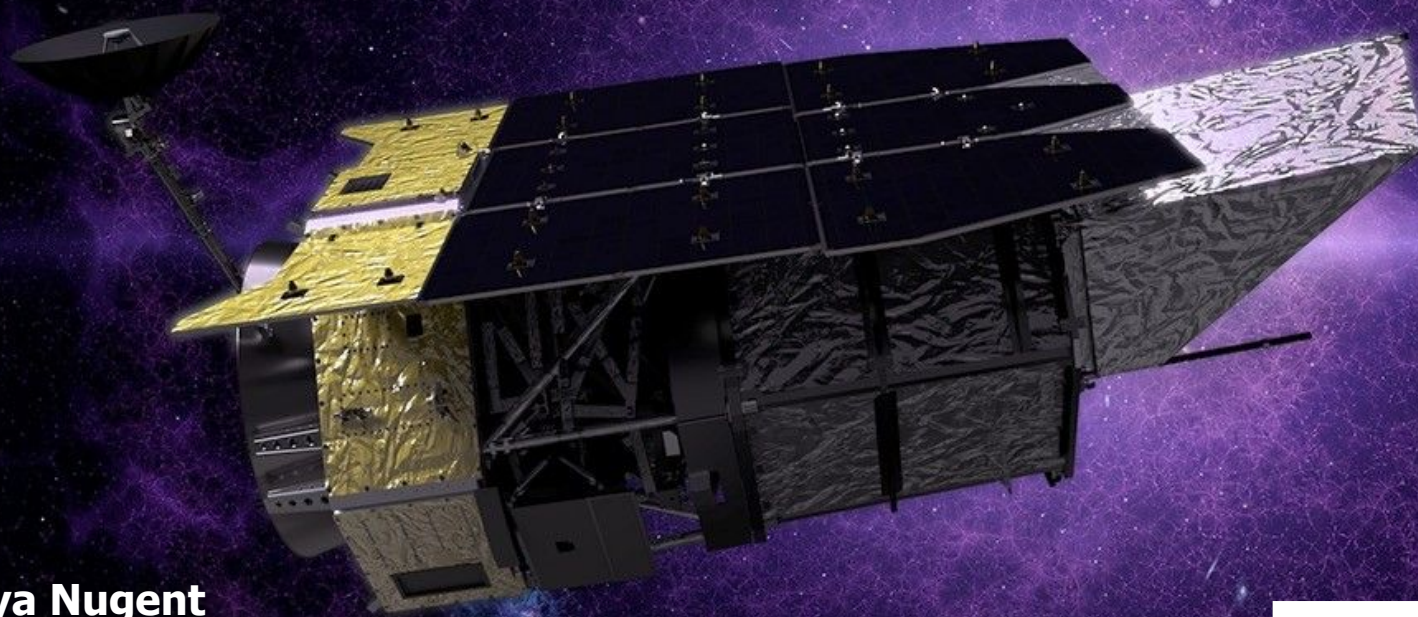


Utilizing the Power of Host Galaxies to Discover Transients with Roman



Anya Nugent

Current CfA Postdoc

Incoming Clay Fellow

Shifting Landscapes in Astrophysics

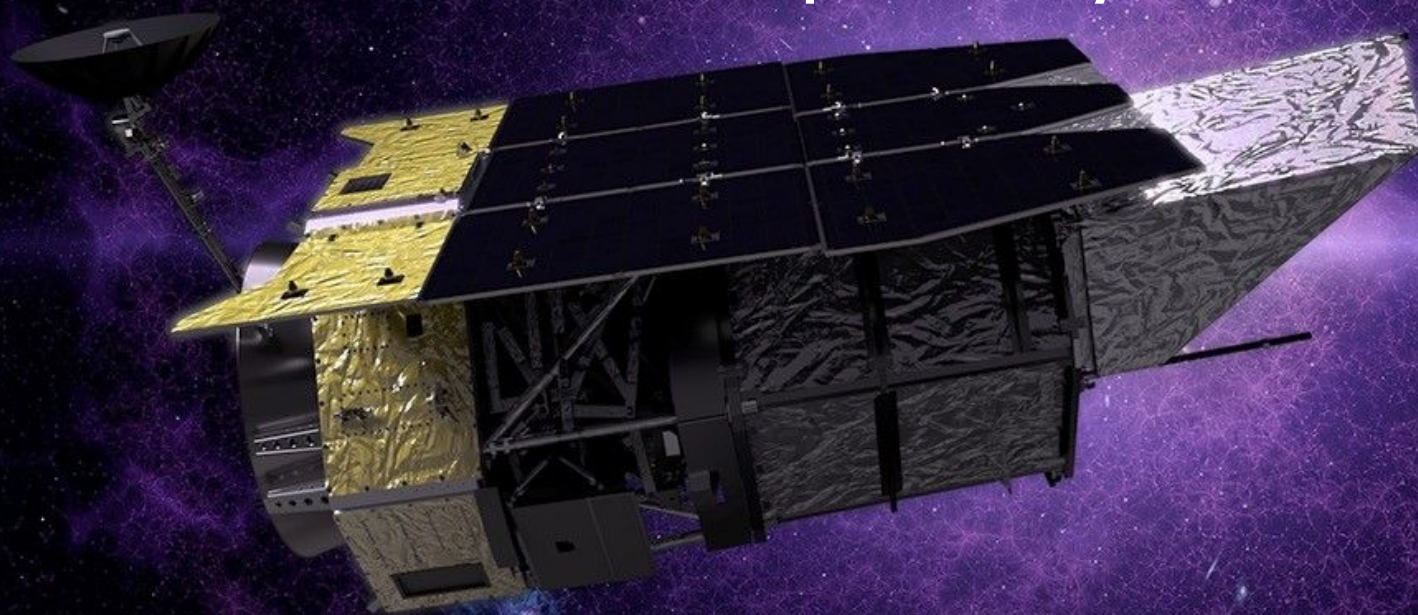
July 15, 2026

CENTER FOR

ASTROPHYSICS

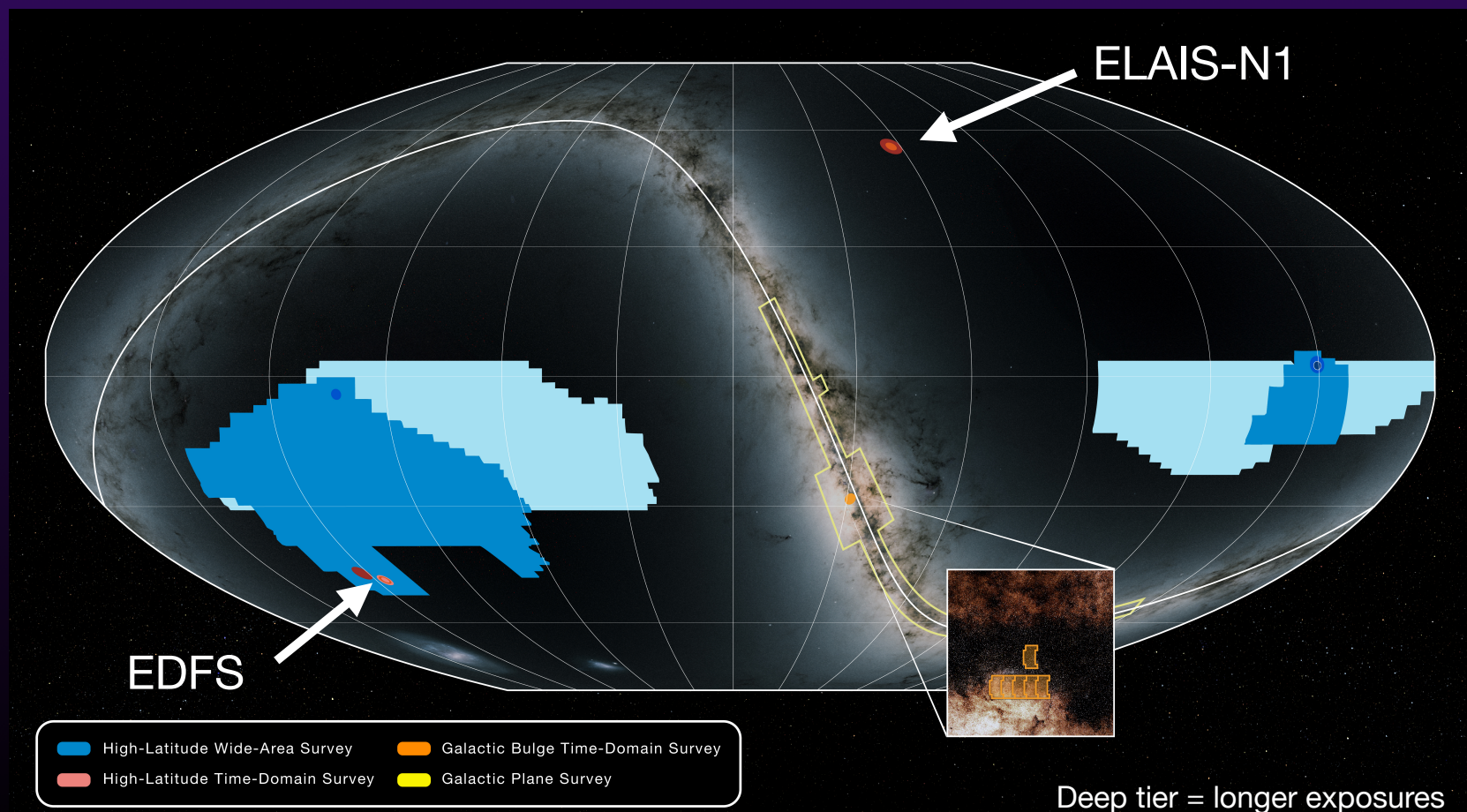
HARVARD & SMITHSONIAN

Roman will transform extragalactic transient astronomy through imaging the same fields repeatedly

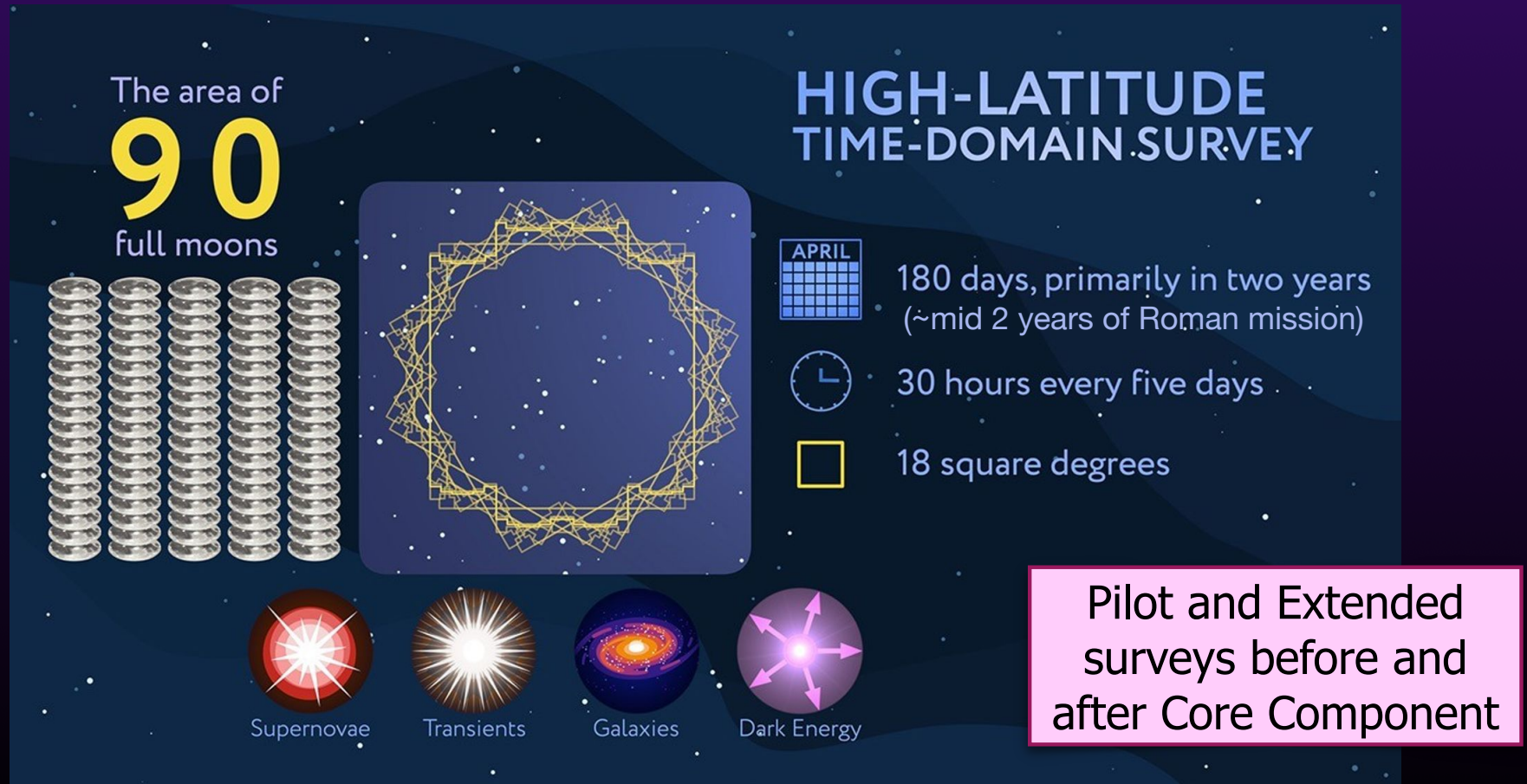


See Jacob Jencson's talk next for more details!

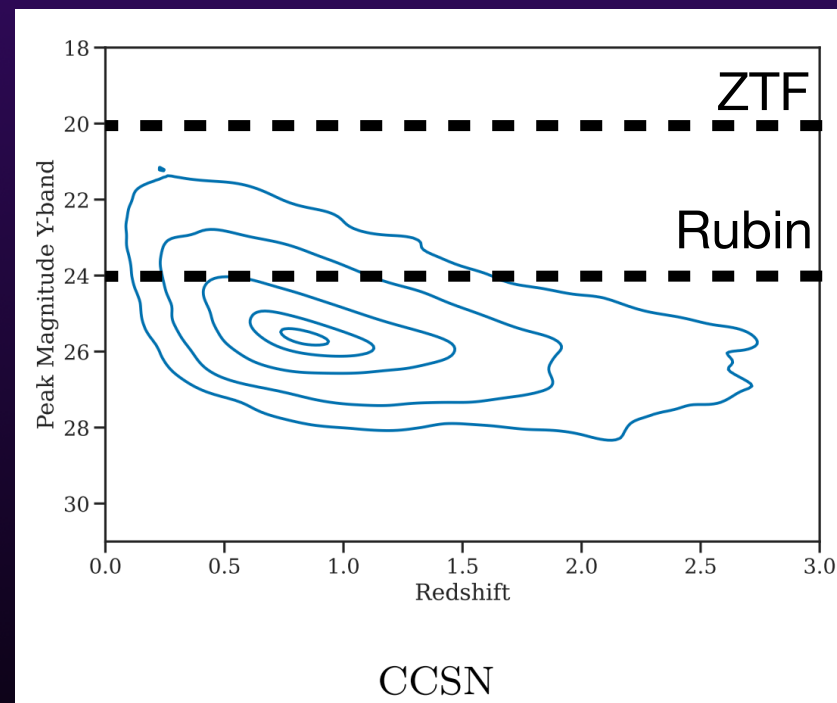
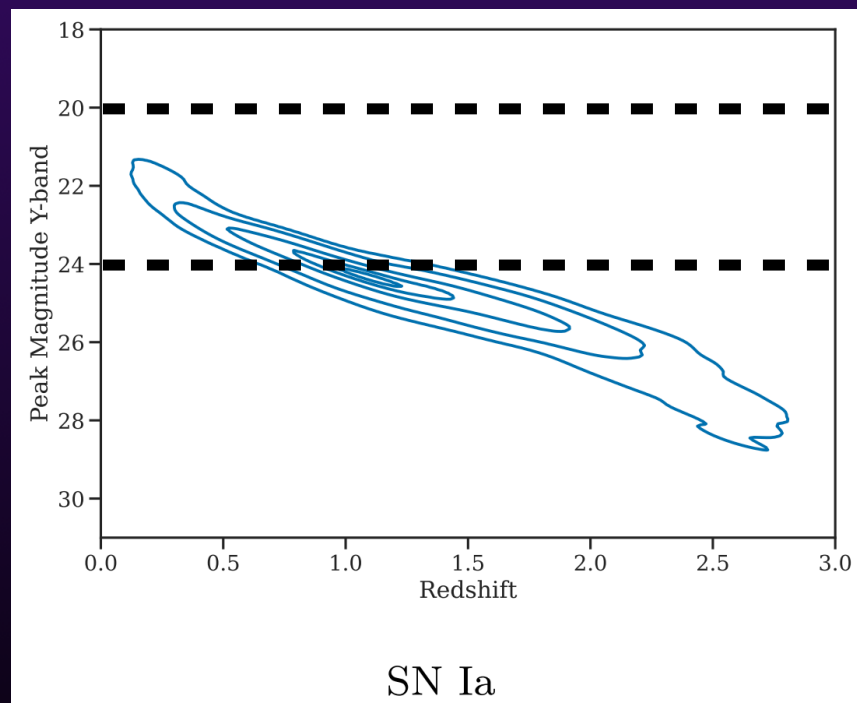
The High-Latitude Time-Domain Survey: Roman's Transient Powerhouse Survey



The High-Latitude Time-Domain Survey: Roman's Powerhouse in Transient Discovery



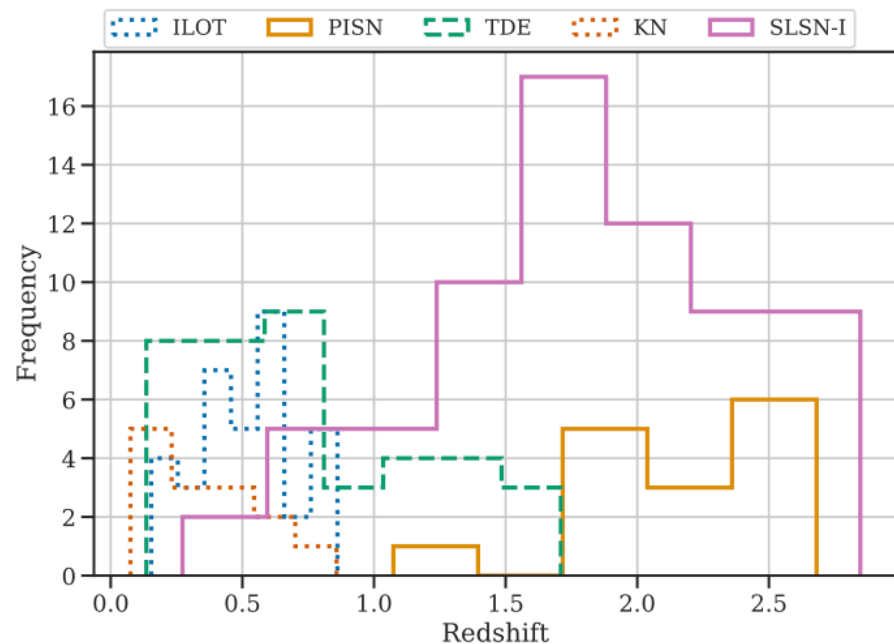
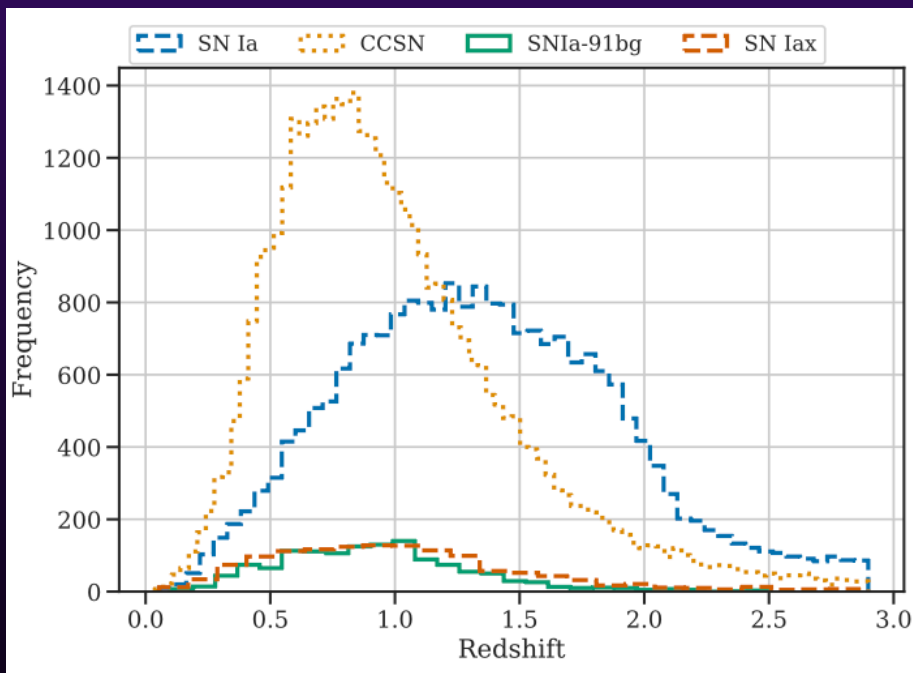
Roman's HLTDS will bring breakthrough discoveries in high-redshift transient science



The Hourglass Simulation; Rose+ 2025

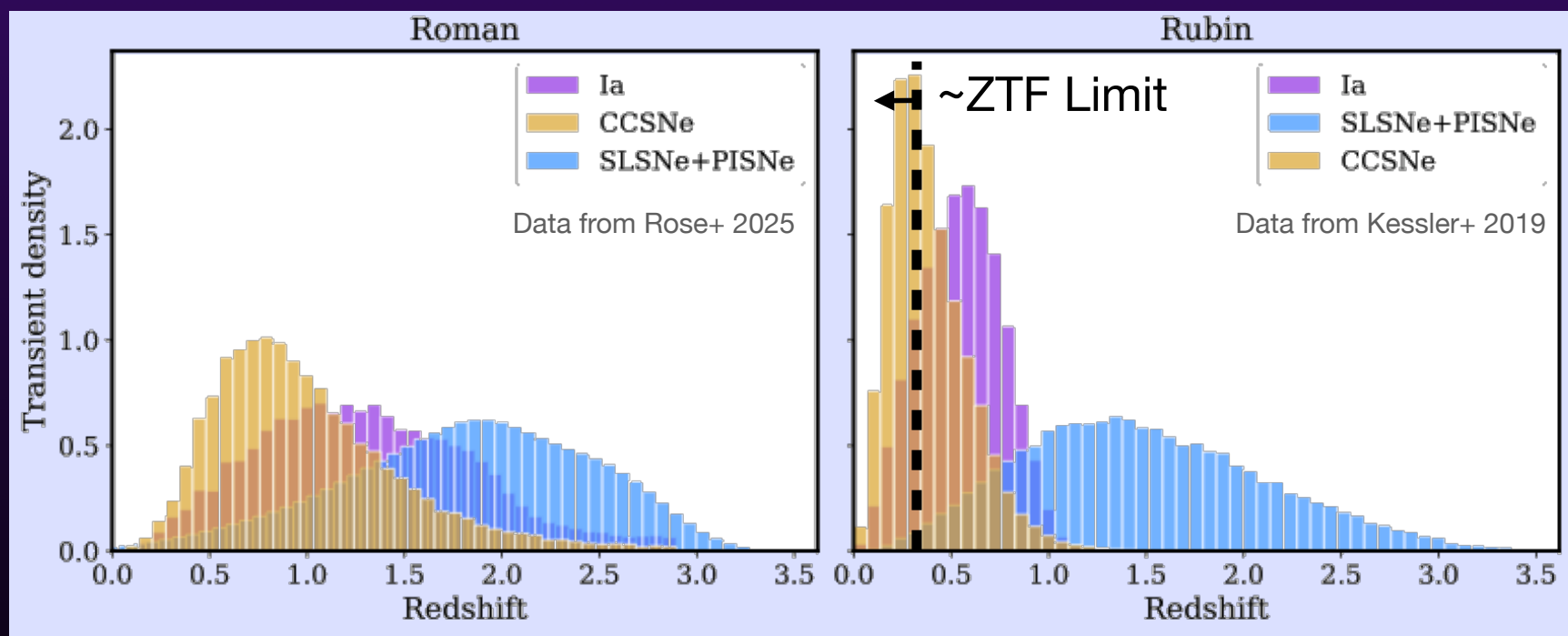
Sensitivity + NIR filters will allow us to discover fainter transients at higher redshifts

Roman's HLTDS will bring breakthrough discoveries in high-redshift transient science



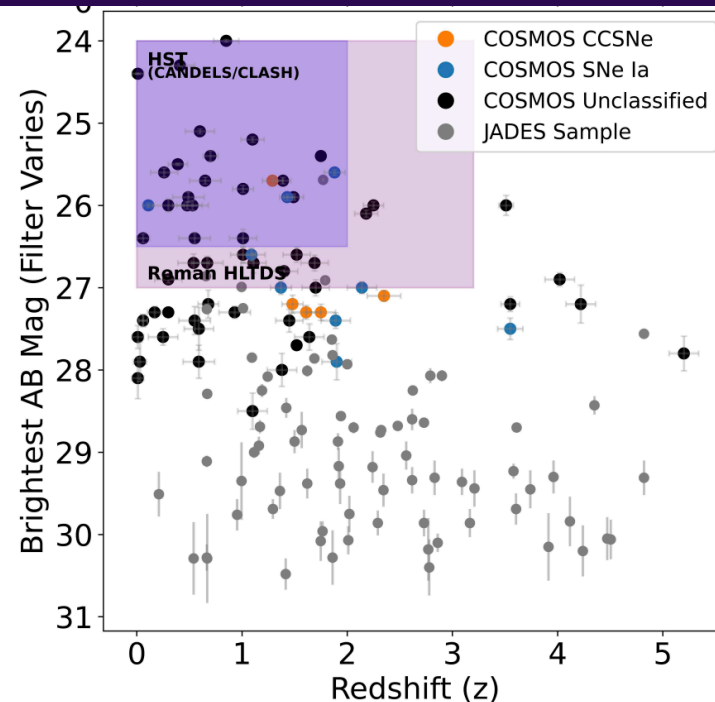
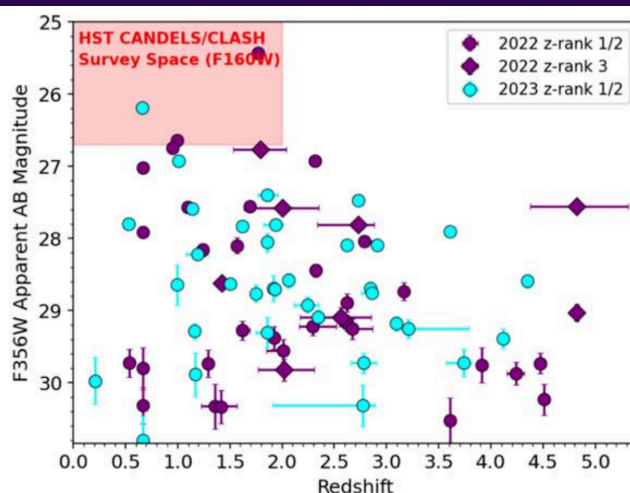
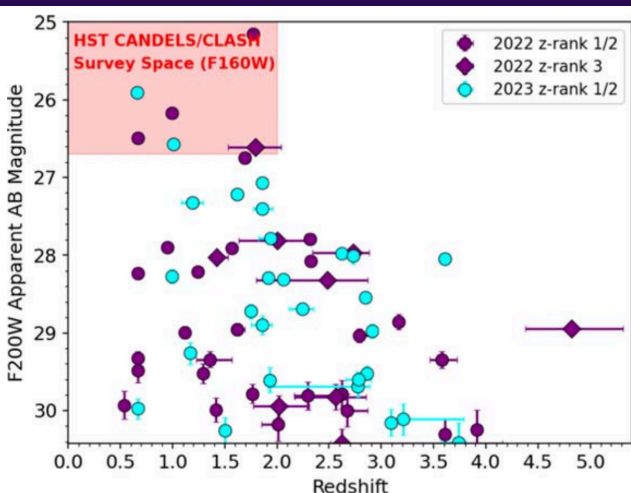
The Hourglass Simulation; Rose+ 2025

~21,000 SNe Ia, ~40,000 CCSNe with the majority beyond $z > 1$!

Roman's HLTDS will bring breakthrough discoveries in high-redshift transient science

While the number of transients won't be as great as what will be discovered with Rubin's LSST, Roman's transient population will reach far higher redshifts

High-redshift transient science is still relatively new



JADES; DeCoursey+ 2025

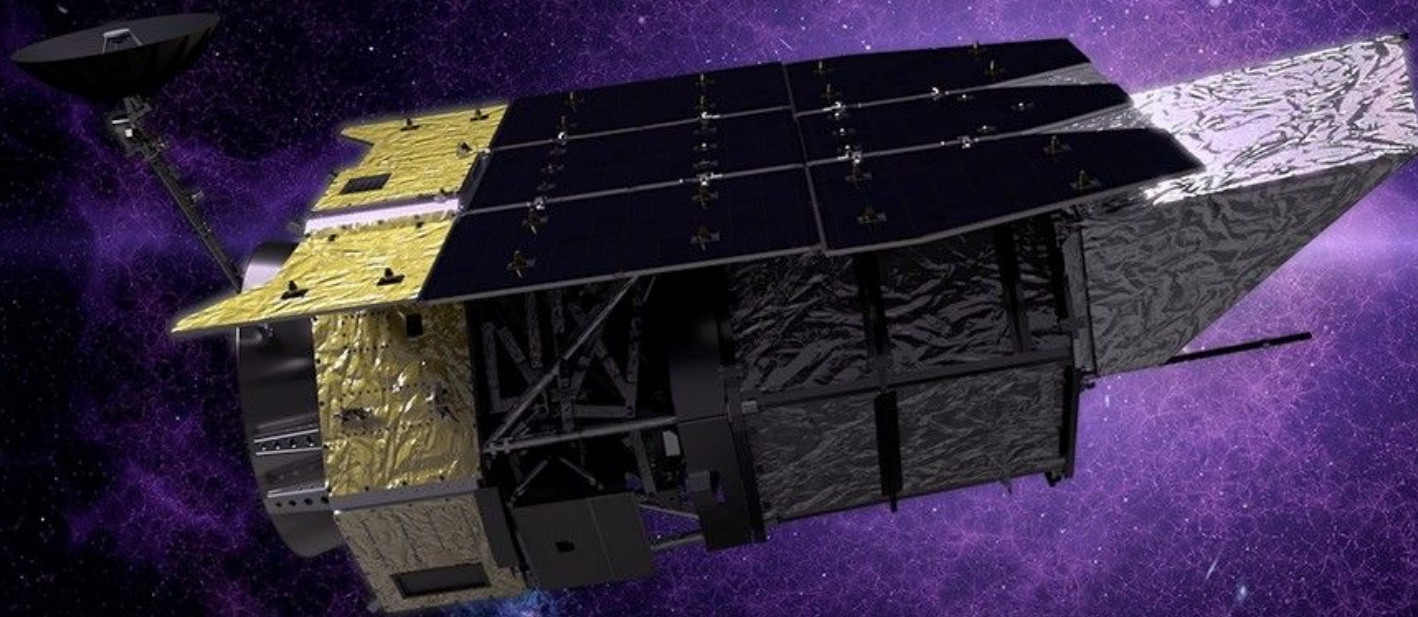
COSMOS-Web; Fox & Rest+ 2026

See also: Rodney+ 2014, Angus+2019, Moriya+ 2019, Gomez+ 2024, Pierel+ 2025 Coulter+ 2026a,b, Siebert+ 2026

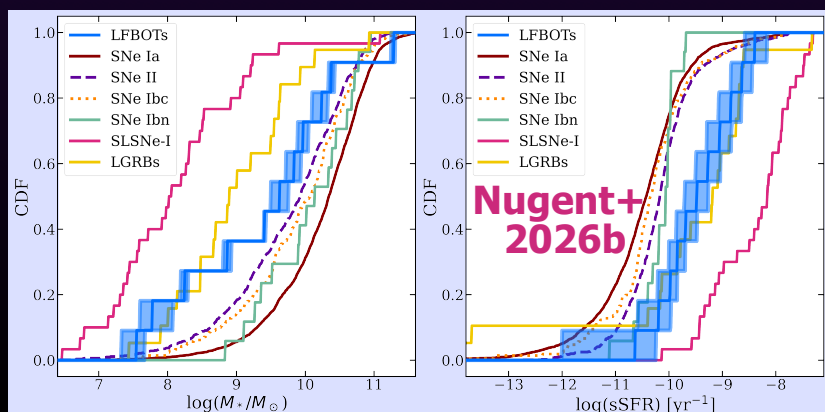
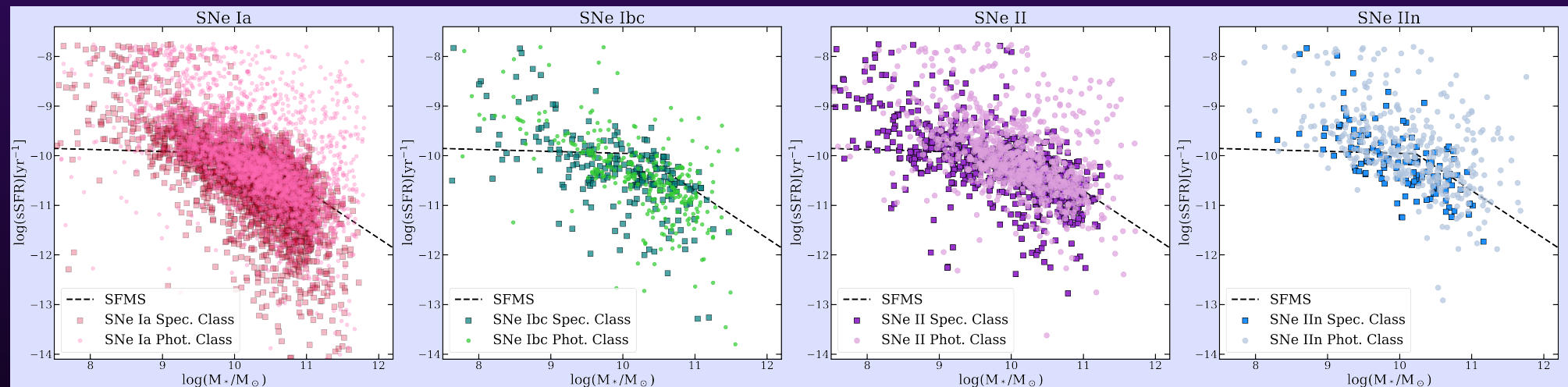
~100 transients currently discovered at $z > 1$, with even less that are spectroscopically classified

How do we go about classifying transients
with limited photometric data?

Host galaxies!



Host galaxies are key in distinguishing transient types and their progenitors at low redshift

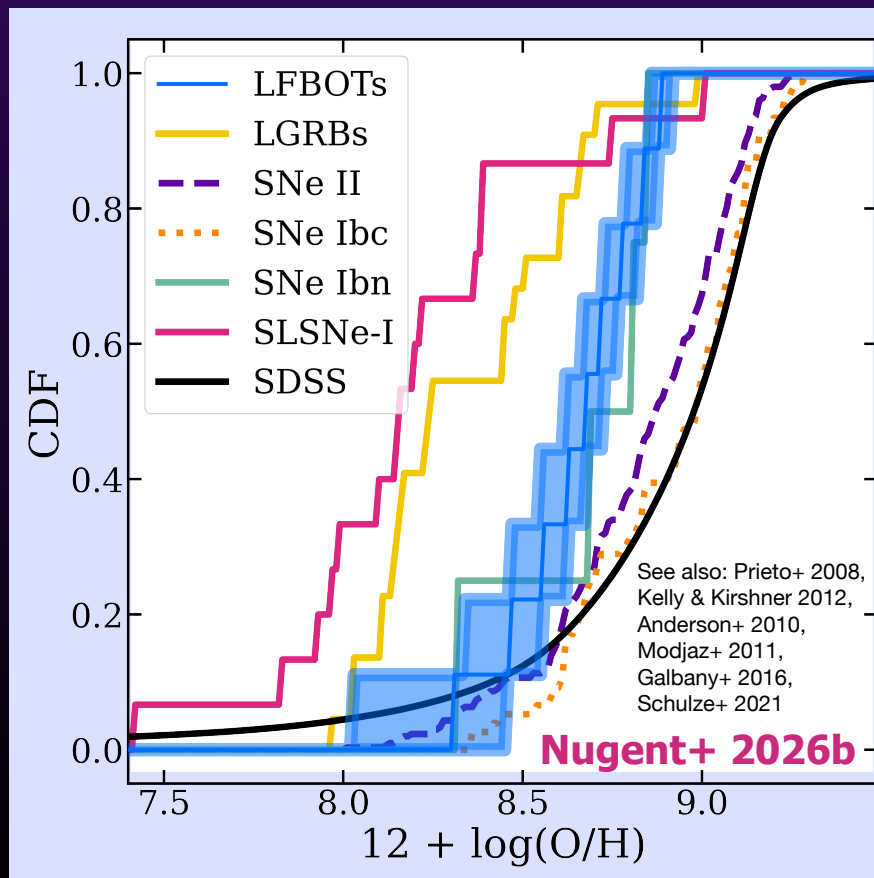
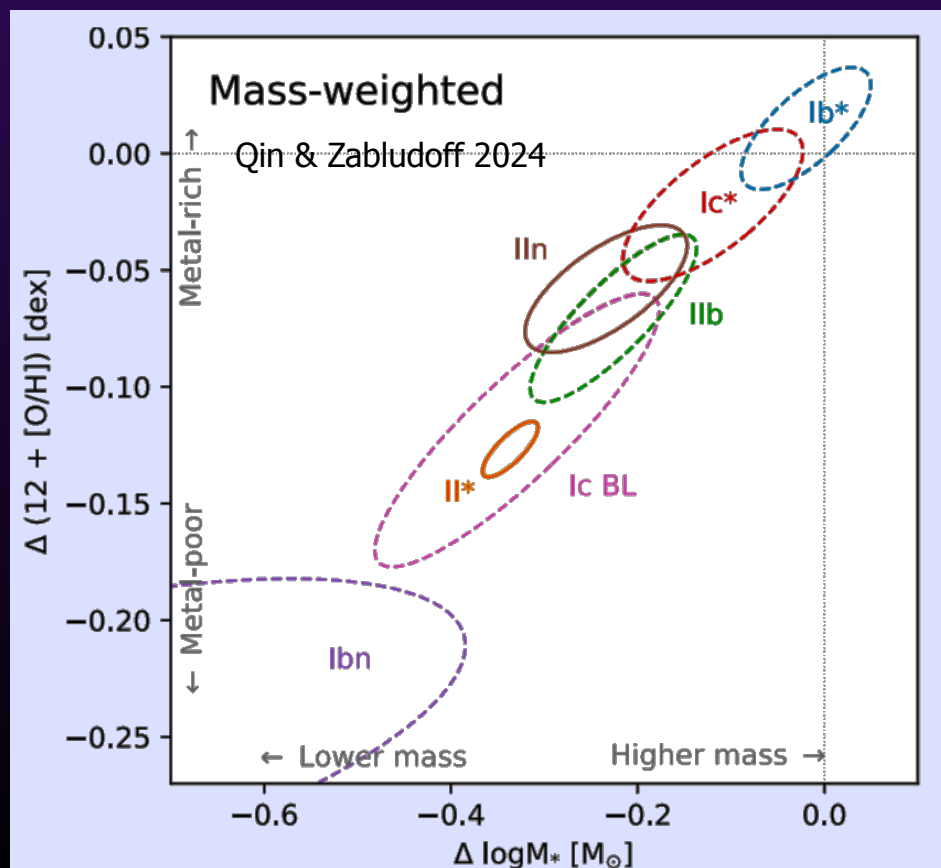


Nugent+2026a, see also: Schulze+2021, Qin & Zabludoff 2024

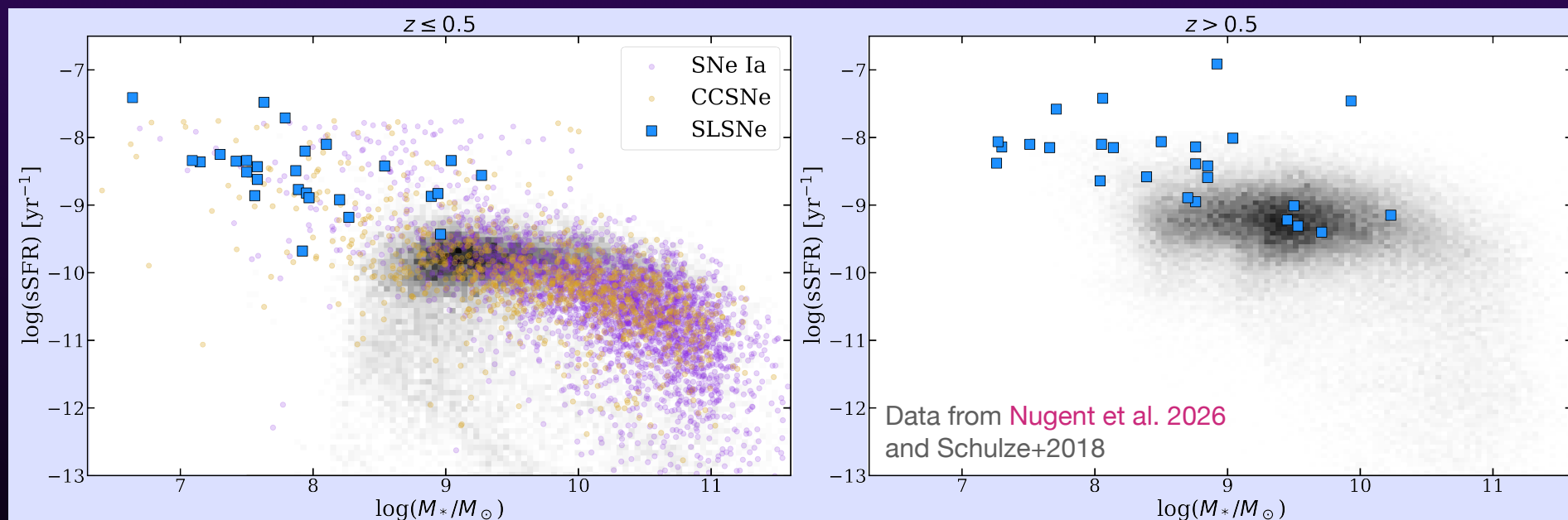
Transients trace different combinations of stellar mass and star formation, which relates directly to their formation pathways and timescales

Data from: Svensson+ 2010, Perley & Perley 2013, Wang & Dai 2014, Niino+ 2017, Schulze+ 2021, Nugent+ 2026a,b

Metallicity is also quite distinct between transient host populations!



Host properties are even useful for distinguishing extreme transients at high redshift!



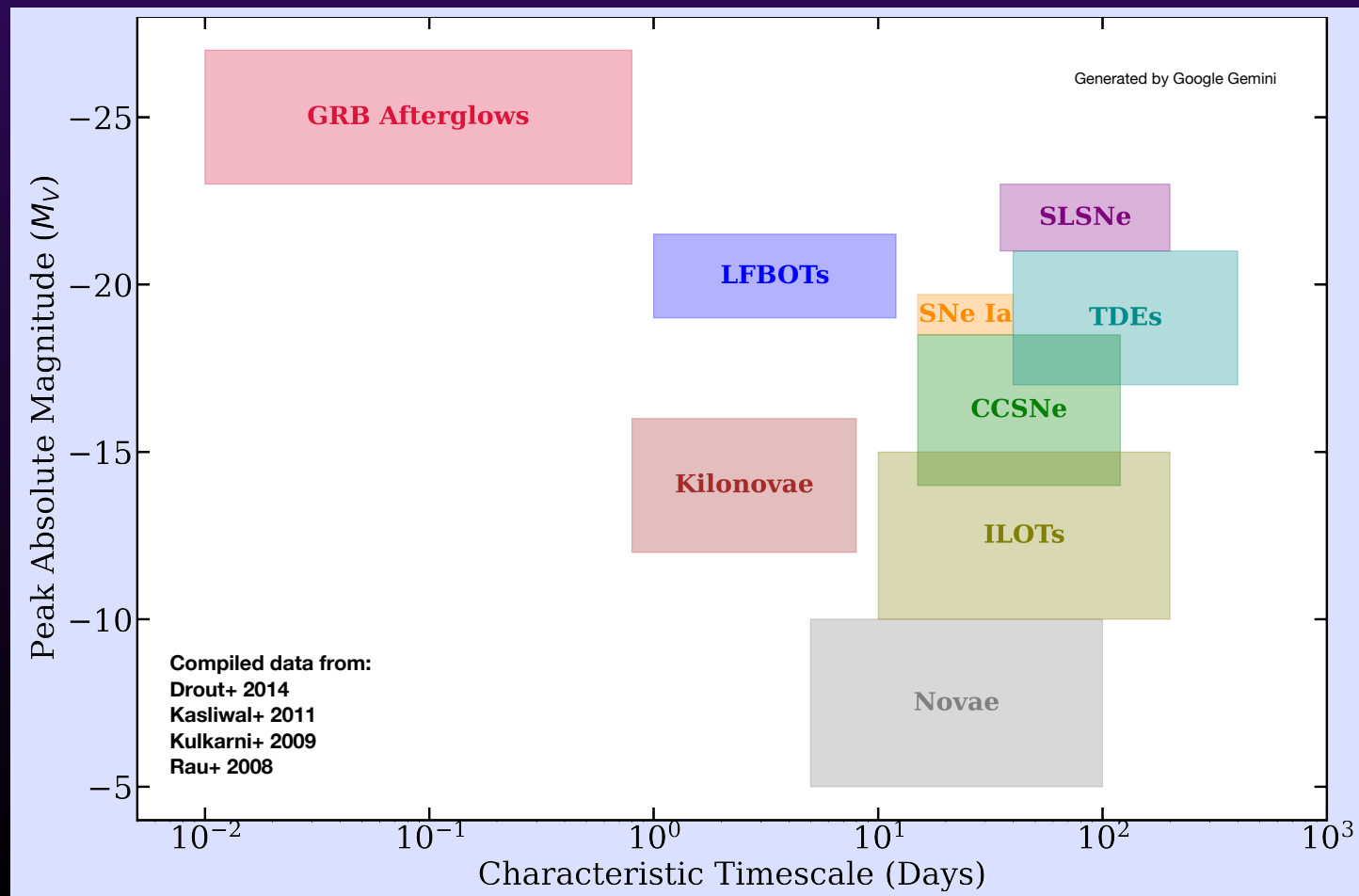
Hydrogen-poor super luminous supernovae occur in the most extreme environments at both low and high redshift

A visualization of the cosmic web, showing a dense network of purple filaments and nodes against a black background. Numerous galaxies are scattered throughout, some appearing as bright blue/white points and others as fainter, more complex structures. The text is centered within a black rectangular box.

Host galaxies will therefore be very useful for
early transient classification!

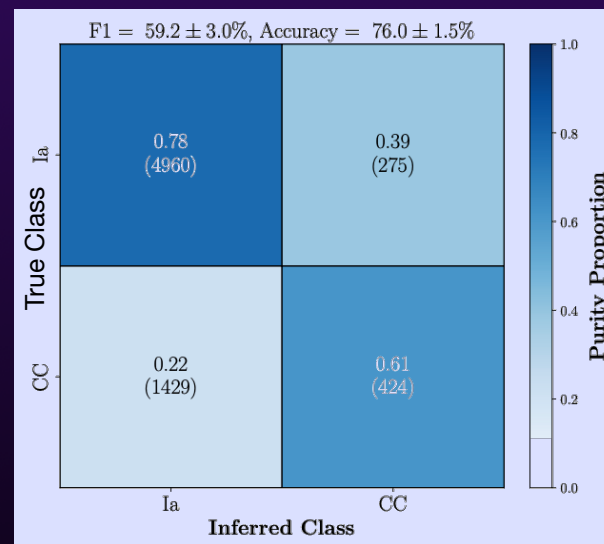
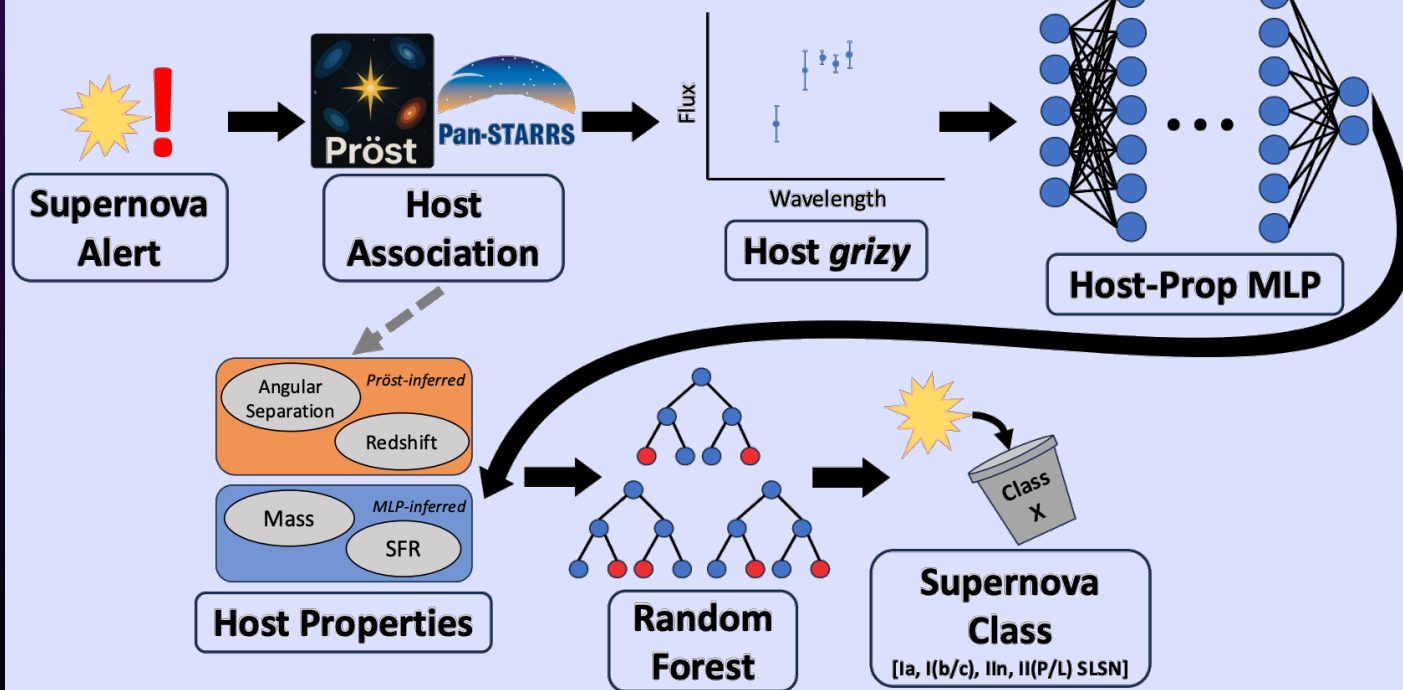


Hosts give us redshift estimates → transient luminosities



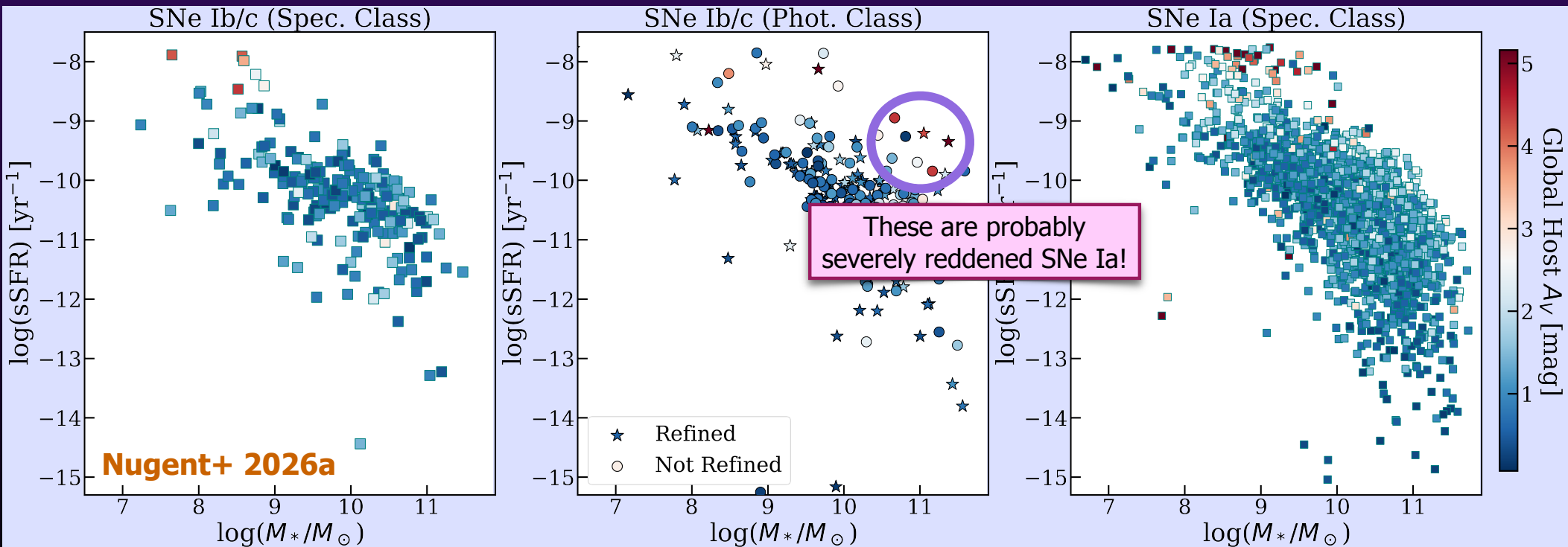
Hosts properties are valuable in transient machine-learning based classifiers at low redshift

SPLASH; Boesky+ 2026

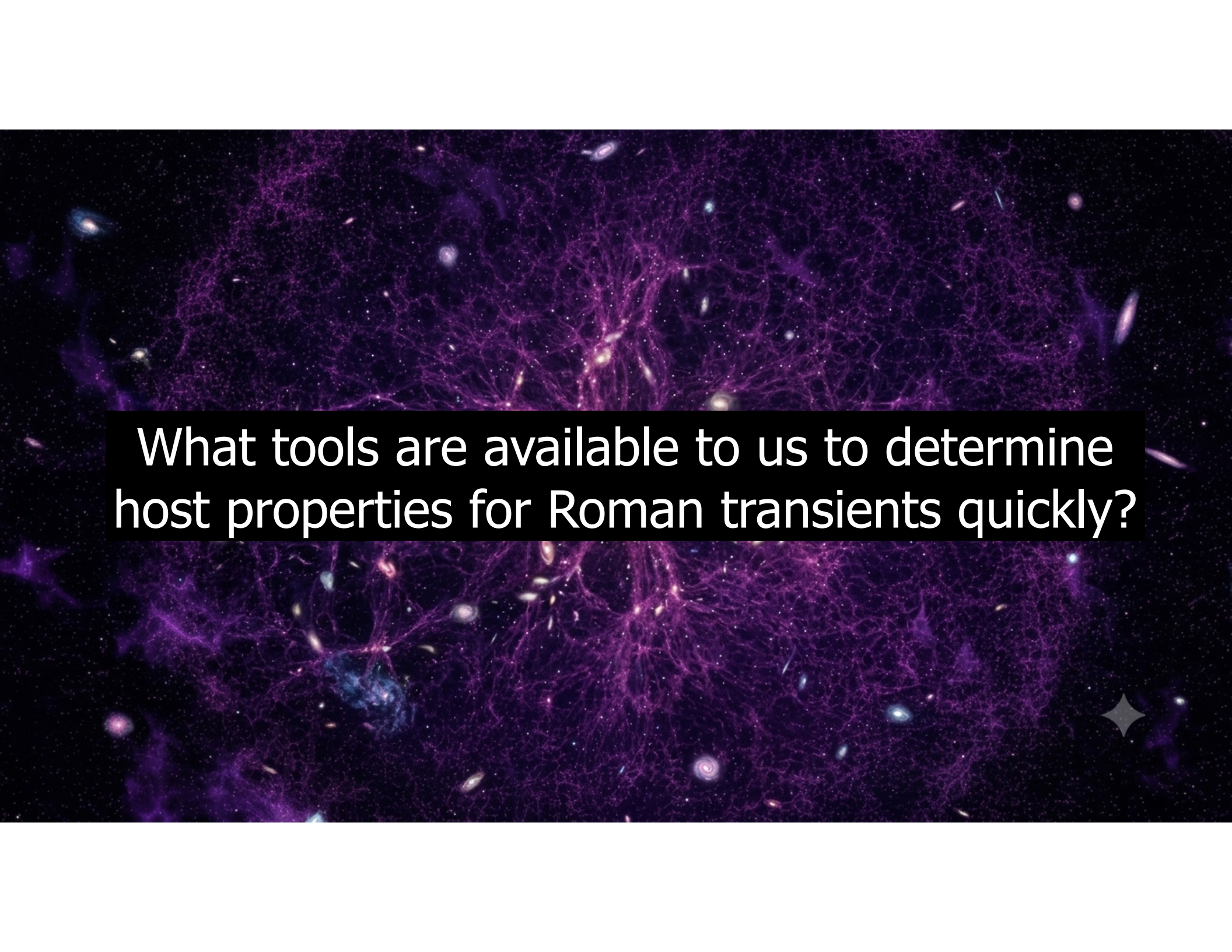


See also: Foley & Mandel 2013, Jones+ 2017, Gomez+ 2020, 2023a,b, Gagliano+ 2023, Kisley+ 2023, Sheng+ 2024, Villar+ 2025, Shah+ 2026

Hosts allow us to constrain line-of-sight extinction



Dust reddens transients - this may make SNe Ia appear more similar to SNe Ib/c!

A visualization of the cosmic web, showing a dense network of purple filaments and nodes against a black background. Numerous galaxies are scattered throughout, some appearing as bright blue or white points, others as faint, elongated structures. The overall effect is a complex, interconnected web of matter in the universe.

What tools are available to us to determine
host properties for Roman transients quickly?



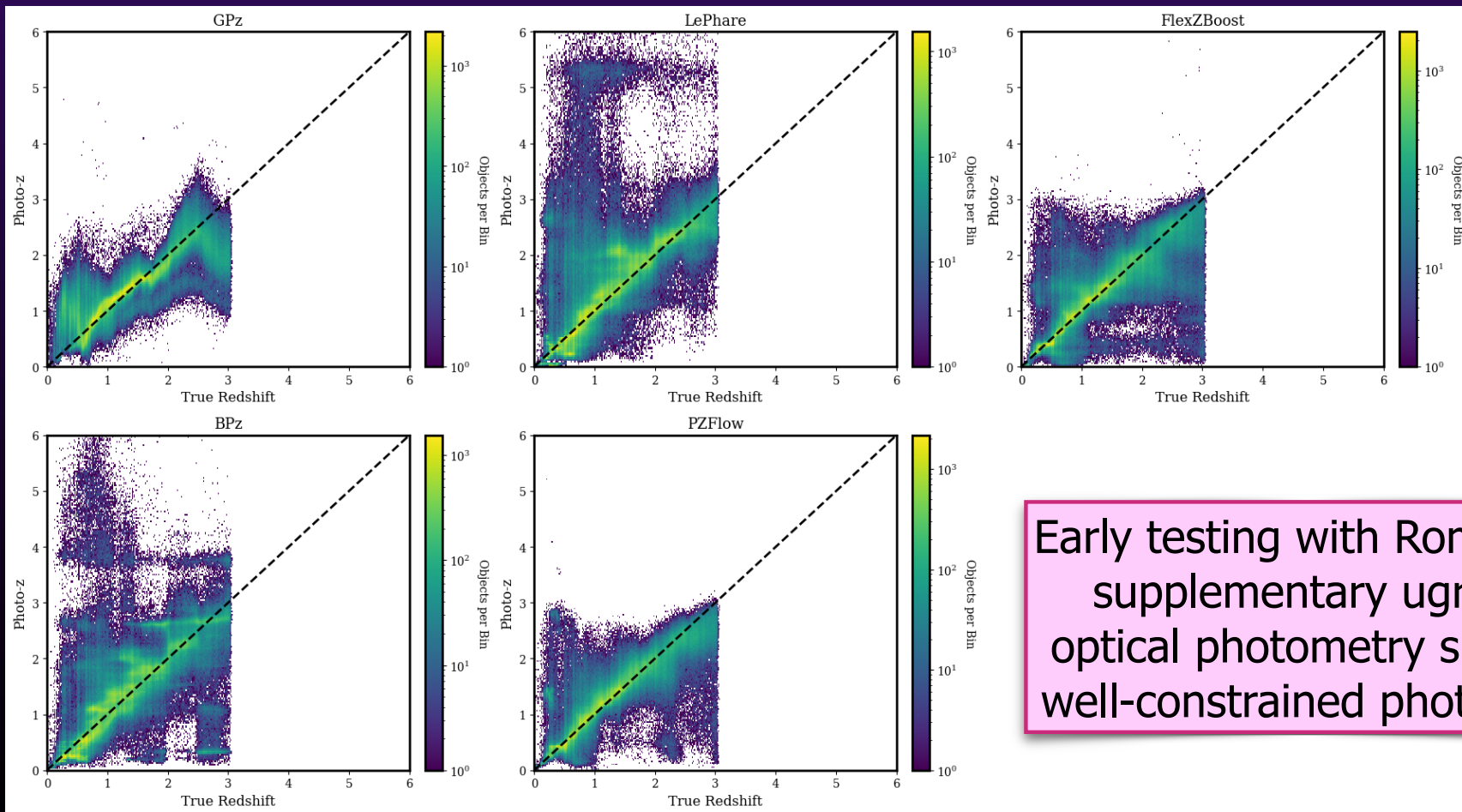
Photometric Redshift Tools

Redshift Assessment Infrastructure Layers (RAIL)			
Algorithm name	Available stages	Home package	Reference
BPZ	CatInformer, CatEstimator	rail-bpz	Benítez (2000)
CMNN	CatInformer, CatEstimator	rail-cmnn	Graham et al. (2018)
Delight	CatInformer, CatEstimator	rail-delight	Leistedt & Hogg (2017)
DNF	CatInformer, CatEstimator	rail-dnf	De Vicente et al. (2016)
FlexZBoost	CatInformer, CatEstimator	rail-flexzboost	Izbicki & Lee (2017b)
GPz	CatInformer, CatEstimator	rail-gpz-v1	Almosallam et al. (2016)
<i>k</i> -nearest neighbors	CatInformer, CatEstimator	rail-sklearn	This work
LePHARE	CatInformer, CatEstimator	rail-lephare	Arnouts et al. (1999)
Neural network	CatInformer, CatEstimator	rail-sklearn	This work
pzflow	CatInformer, CatEstimator	rail-pzflow	Crenshaw et al. (2024)
Random Gaussian	CatInformer, CatEstimator	rail-base	This work
TPZ	CatInformer, CatEstimator	rail-tpz	Carrasco Kind & Brunner (2013)
trainZ	CatInformer, CatEstimator	rail-base	Schmidt et al. (2020)
Uniform binning	PZClassifier	rail-base	This work
Equal count binning	PZClassifier	rail-base	This work
Random forest	CatInformer, CatClassifier	rail-sklearn	Breiman (2001)
Variational inference stacking	PzInformer, PZSummarizer	rail-base	Rau et al. (2022)
minisom	CatInformer, PZSummarizer	rail-som	This work
Naive stacking	PzInformer, PZSummarizer	rail-base	Malz & Hogg (2020)
	CatInformer, PZSummarizer	rail-som	This work
	CatInformer, CatSummarizer	rail-sklearn	Lima et al. (2008)
Histogram	PzInformer, PZSummarizer	rail-base	This work
izz	YawSummarize (final stage)	rail-yaw	van den Busch et al. (2020)

Currently exploring these with Roman transient alerts!

The RAIL Team+ 2026

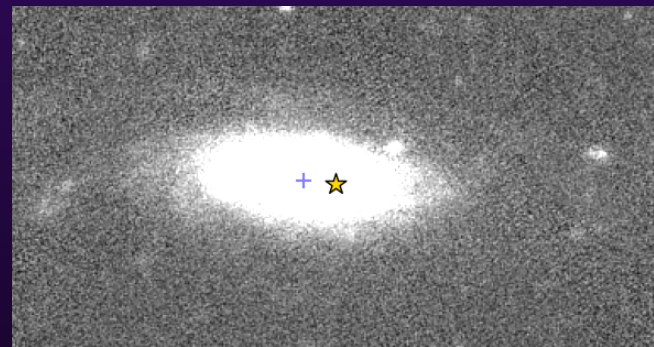
Photometric Redshift Tools



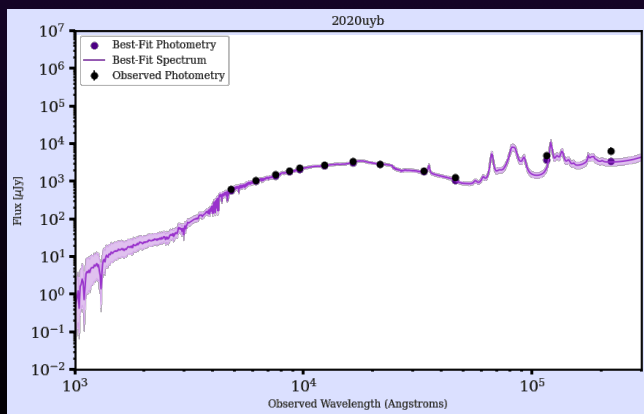
Early testing with Roman + supplementary ugrizy optical photometry shows well-constrained photo-z's!

FrankenBlast: our rapid transient host tool

1. Transient host association with Pröst (Gagliano+ 2025)
2. Aperture photometry on host using a variety of publicly available surveys (GALEX, PanSTARRS, DECaLS, 2MASS, WISE)
3. Rapid host galaxy SED fit with SBI++ to obtain estimates on stellar mass, SFR, dust, age, etc.



All steps completed in
<15 minutes!



We are actively
developing versions of
FrankenBlast for
Roman and Rubin data

Based on the Blast web application

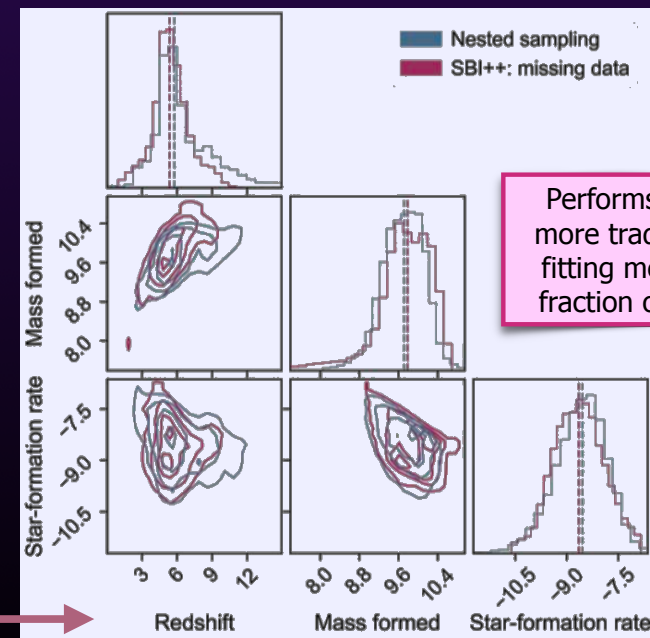
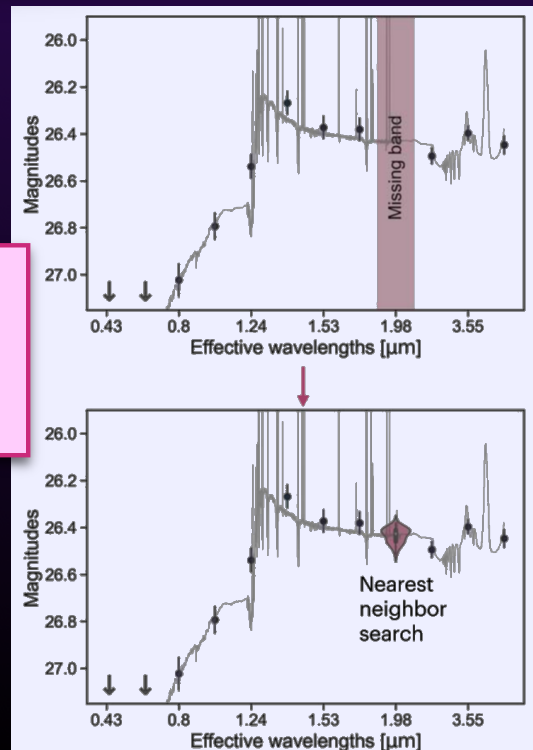


blast.scimma.org, Jones+ 2024

What is simulation based inference (SBI)?

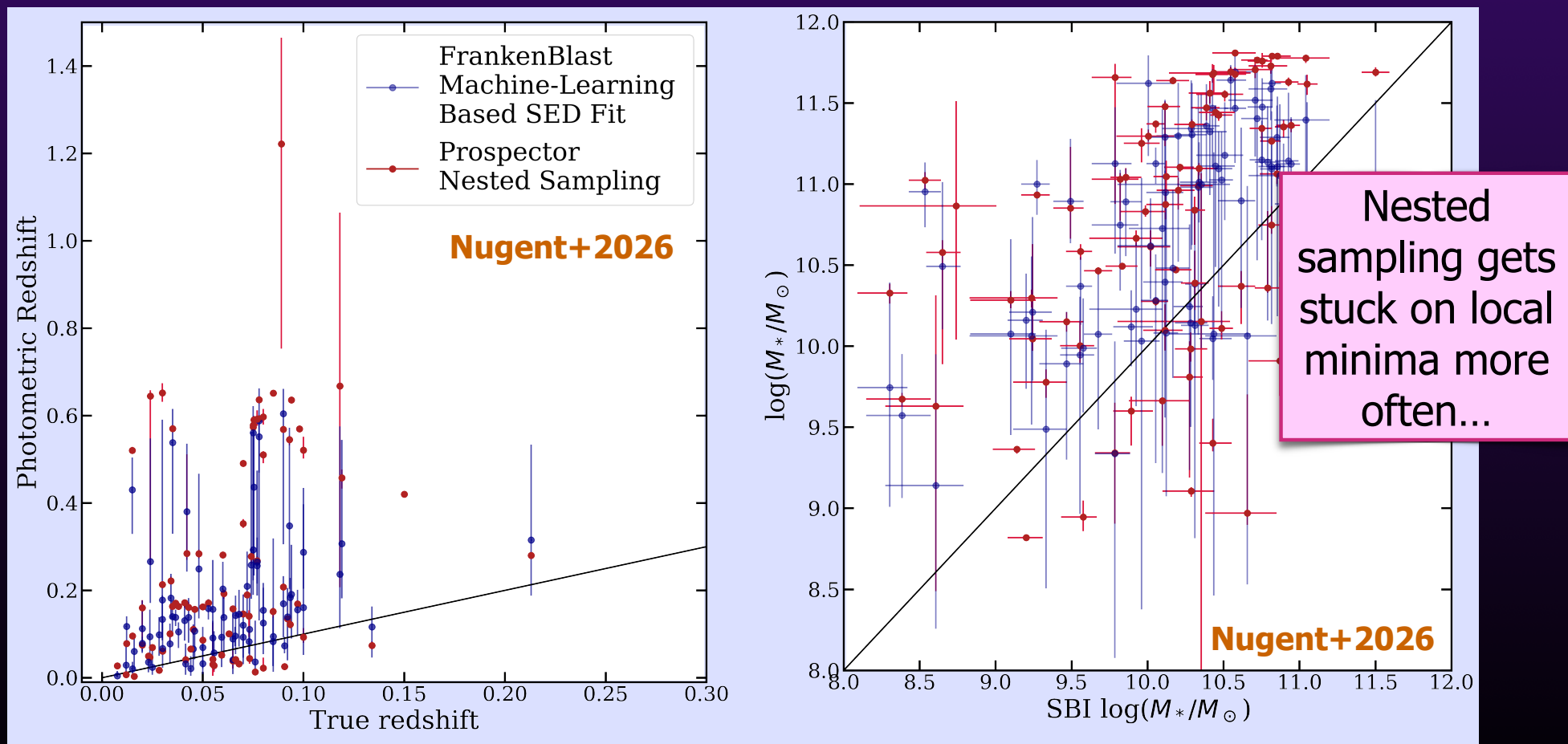
Uses normalizing flows to learn posterior densities of stellar population properties directly from simulated photometry

SBI++ can handle noisy and missing observations



Figures from Wang+ 2023

SBI++ has also shown to perform BETTER than nested sampling!



Roman Cycle 1 Proposal: A Publicly Available Repository of Roman Transient Hosts

A Comprehensive Census of Roman and Rubin Transient Host Environments from Low to High Redshift

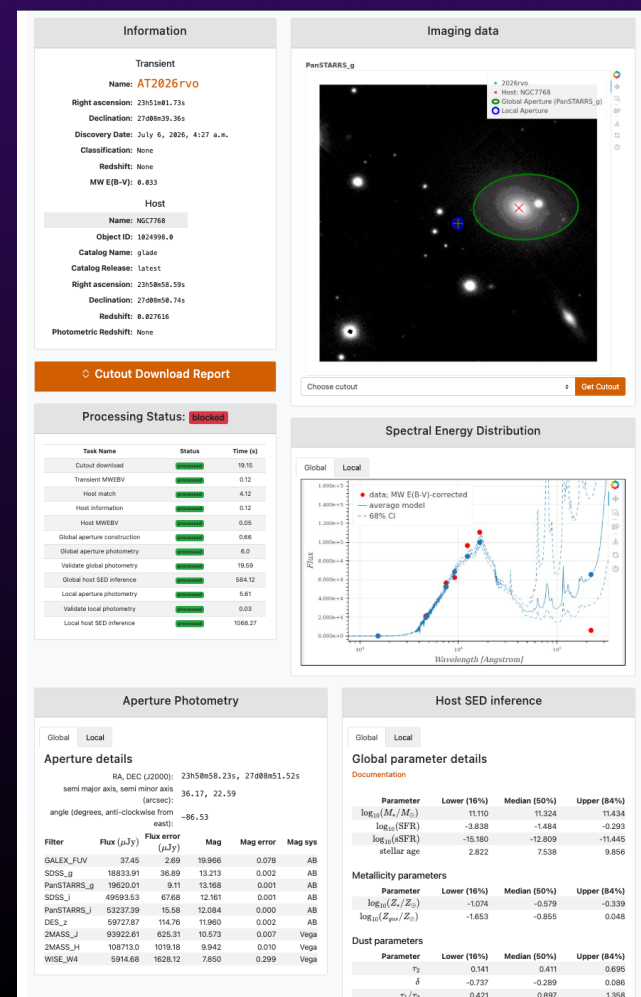
A Blast-like web server to that will publicize:

- Host galaxy associations
- Host galaxy photometry in Roman + optical* filters
- Photometric redshift estimates
- Host galaxy SED fits and resulting stellar population properties via SBI++

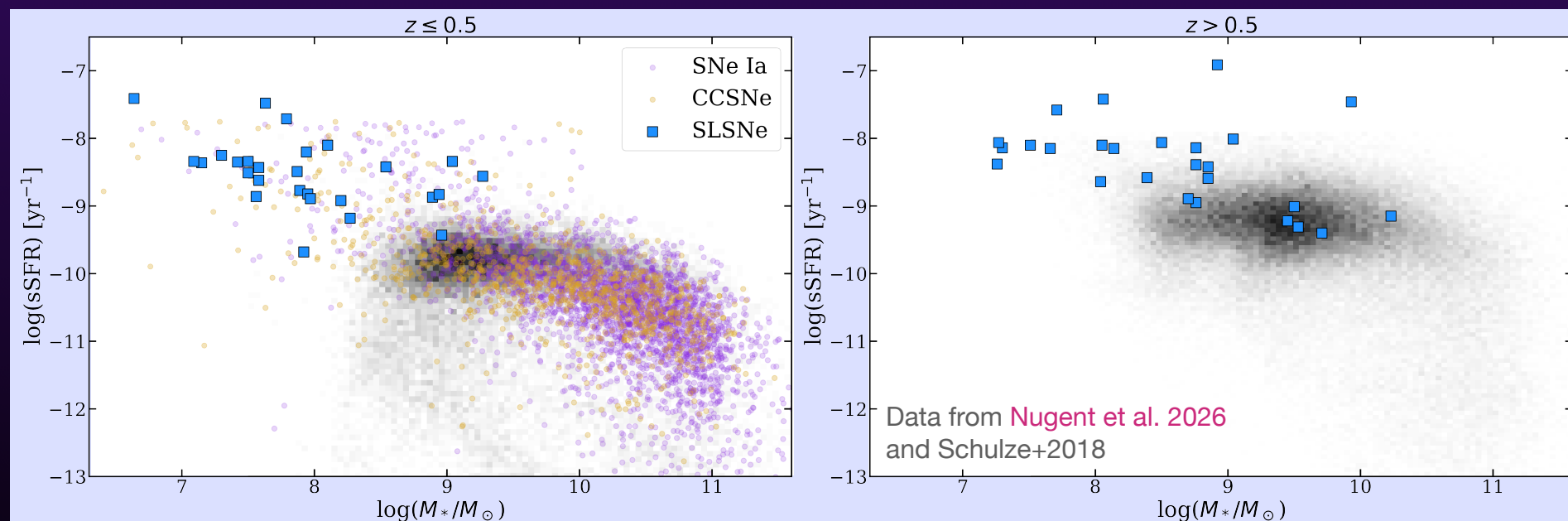
for ALL Roman-discovered transients and Rubin discovered transient in Roman fields within 48 hours of transient discovery

* HSC, DECaLS, or Rubin

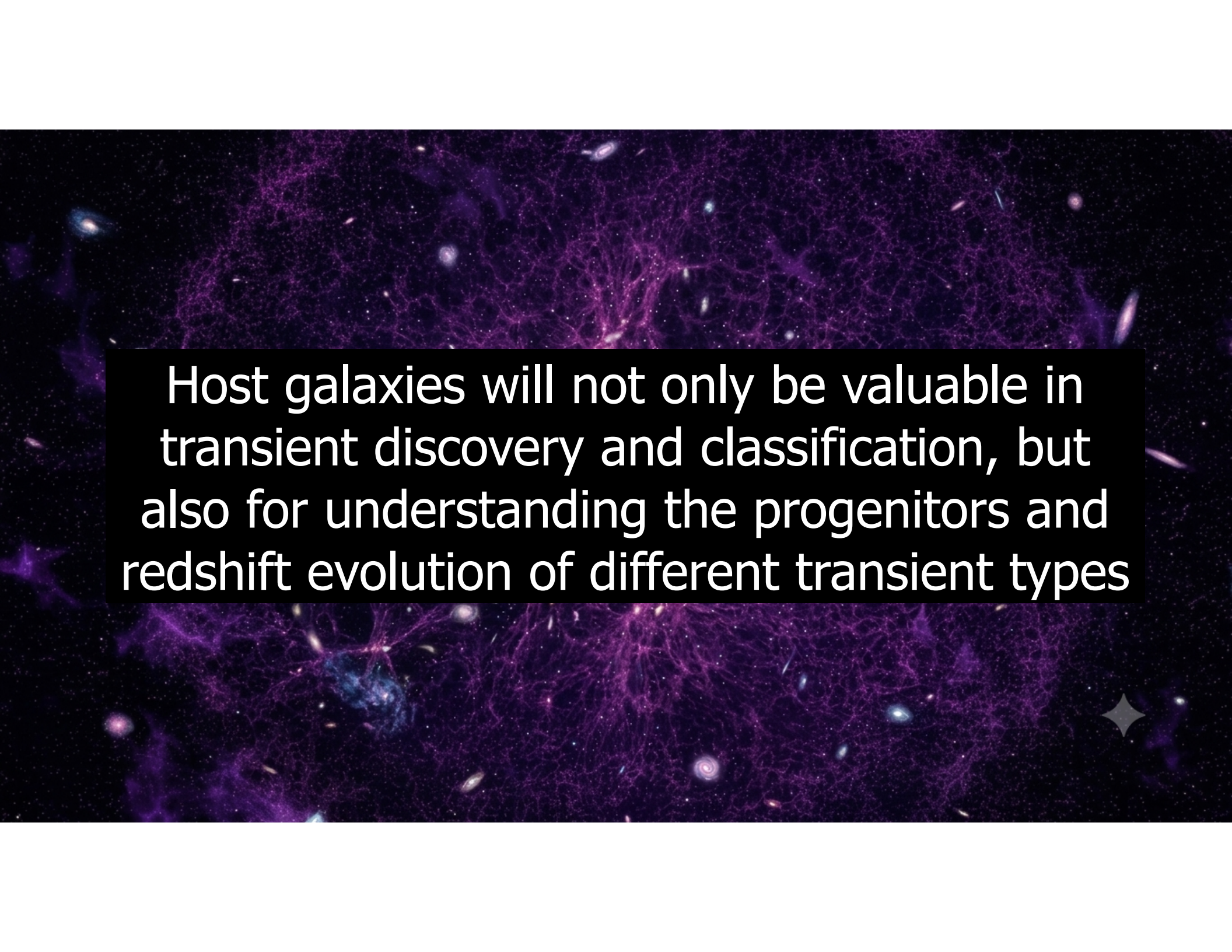
I am open to hearing your thoughts on what you would like to see, please come talk to me!



With this public repository we can track down the most extreme transients in the Universe - like SLSNe and PISNe!



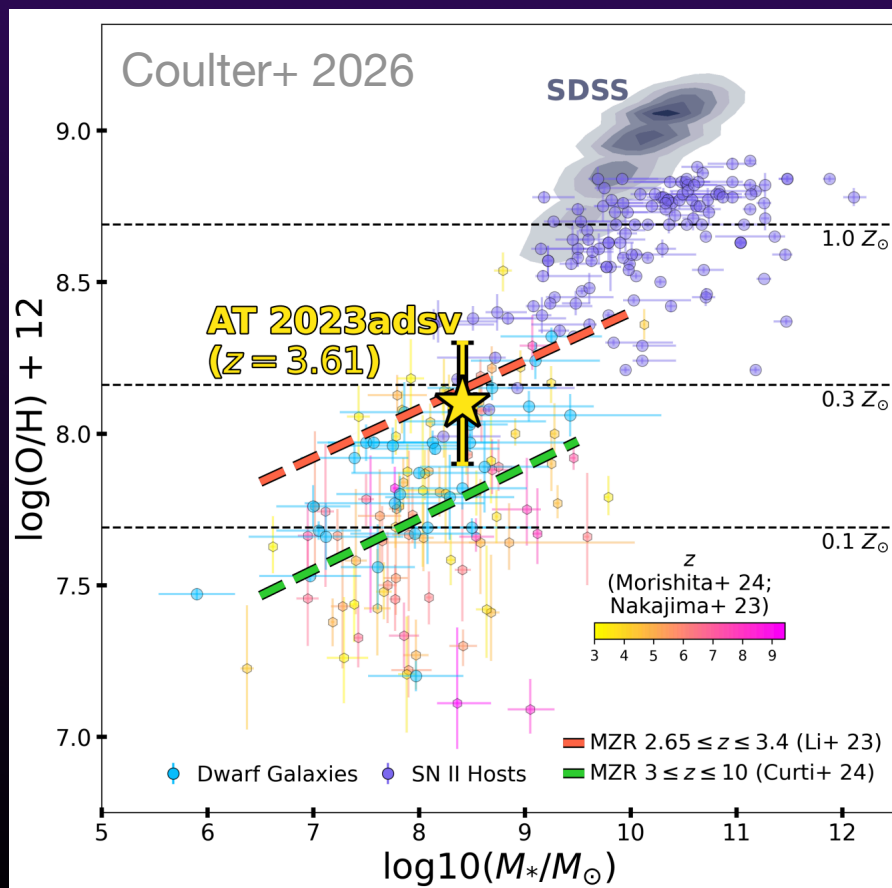
Hydrogen-poor super luminous supernovae occur in the most extreme environments at both low and high redshift

A visualization of the cosmic web, showing a dense network of purple filaments and nodes against a dark background. Numerous galaxies are scattered throughout, some appearing as bright blue/white points and others as fainter, more diffuse structures. The overall structure is complex and interconnected, representing the large-scale distribution of matter in the universe.

Host galaxies will not only be valuable in transient discovery and classification, but also for understanding the progenitors and redshift evolution of different transient types



Are transients different at high- z ?



How do transients track mass, star formation, and metallicity at high- z ?

Are transient hosts different at high- z than at low- z ?

What can the evolution of host properties tell us about the evolution of transient progenitor formation channels?

What is the redshift-dependent rate of CCSNe? What does this say about massive star production?

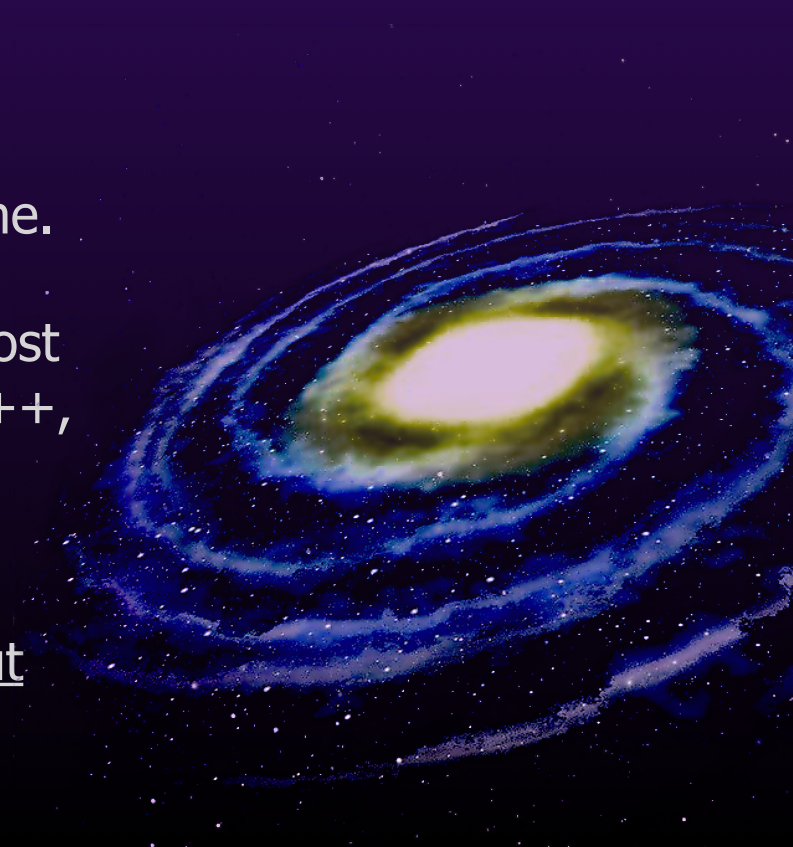
Conclusions

Host galaxy studies will be vital for identifying transient classes and discovering the unique origins of high-redshift Roman transients

Host galaxy studies will aid us in understanding how transients and their progenitors evolve over cosmic time.

There are many tools that can help us achieve rapid host characterization in the Roman era - FrankenBlast, SBI++, photo-z tools (e.g., RAIL)

We will soon have a web server to publicize transient host galaxy properties in Roman fields. Let's chat about what you would like to see on there!



Nested sampling is quite slow and computationally expensive....

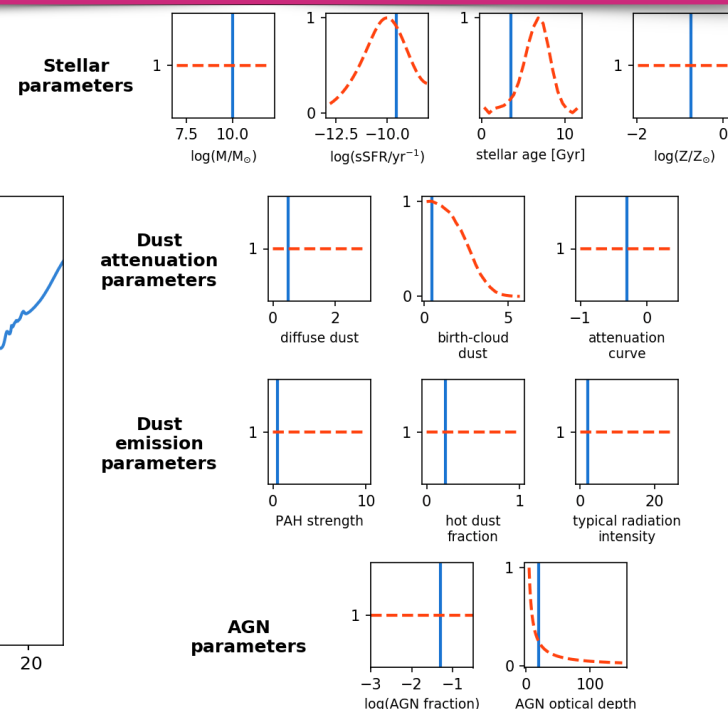
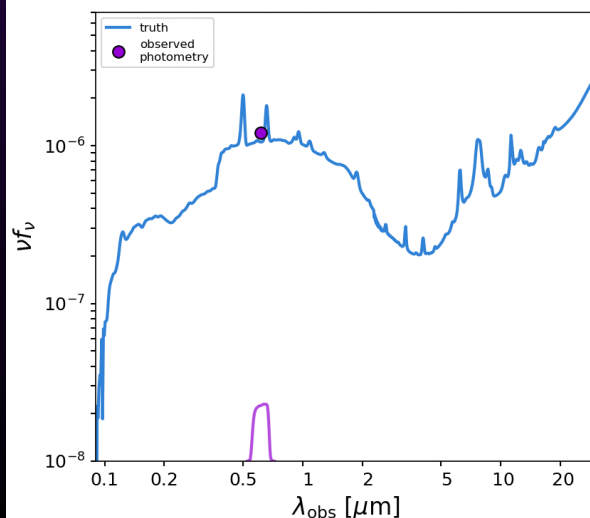


This is why SBI++ is far better for fitting a large population of transient hosts!

Fits can take anywhere between 30 minutes - 2 days (1 node, 20 tasks on supercomputer) depending on model complexity and breadth of observational data

That's like several billion years to fit all Rubin galaxies!

optical: SDSS *r*



We will soon be able to study redshift evolution of transients in the same way that has been done for long GRBs!

