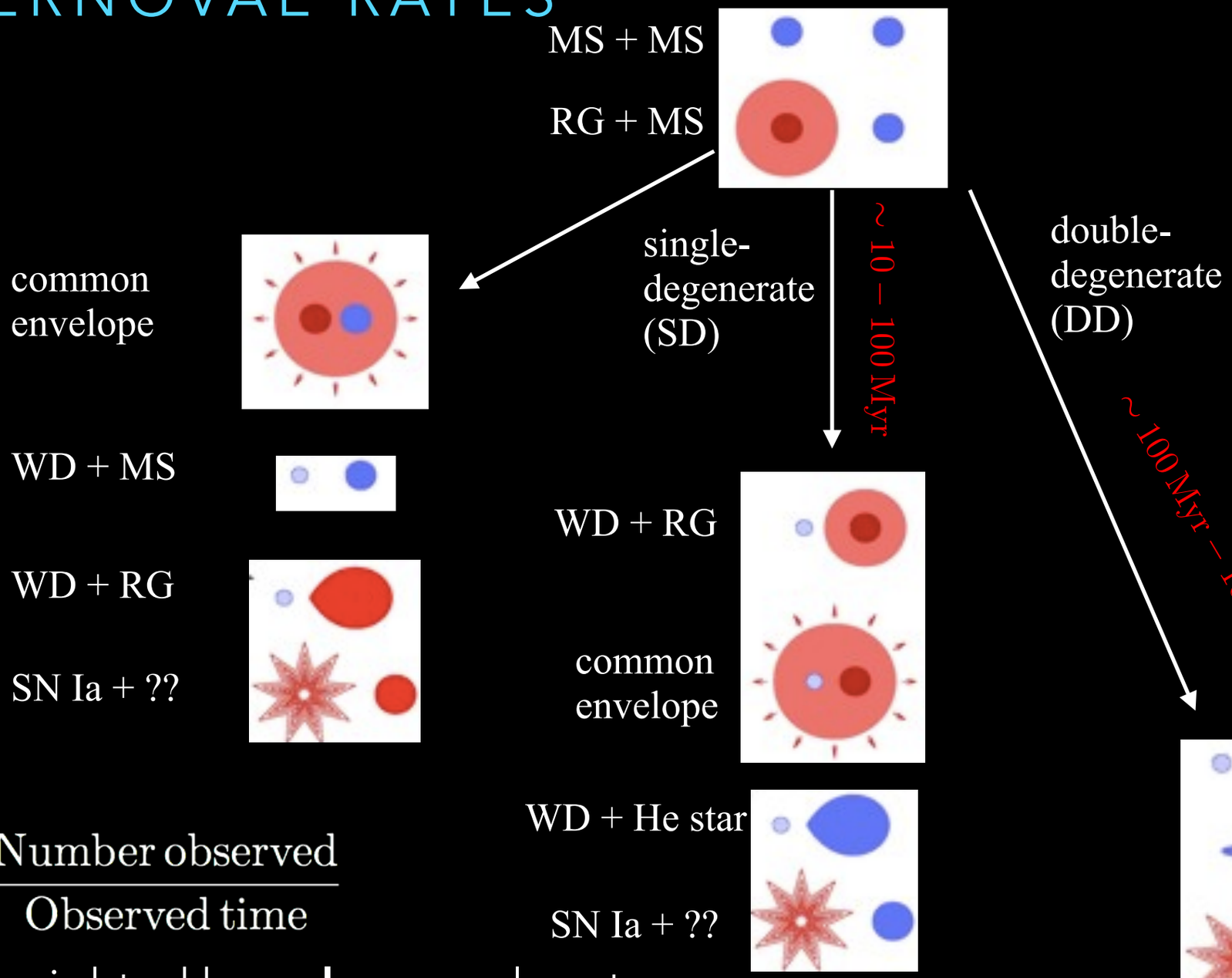
Kelly et al. 2018

LENSING AS AN ODD EVENT DETECTOR



~3 CC SNe at $15 < z < 17$ with JWST!

SUPERNOVAE RATES



$$\text{Rate} = \frac{\text{Number observed}}{\text{Observed time}}$$

Often weighted by **volume**, galaxy type, luminosity, or mass for comparative context.

Stellar birth rate

Delay-time Function

$$R(t) = [\dot{\rho}_\star(t) * \Phi(t)]\, h^2\, k\, \varepsilon$$

Stellar death rate

Mechanism efficiency

Progenitor fraction of IMF

SUPERNOVAE RATES

Stellar birth rate

Delay-time Function

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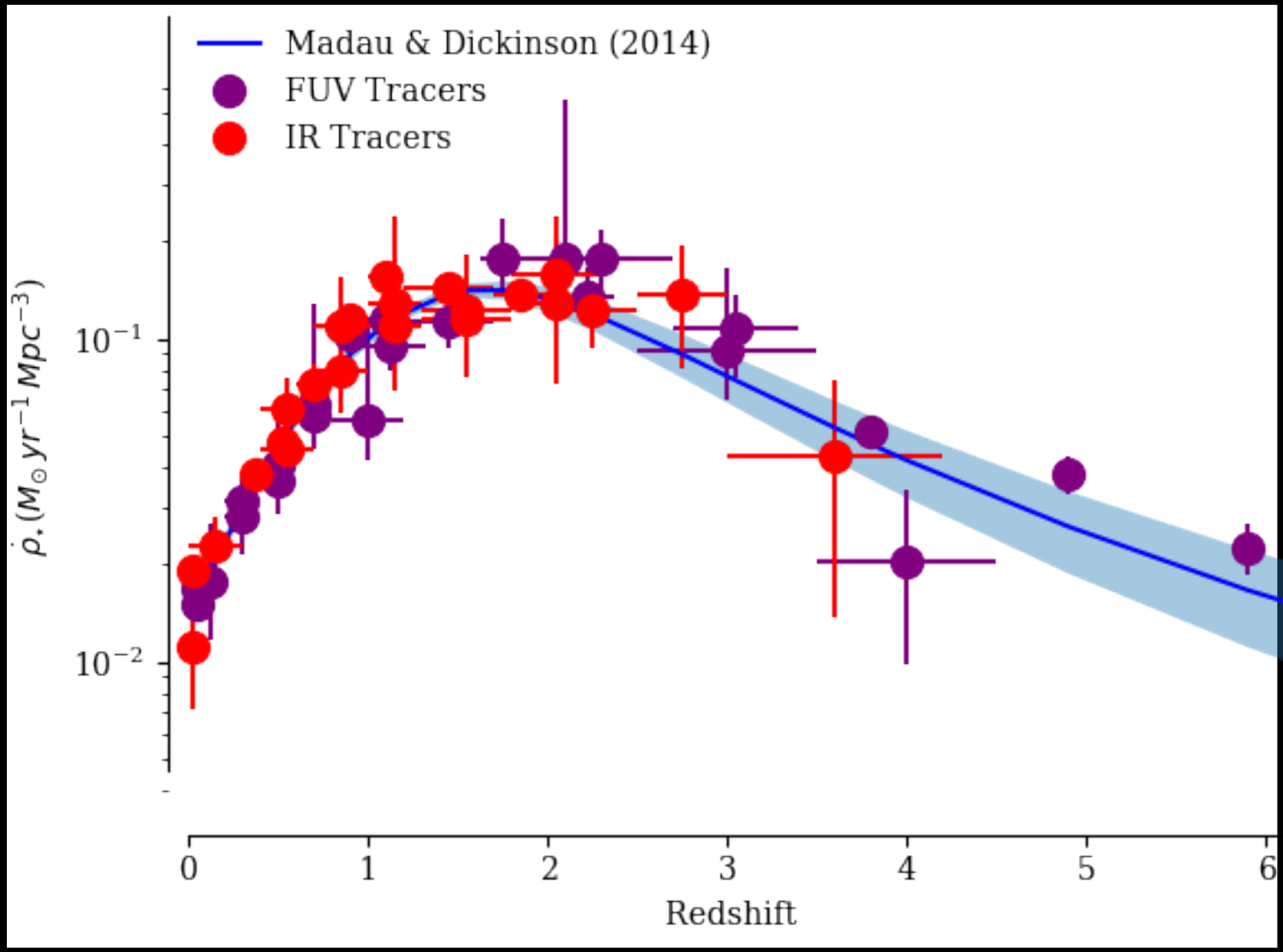
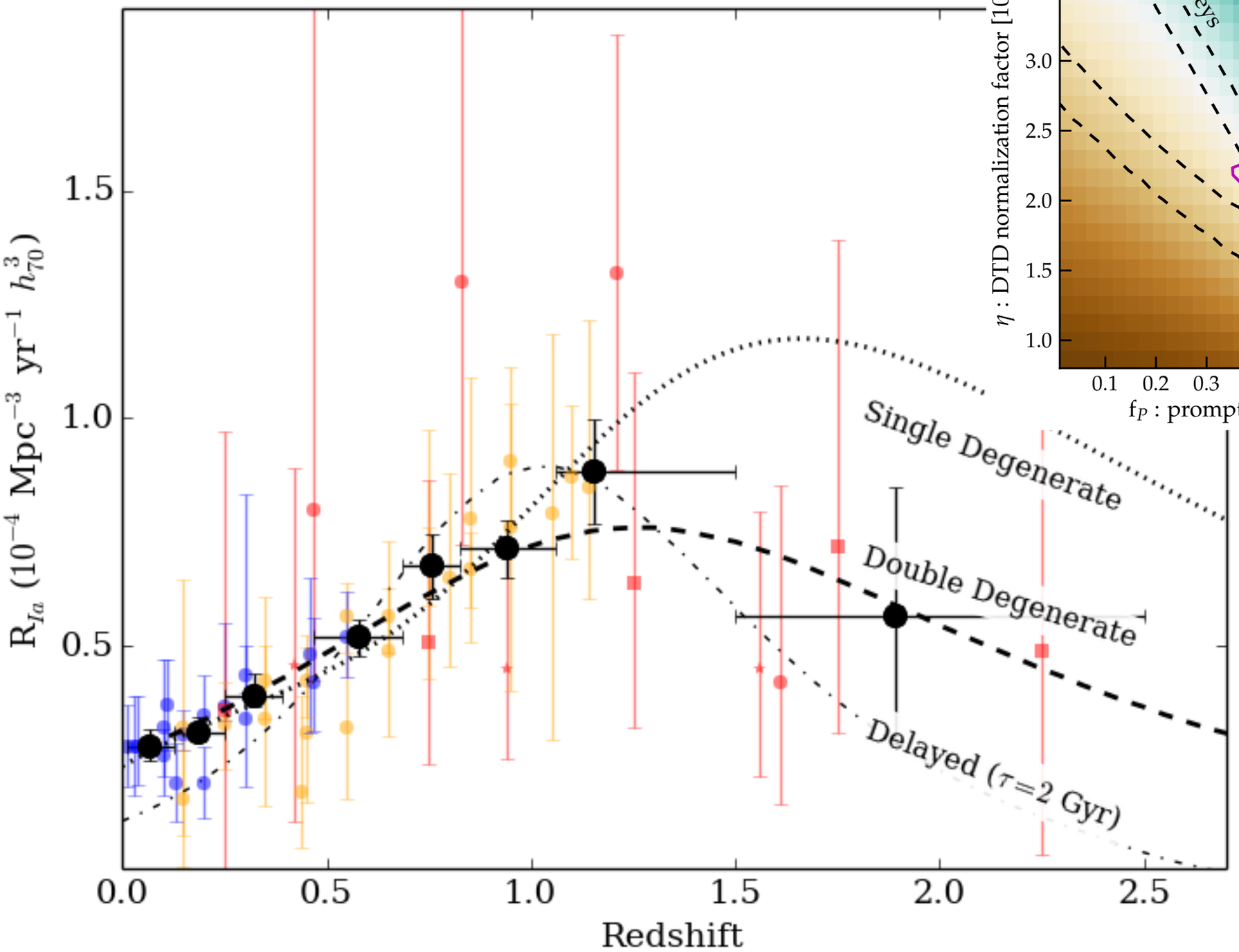
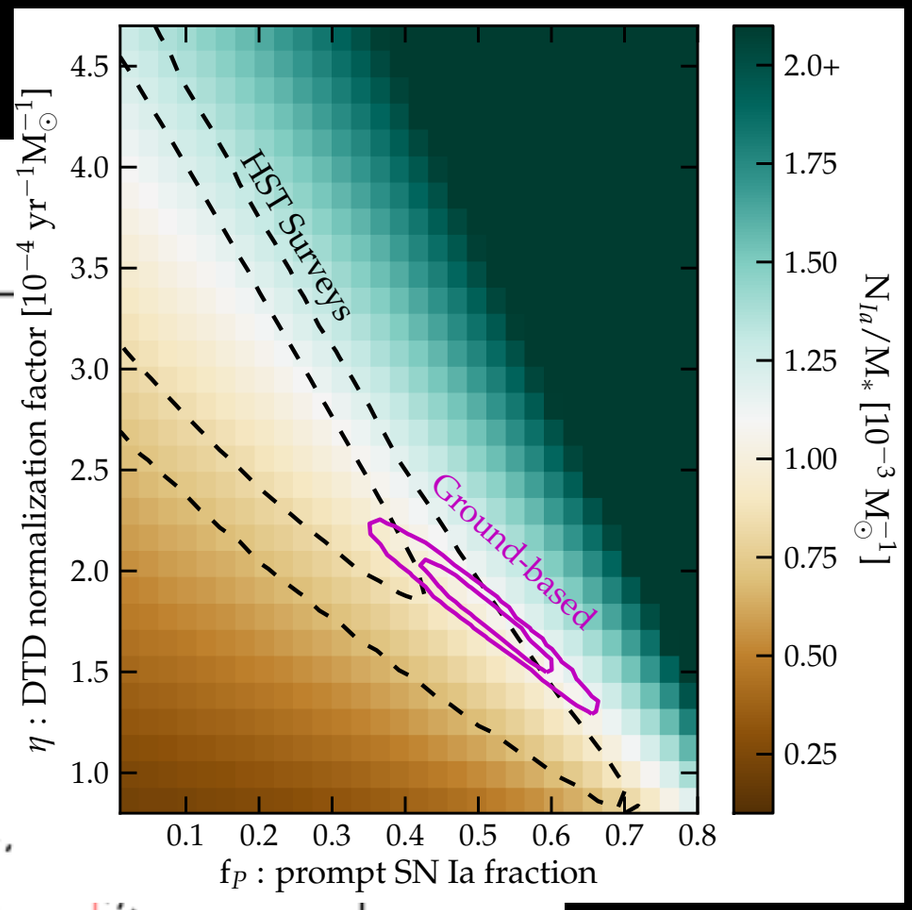


SUPERNOVAE RATES

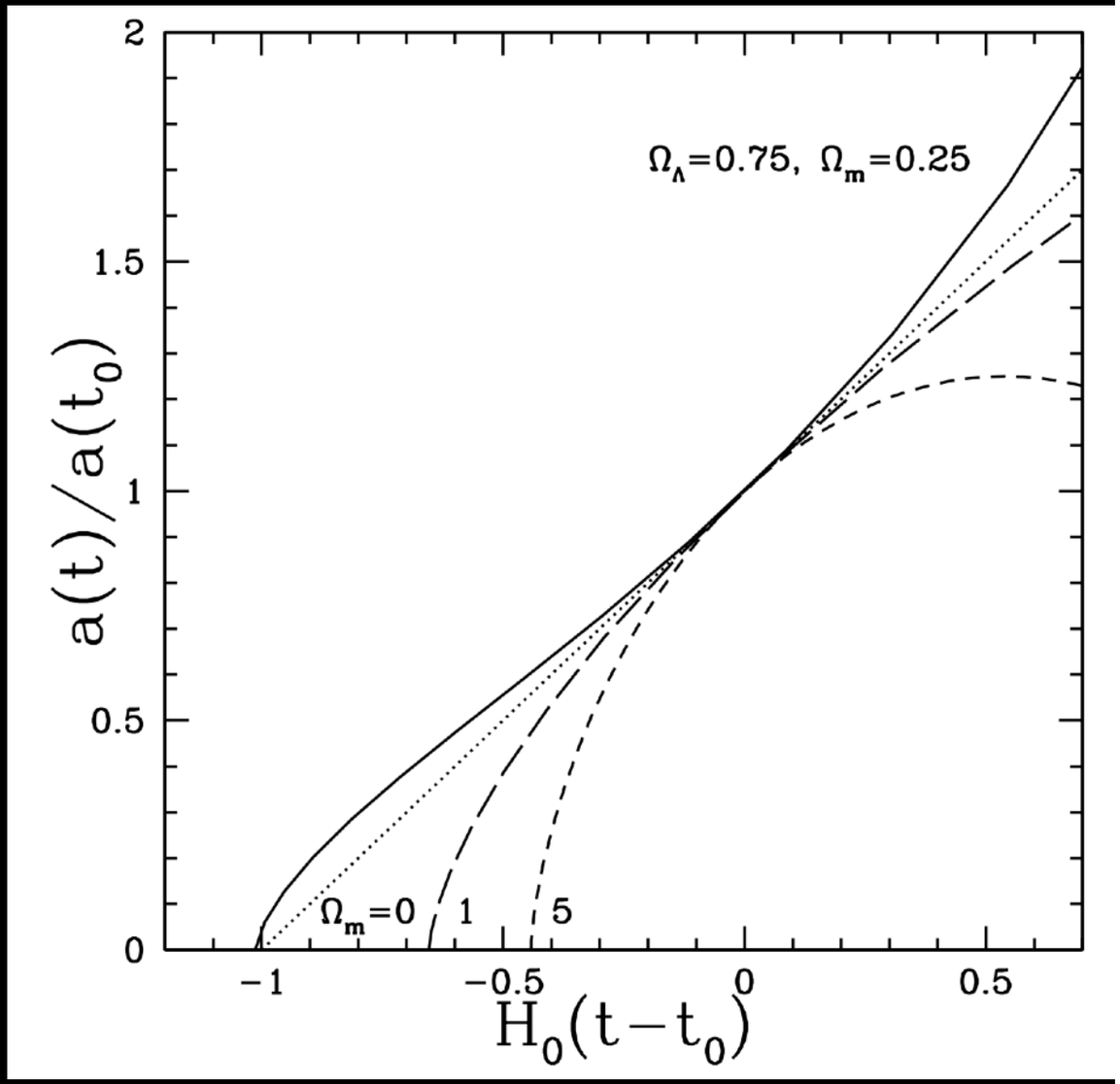
SNLS, IfA, Subaru 2 SDSS, Asiago, NGSS, etc.
GOODS, CANDELS, CLASH



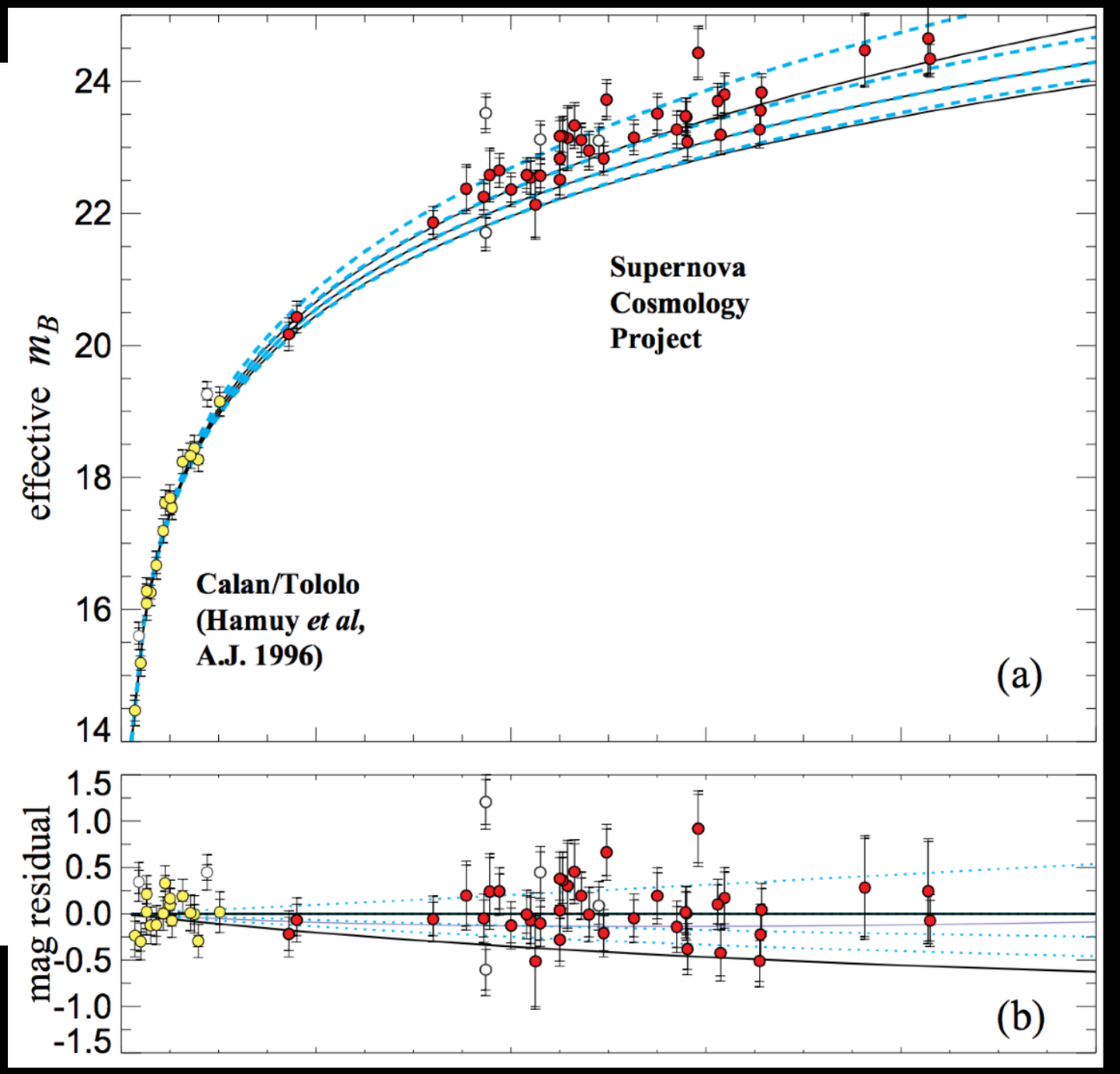


Rodney et al. 2014, AJ, 148, 13
Graur et al. 2014, ApJ, 783, 28

HUBBLE DIAGRAM

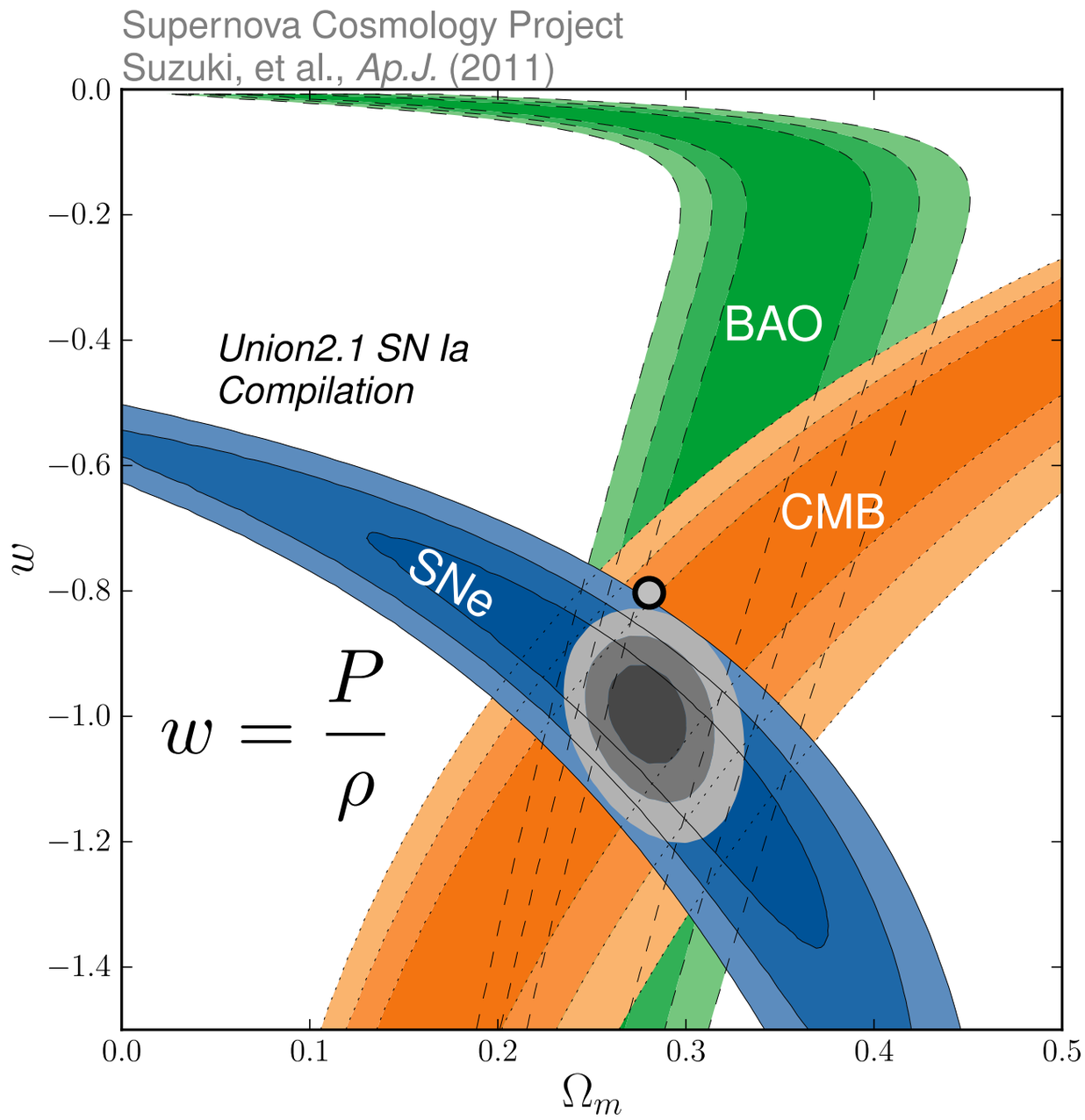


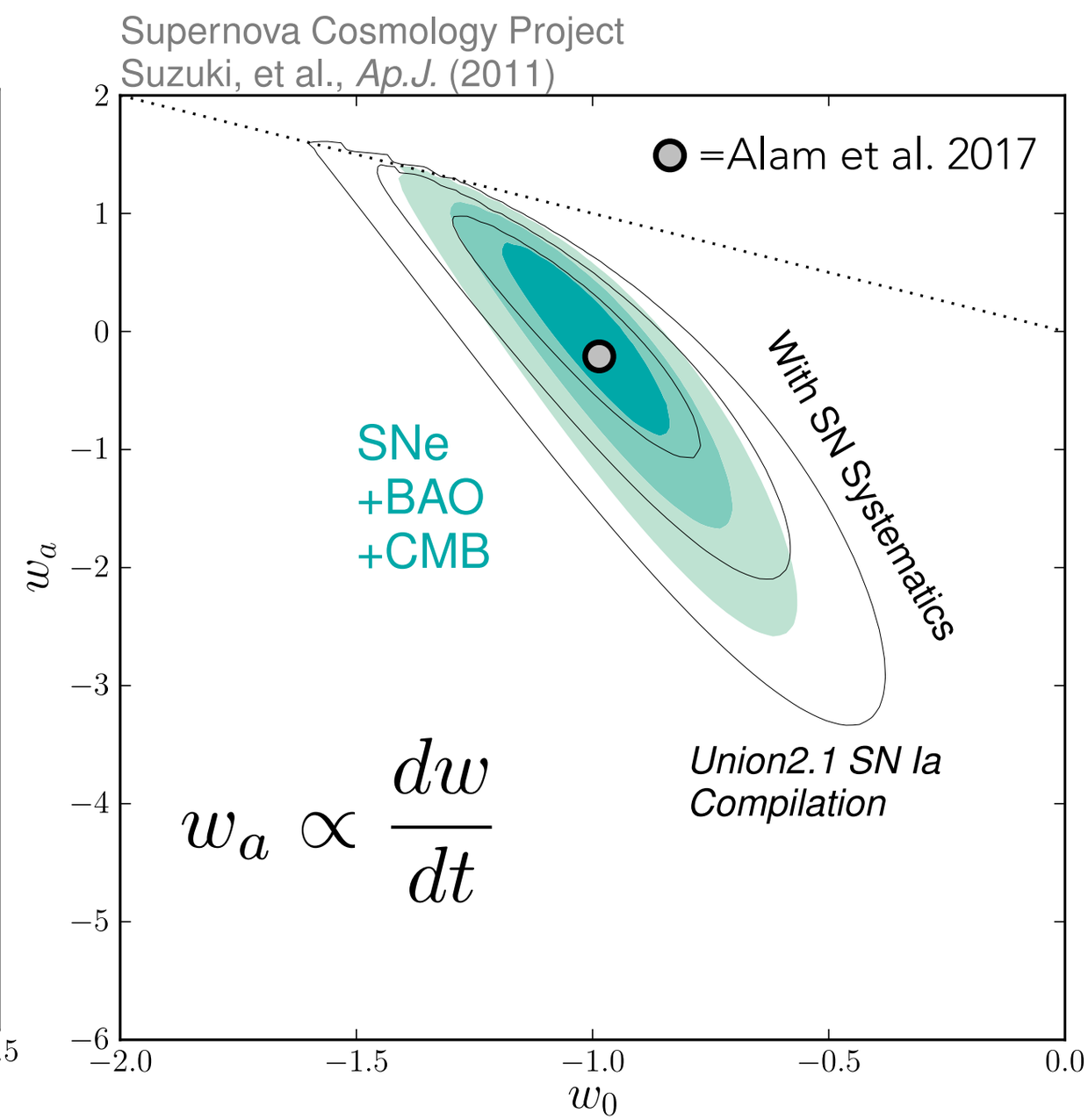
Frieman 2008



Perlmutter et al. 1999

HUBBLE DIAGRAM





CURRENT *RELICS* RESULTS

RELICS: Reionization Lensing Cluster Survey

Table 2. RELICS Supernovae and HST Follow-Up Imaging

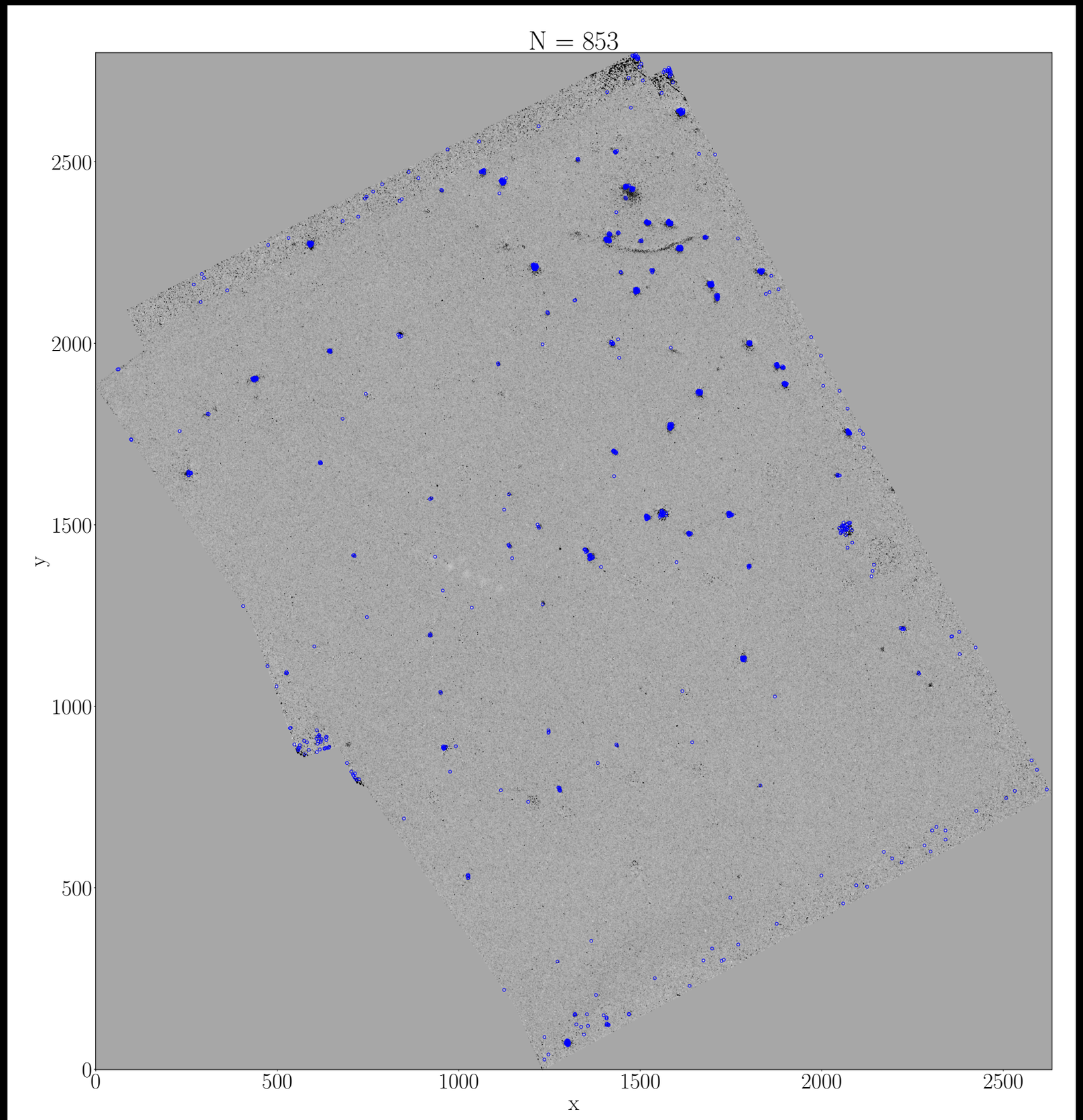
Cluster	Supernova[a]	Abbreviation[b]	R.A. (J2000)	Decl. (J2000)	Notes
rxc0949+17	Eleanor[c]	RLC11Ele	09:49:47.97	+17:07:24.9	cluster member
rxc0949+17	Alexander[c]	RLC11Ale	09:49:48.07	+17:07:24.0	cluster member
rxc0949+17	Antikythera	RLC15Ant	09:49:48.01	+17:07:23.0	cluster member
rxc0142+44	Makapansgat	RLC16Mak	01:43:16.326	+44:33:50.65	parallel field
abell1763	Nebra	RLC16Neb	13:35:15.13	+41:00:15.8	lensed
macs0025-12	Quipu	RLC16Qui	00:25:31.977	–12:23:31.80	cluster member
macs0257-23	Cheomseongdae	RLC16Che	02:57:07.795	–23:27:11.69	lensed or cluster member
plckg171-40	Kukulkan	RLC16Kuk	03:12:59.148	+08:22:43.60	cluster member
clj0152-13	Nimrud	RLC16Nim	01:52:40.352	–13:57:44.81	lensed
rxc0600-20	William	RLC17Wil	06:00:12.227	–20:07:23.91	cluster member
smacs0723-73	Yupana	RLC17Yup	07:23:28.40	–73:27:03.6	lensed or cluster member

CURRENT *BUFFALO* TARGETS

Abell 370

MACS 0717

INITIAL SUPERNOVAE SEARCH

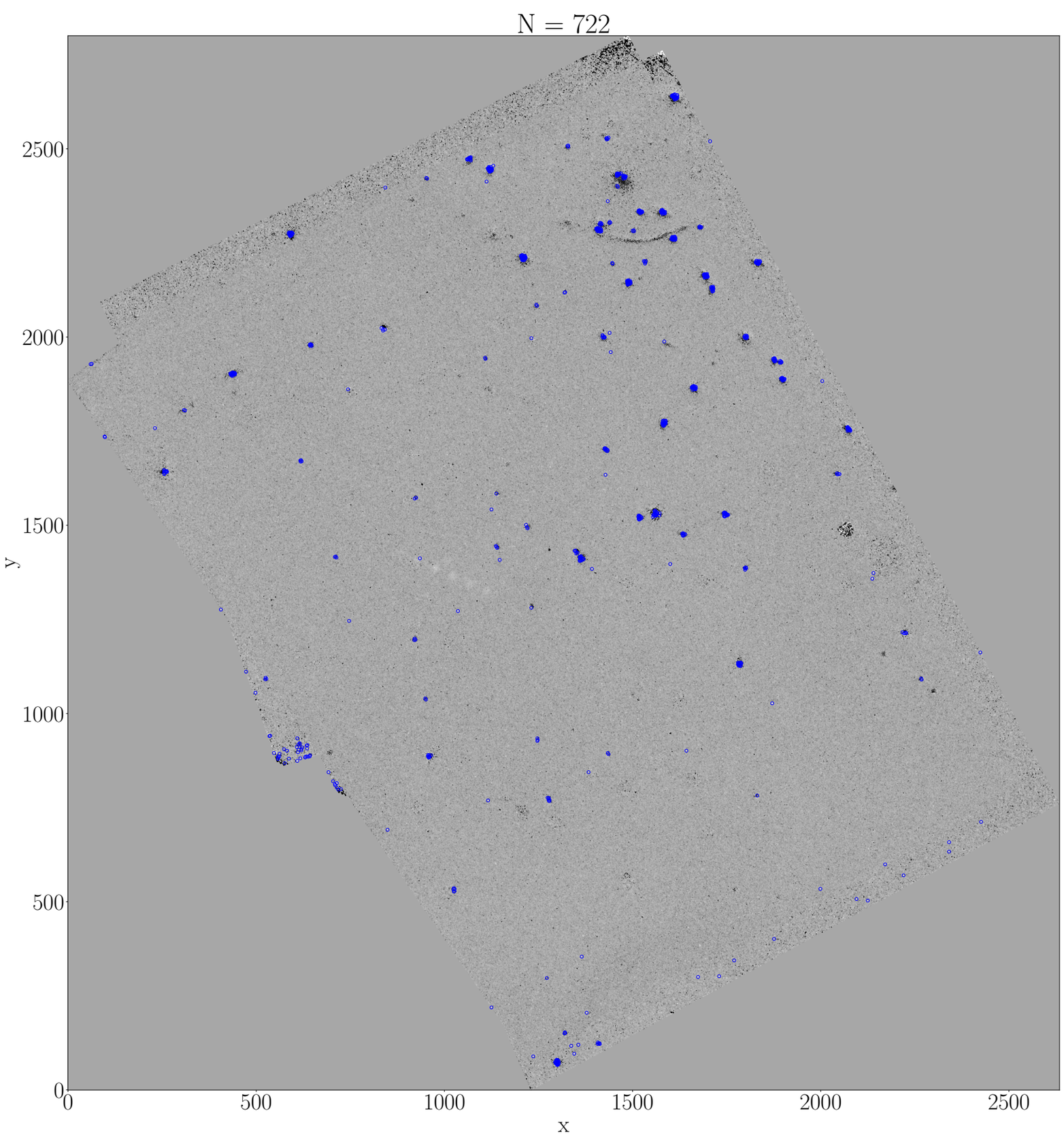


Counts > 0.15/s

Frame weight > 10

No science frame counts > 2.5/s within 10 pixels

INITIAL SUPERNOVAE SEARCH



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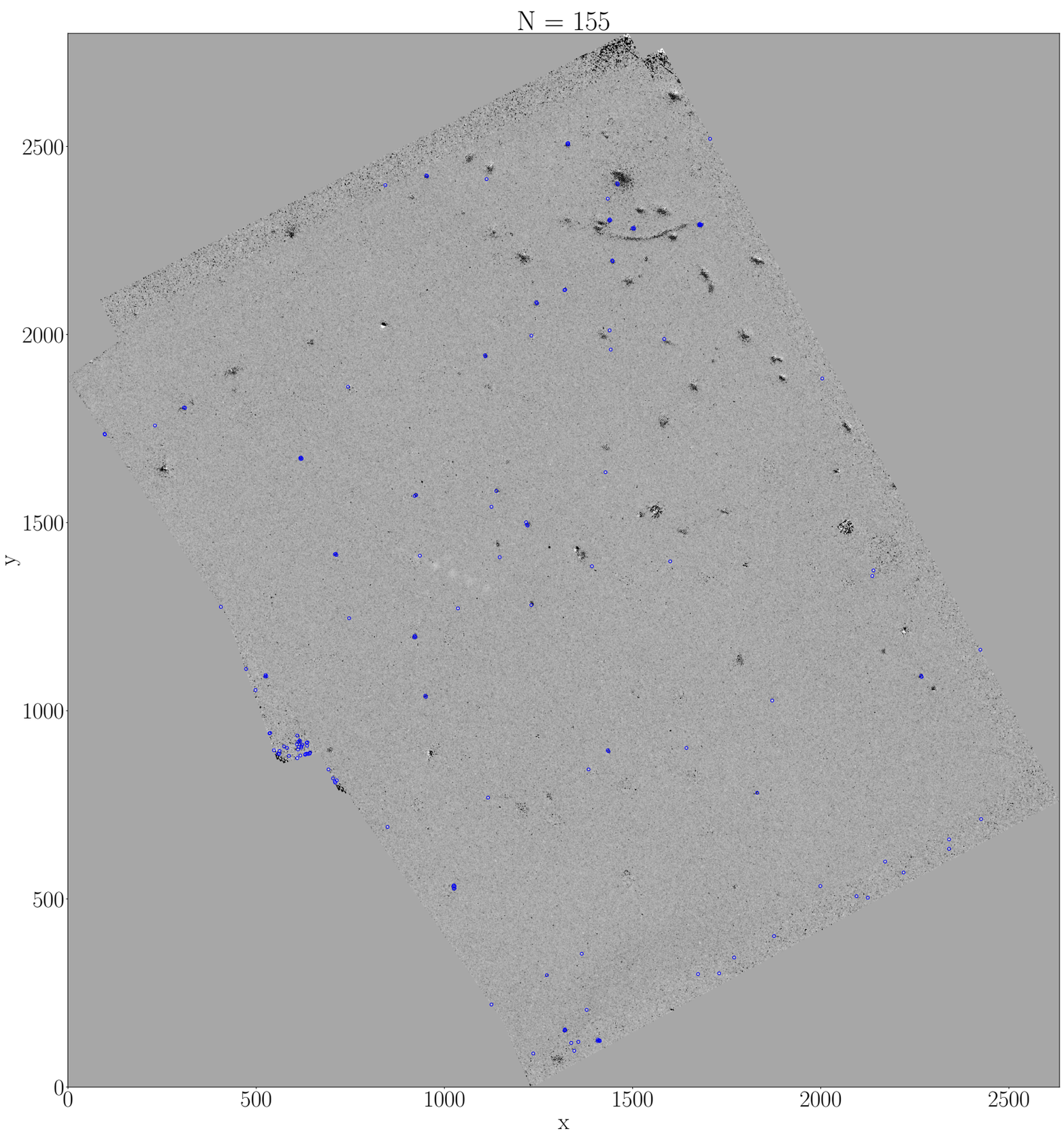

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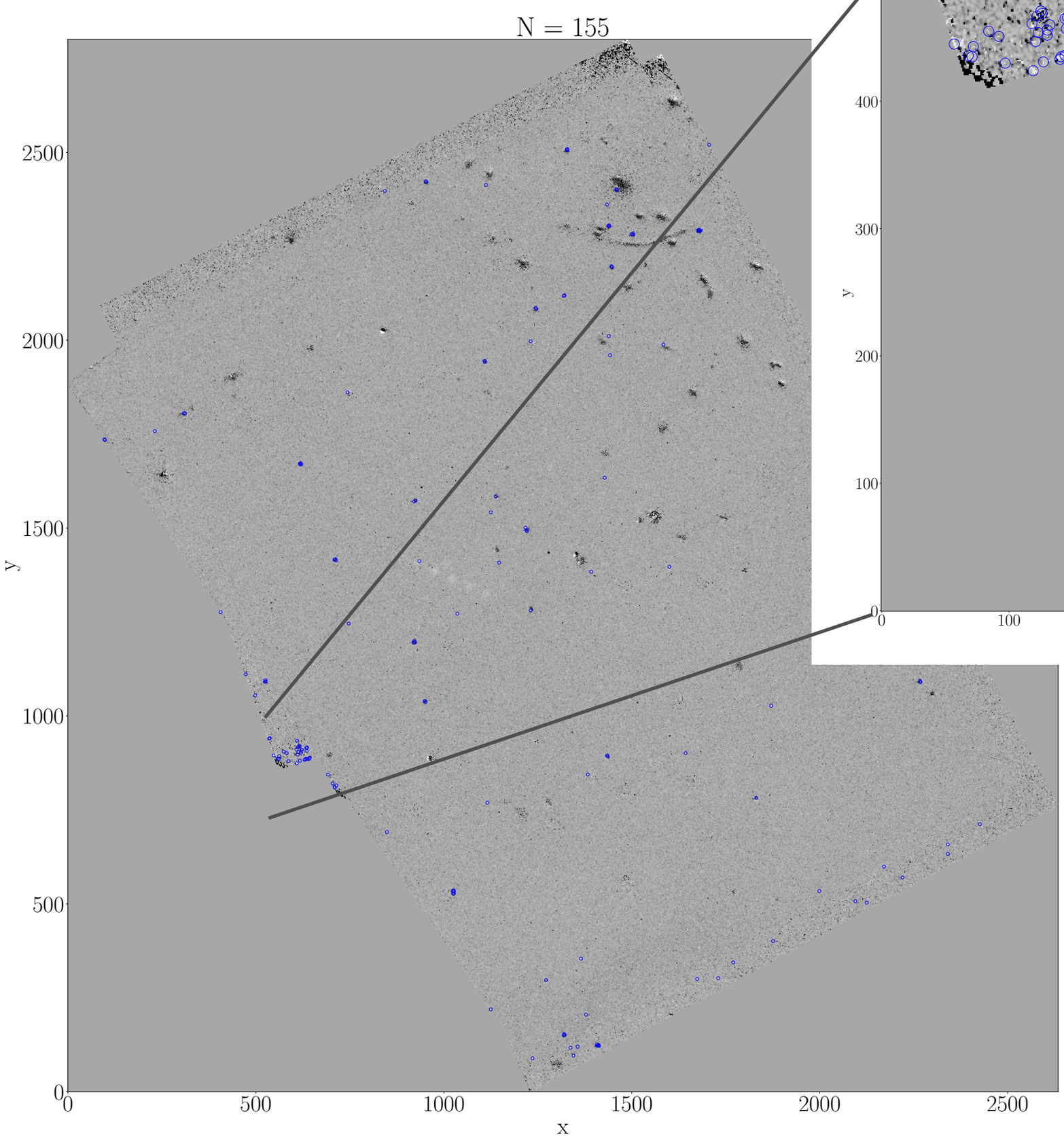
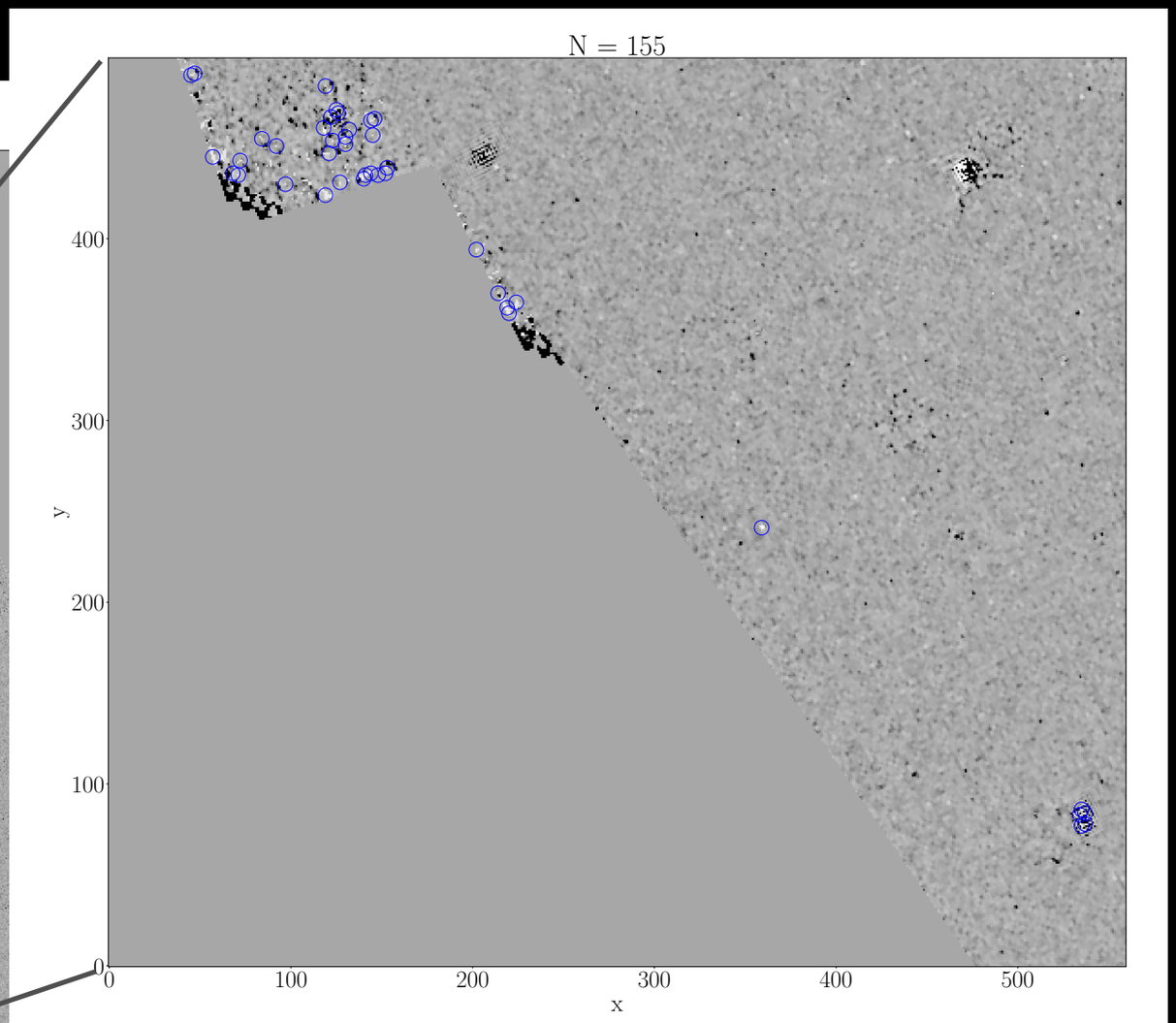




Counts > 0.15/s

Frame weight > 10

No science frame counts > 2.5/s within 10 pixels

2x F160W/F814W science frames or
>1 drizzle level frame across all filters with:

$$\text{Counts} > \sigma_{\text{counts}}$$

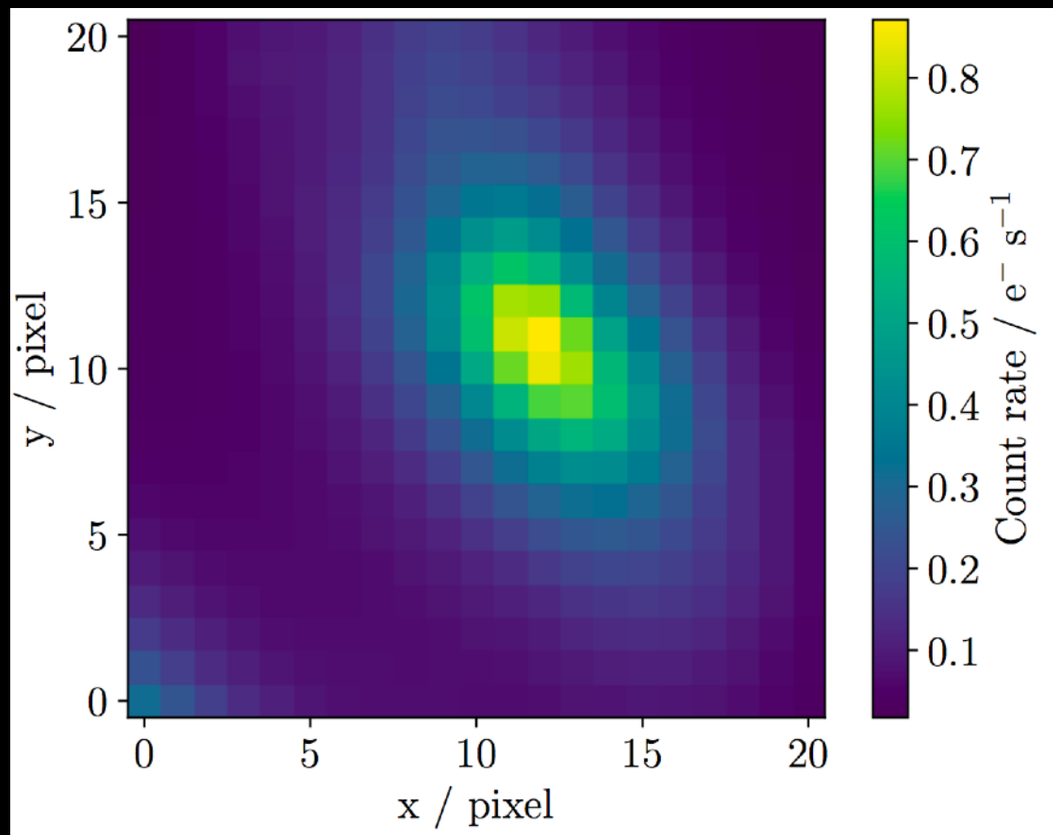
$$\frac{1}{4} < \frac{\text{PeakCount}}{\text{TotalCount}} < \frac{3}{4}$$

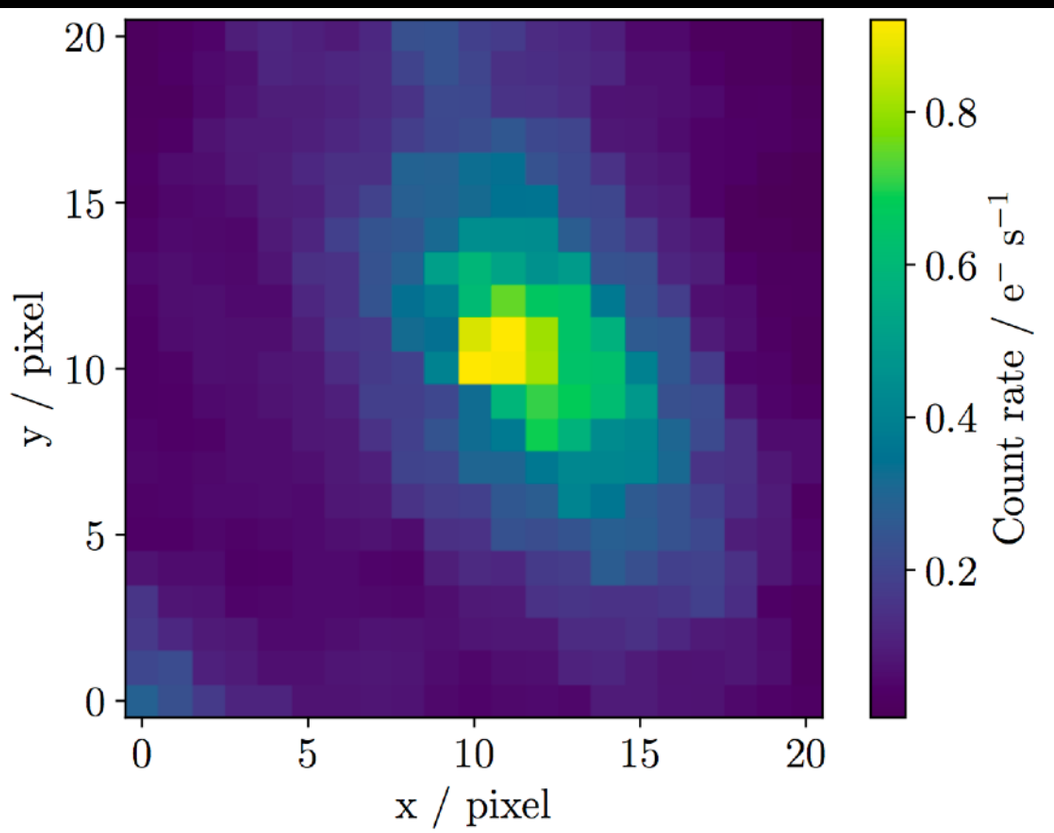
$$|\text{Exp1Count} - \text{Exp2Count}| < 2\sigma_{\text{Exp1Count}}$$
(Red filter only)

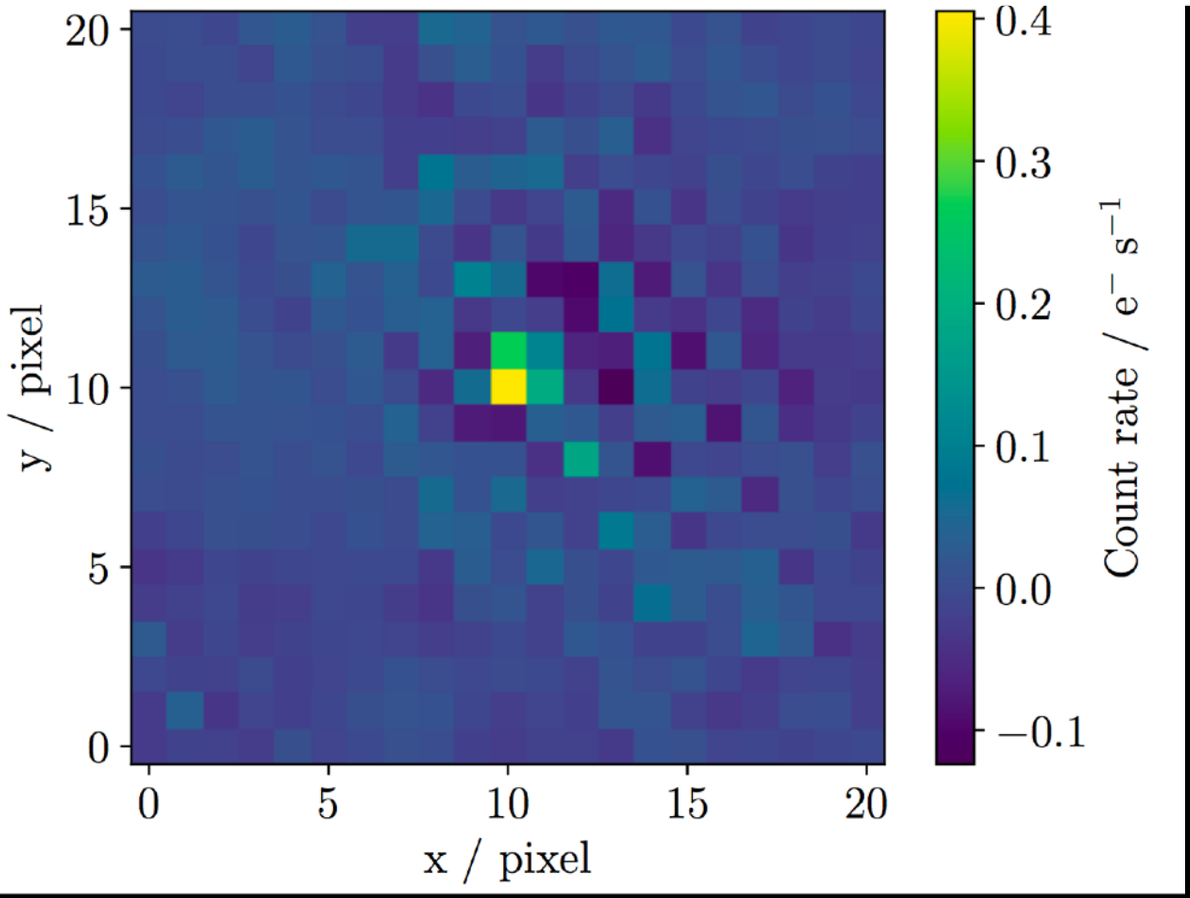
36 Candidates in Abell 370, 60 in MACS 0717

VISUAL INSPECTION OF SUPERNOVAE

Abell 370

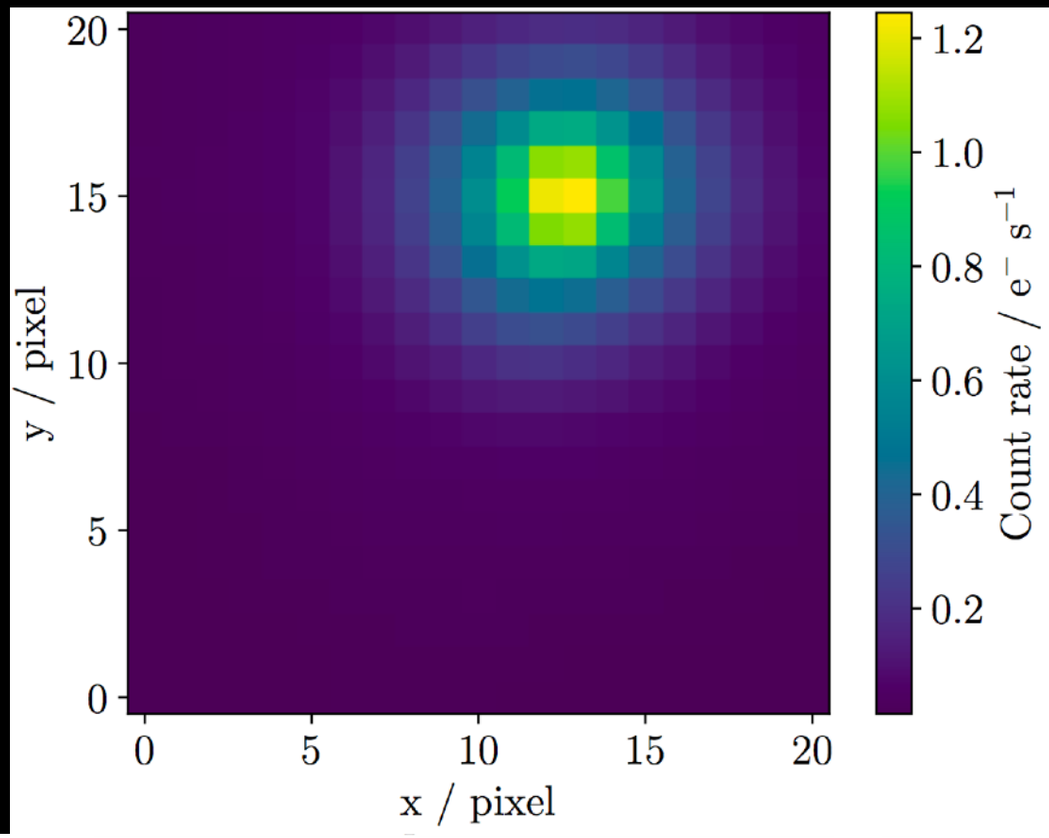


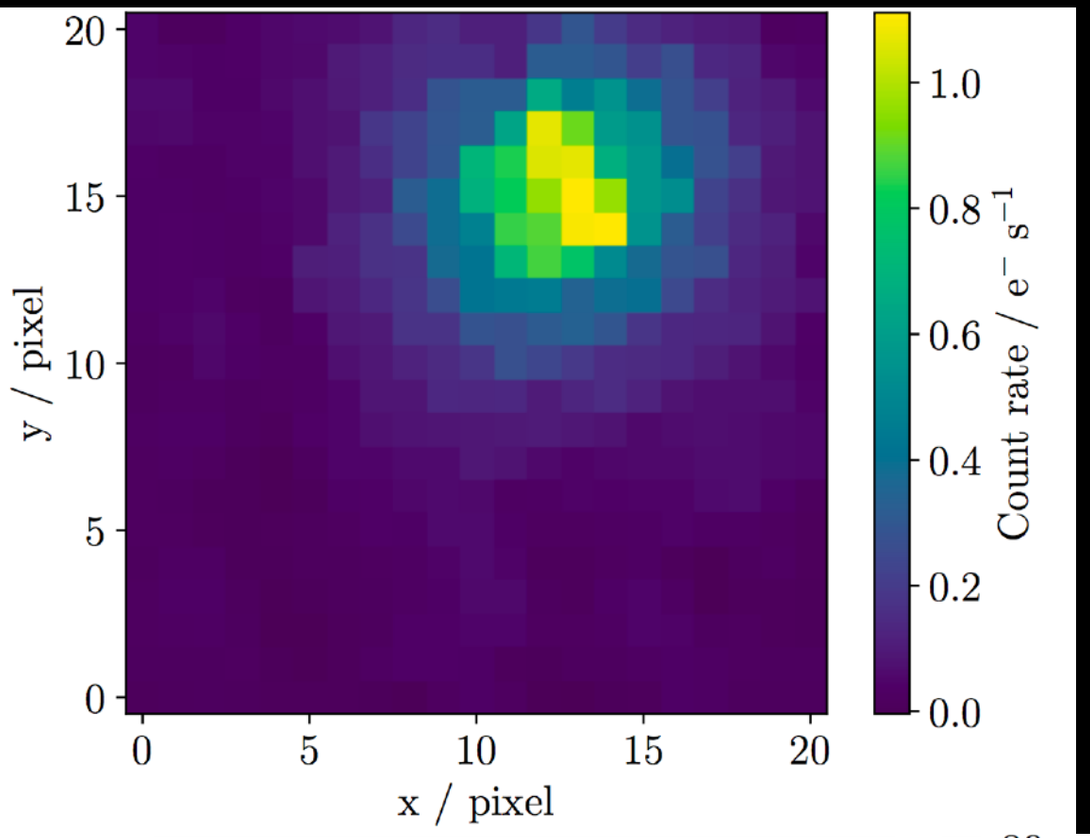


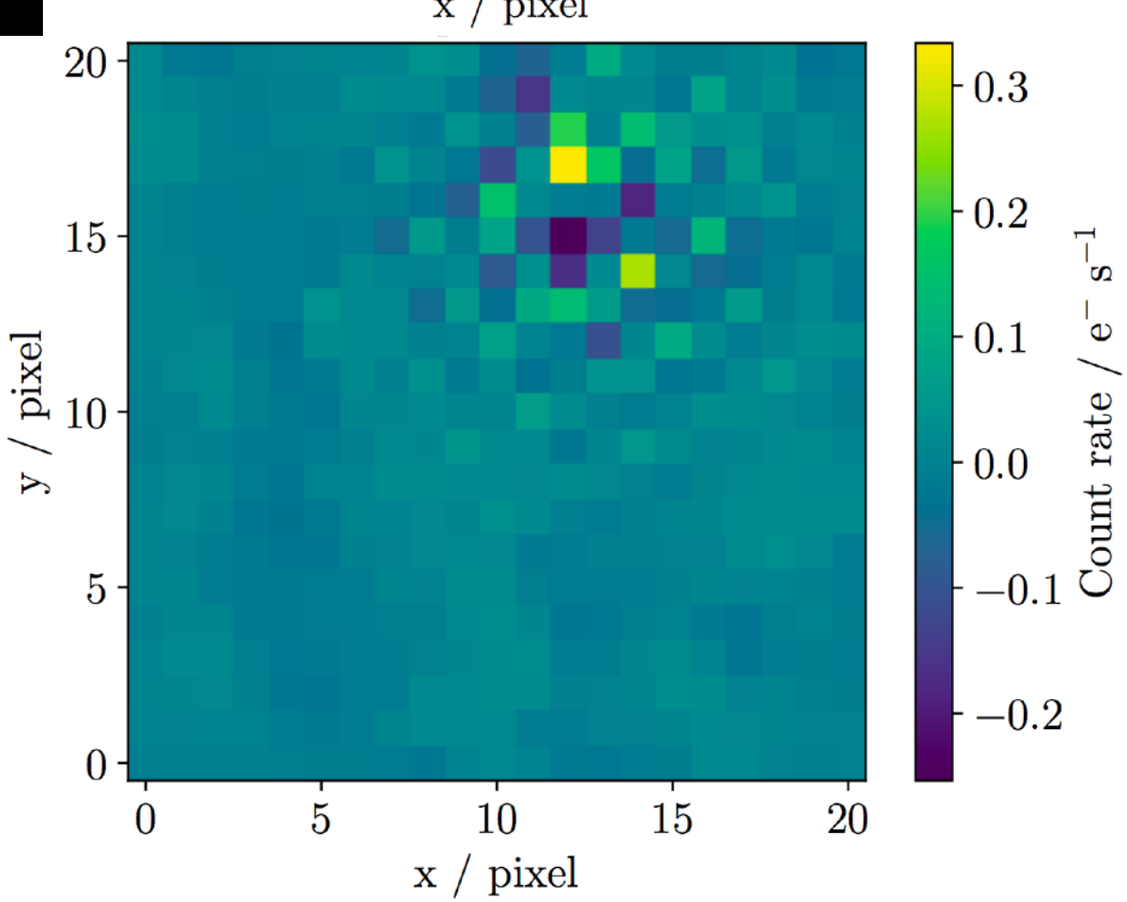


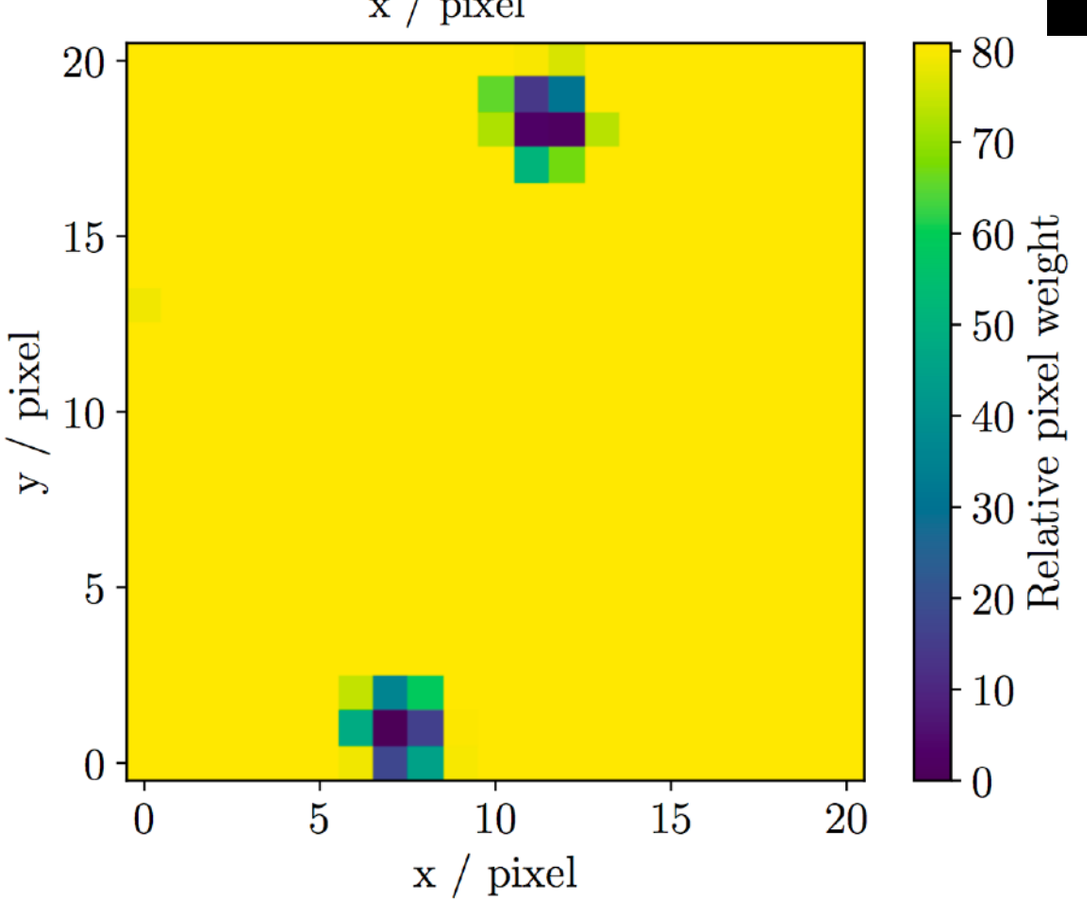
VISUAL INSPECTION OF SUPERNOVAE

Abell 370



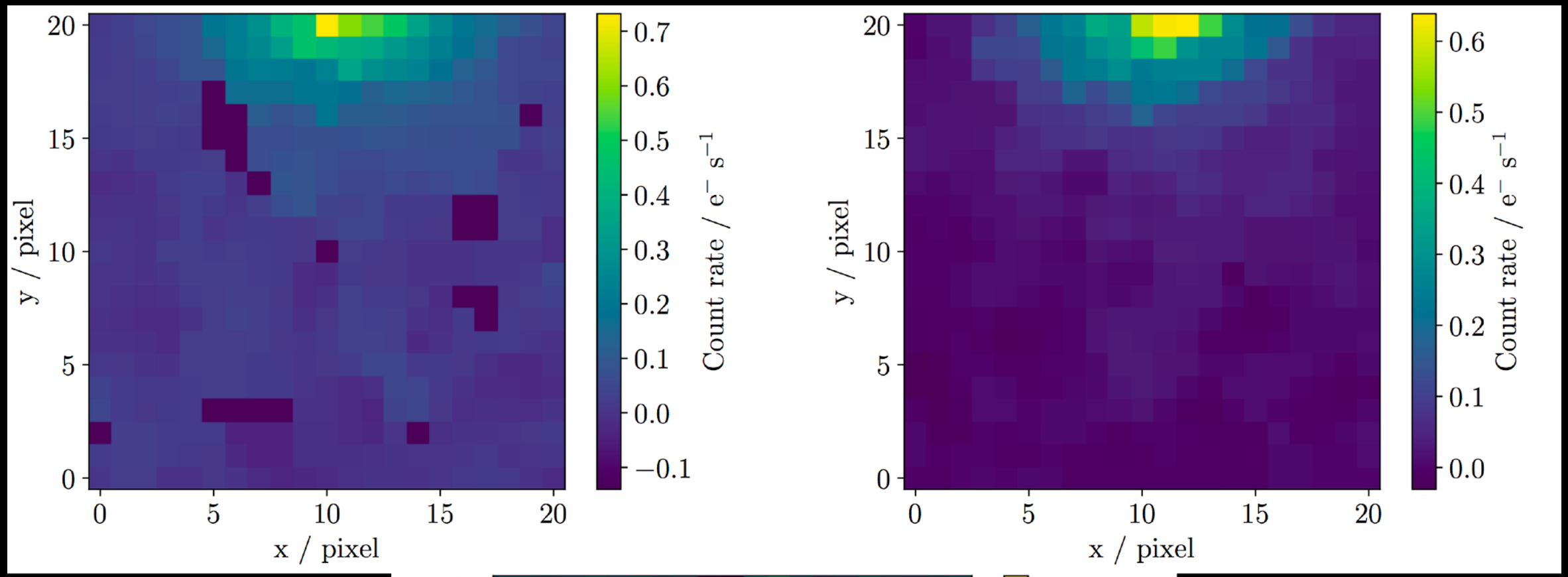


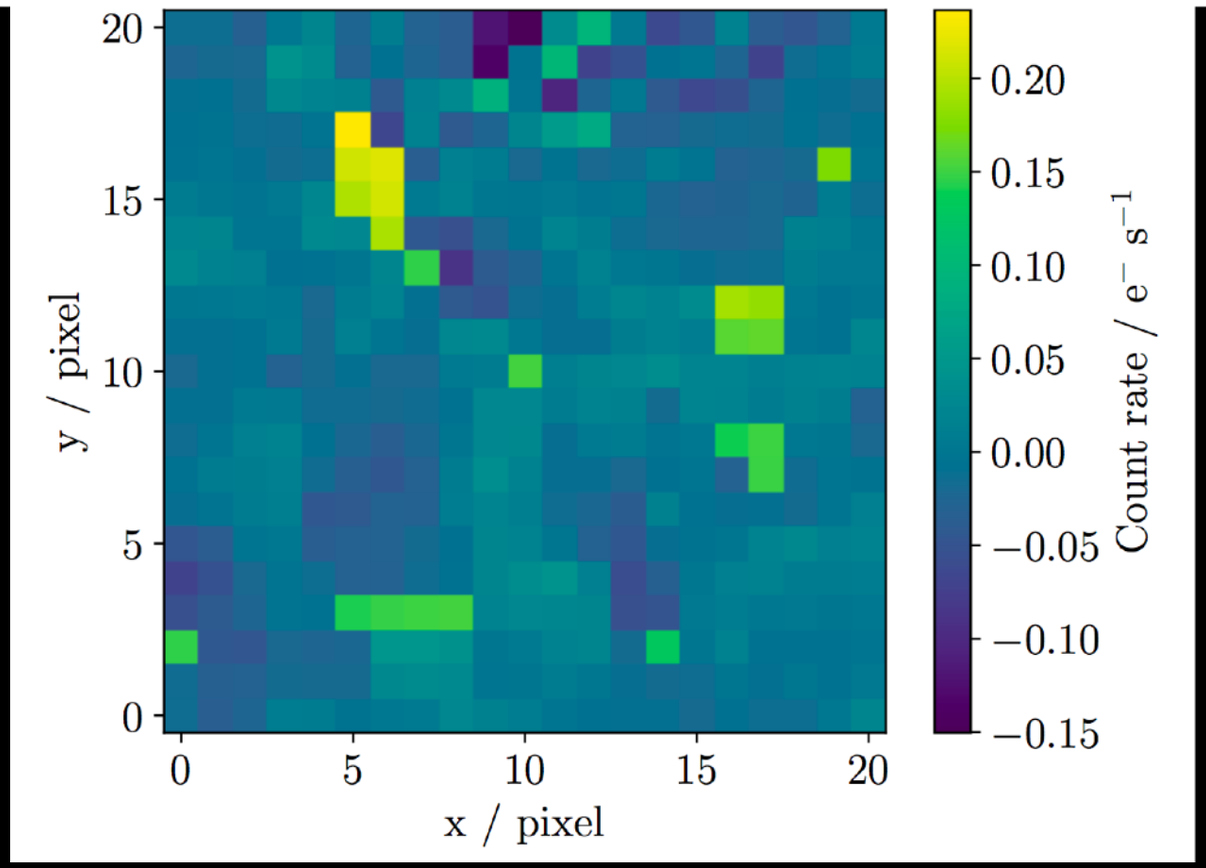




VISUAL INSPECTION OF SUPERNOVAE

MACS 0717





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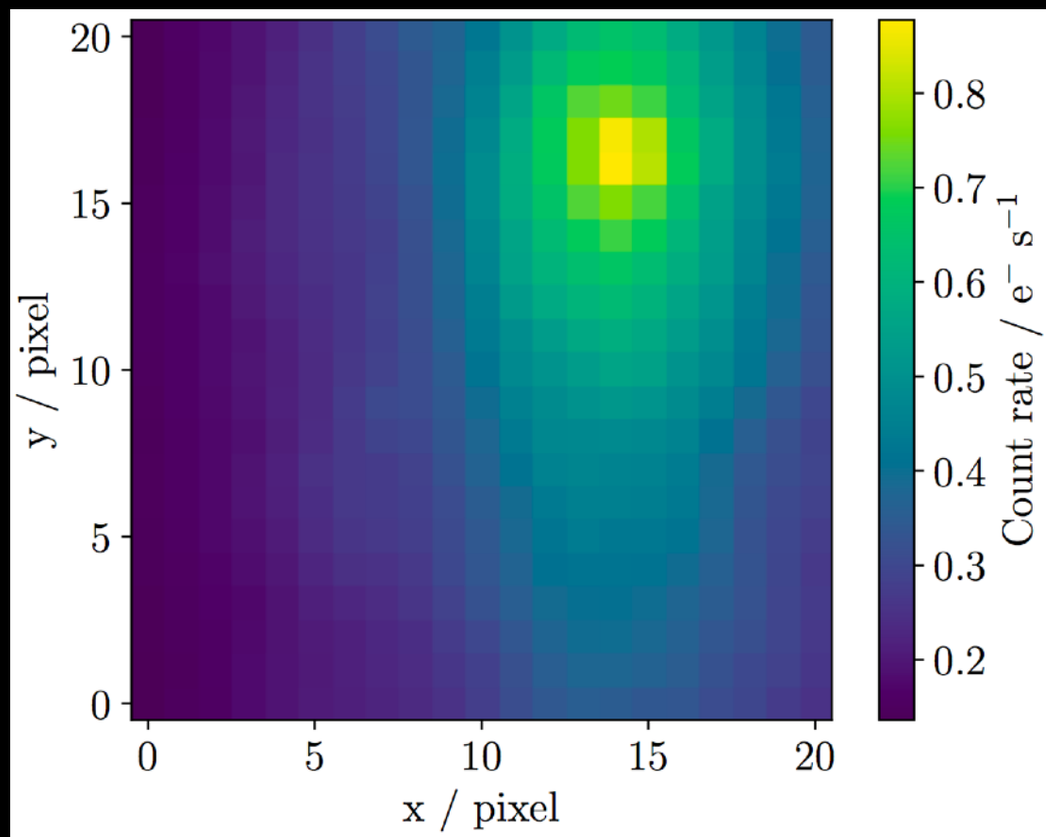

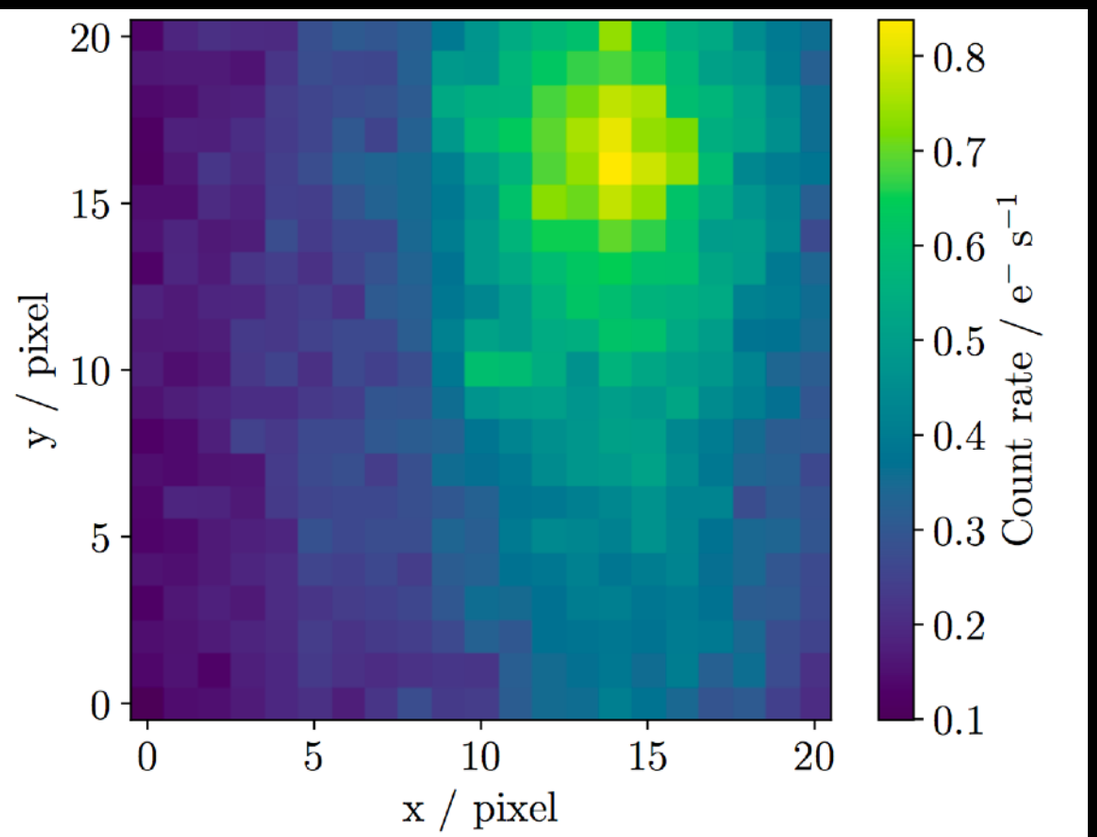

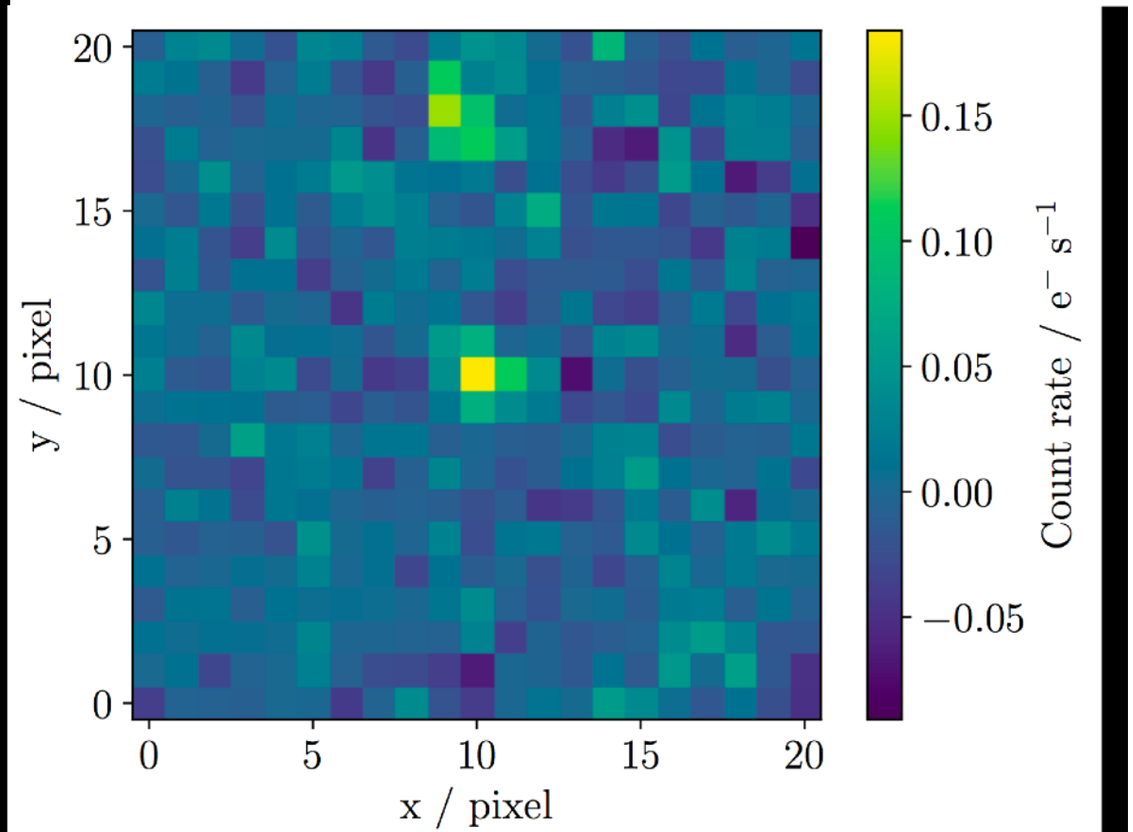

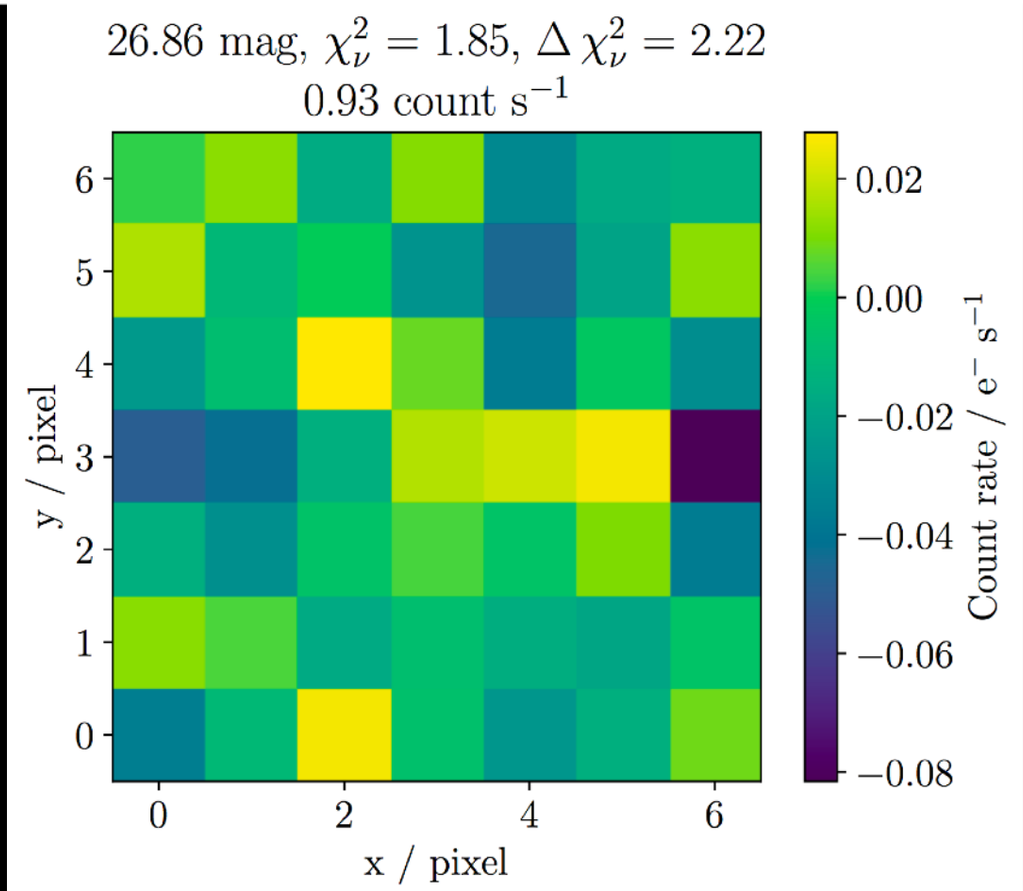

VISUAL INSPECTION OF SUPERNOVAE

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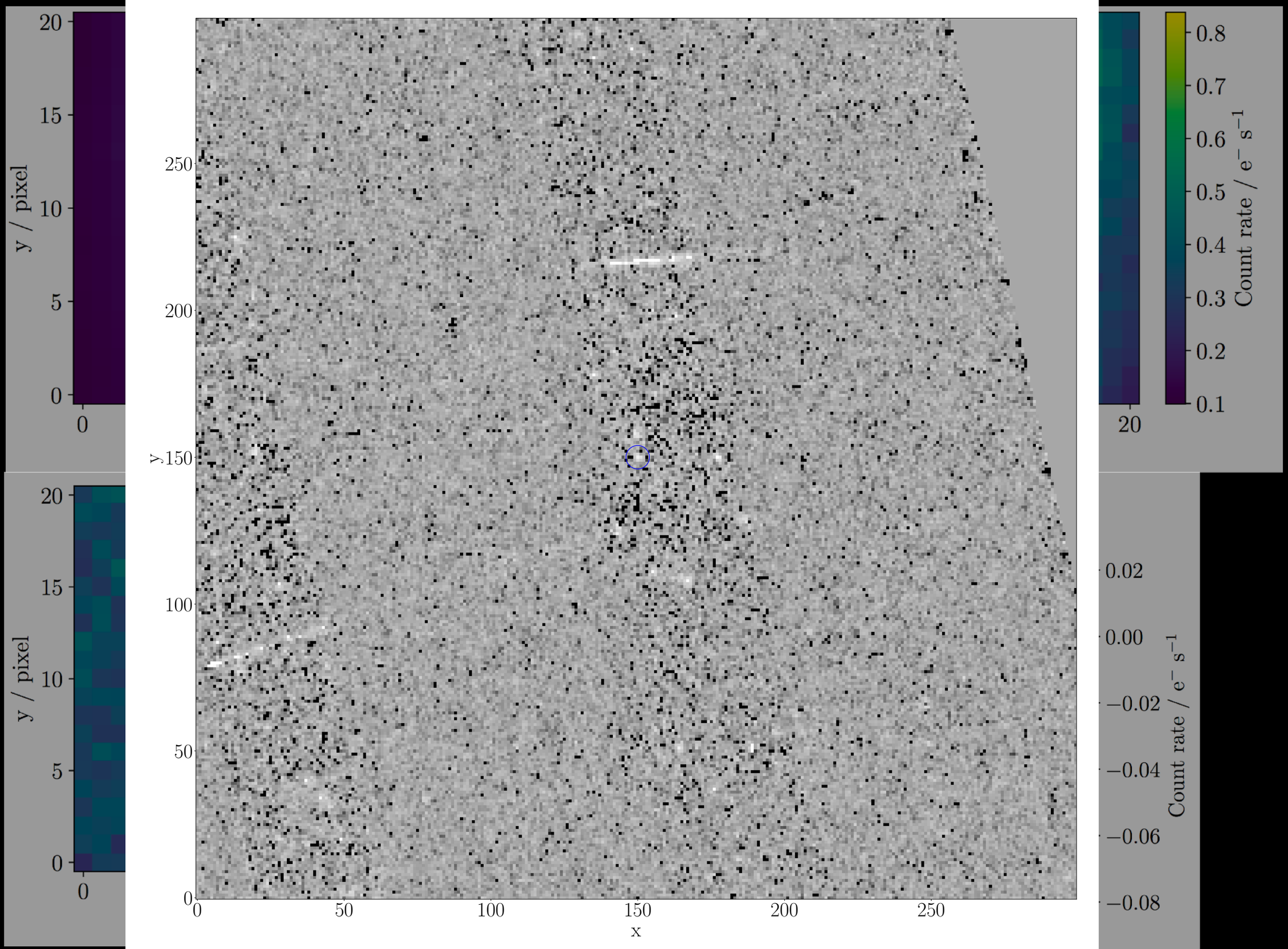
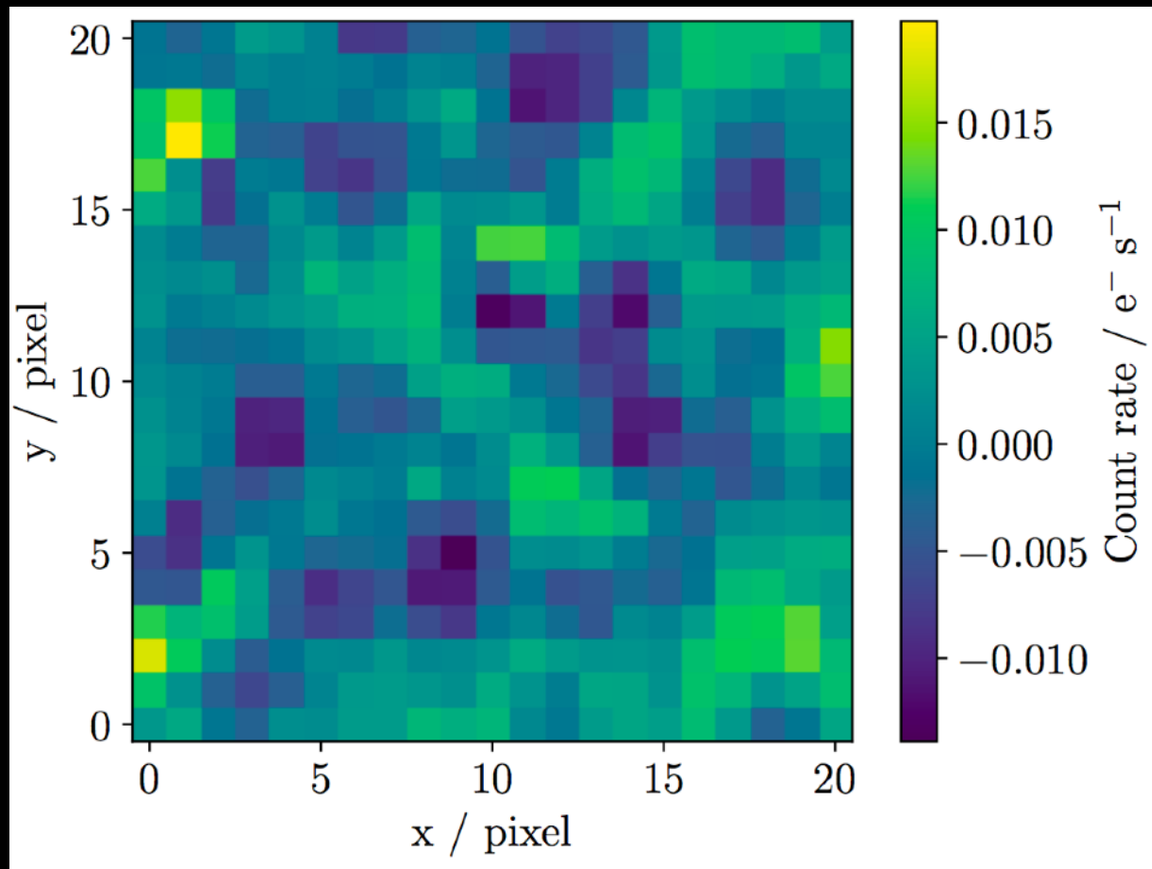
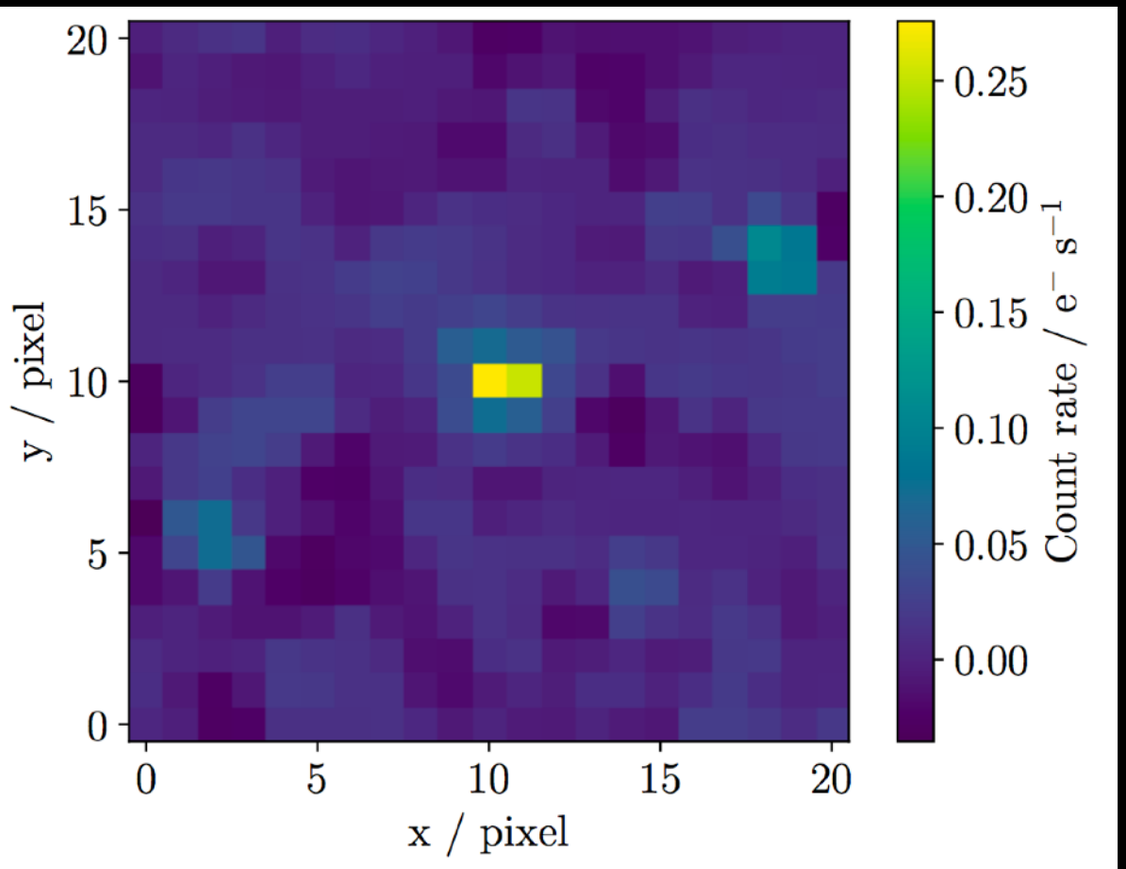
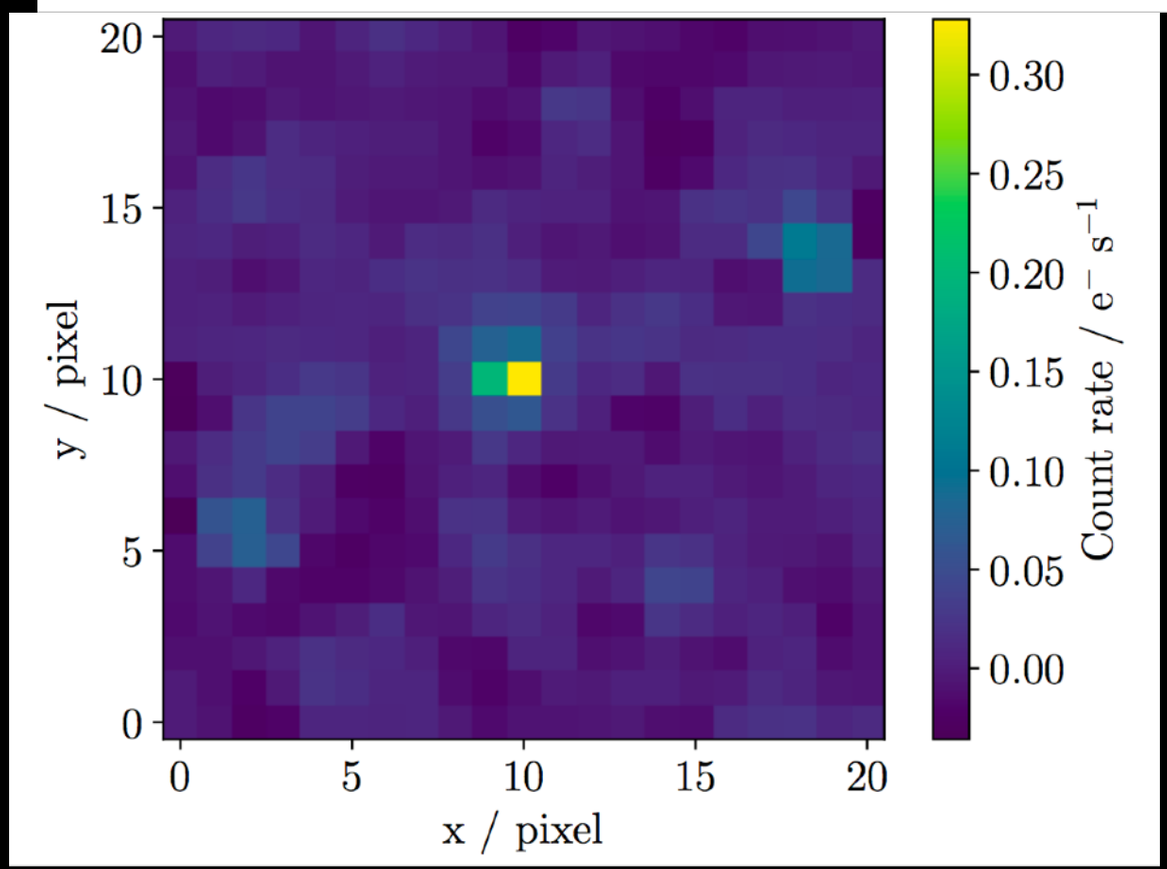


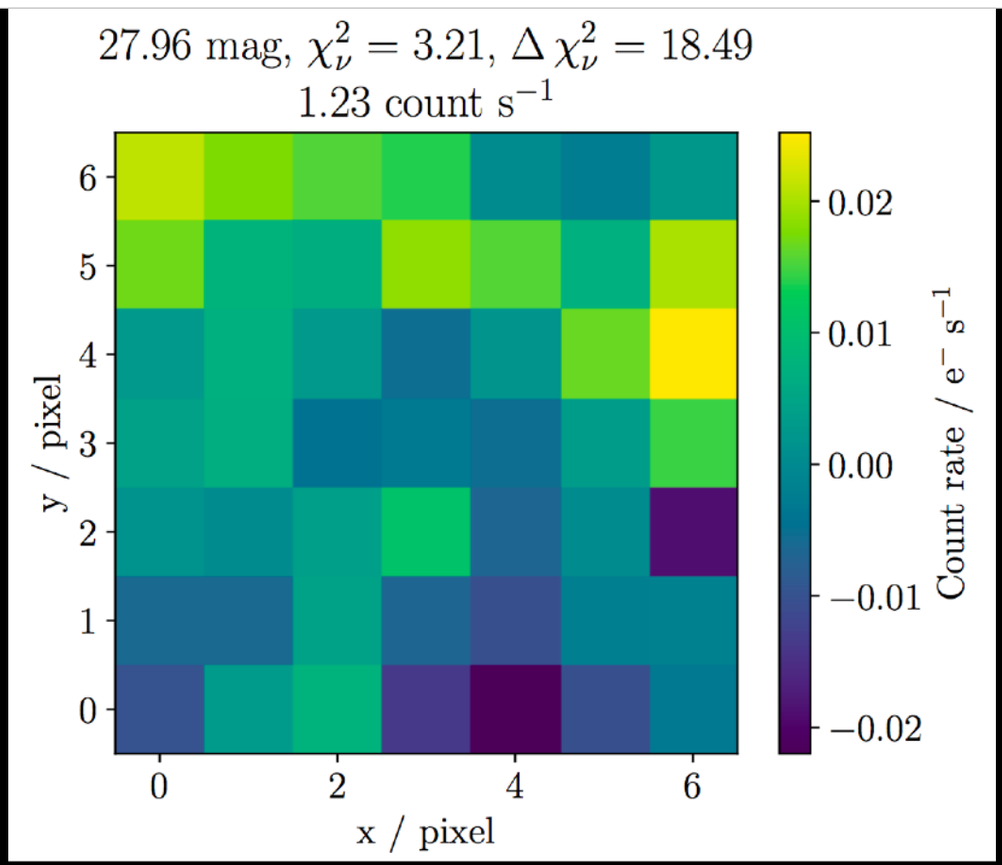
INITIAL *BUFFALO* SUPERNOVAE DETECTIONS

SUPERNOVAE SEARCH EFFICIENCY

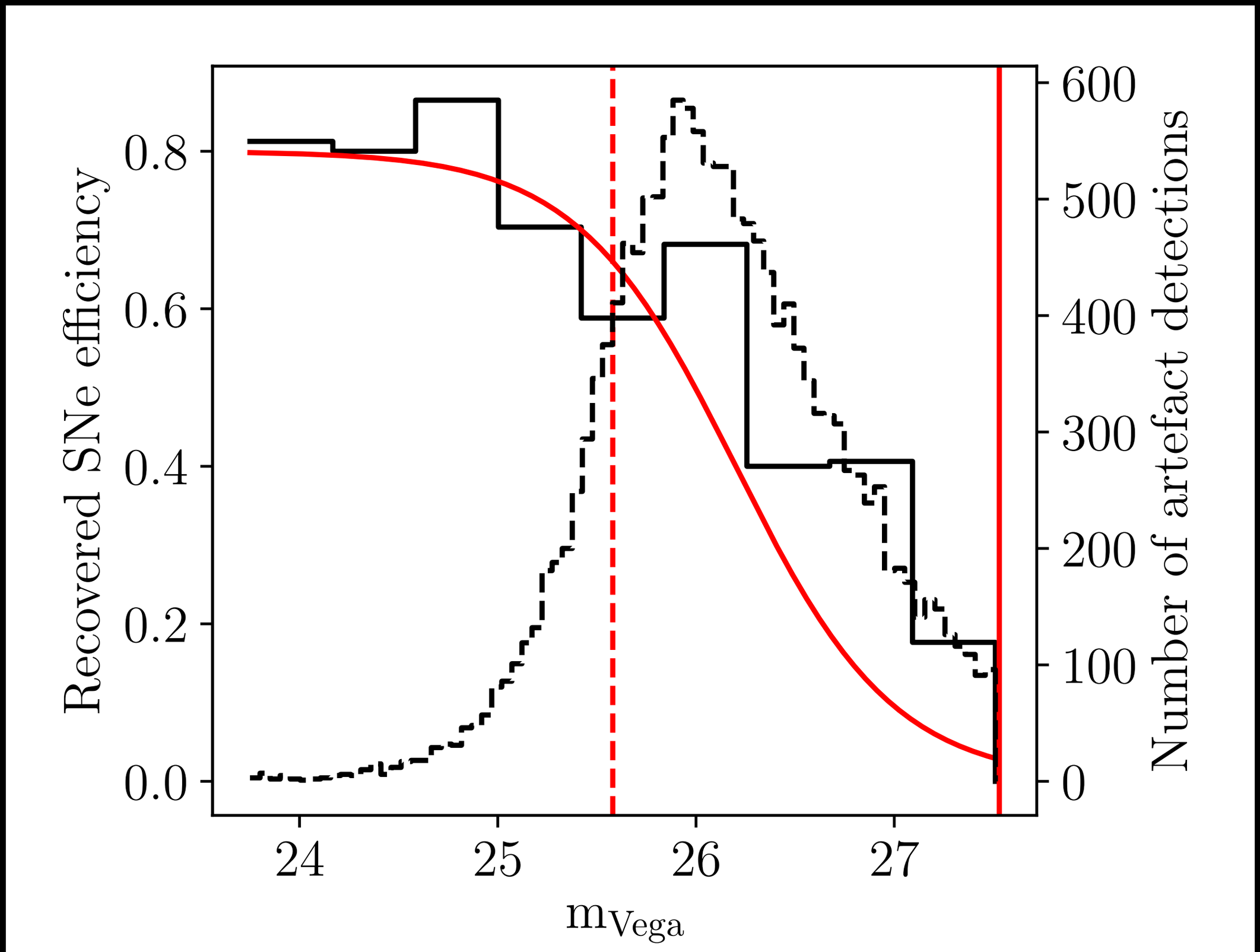








SUPERNOVAE SEARCH EFFICIENCY



SUMMARY

We can use the *BUFFALO* fields to search for supernovae

Utilising a semi-automated method for candidate finding, we find preliminary results of 0 SN in Abell 370 and 0 SN in MACS 0717 after visual inspection of candidates

We recover 78% of injected SNe in the target fields down to our limiting peak count rate 0.15 count/s ($\mathrm{m}_{\mathrm{Vega}} \simeq 25.6$) and 60% of injected SNe down to 0.025 count/s ($\mathrm{m}_{\mathrm{Vega}} \simeq 27.5$)