



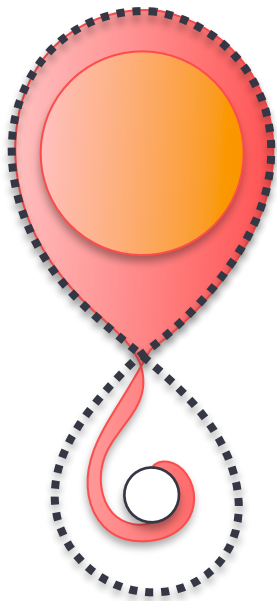
HOST-GALAXY CORRELATIONS AND MACHINE LEARNING FOR TRANSIENT STUDIES WITH UPCOMING SURVEYS

ALEX GAGLIANO

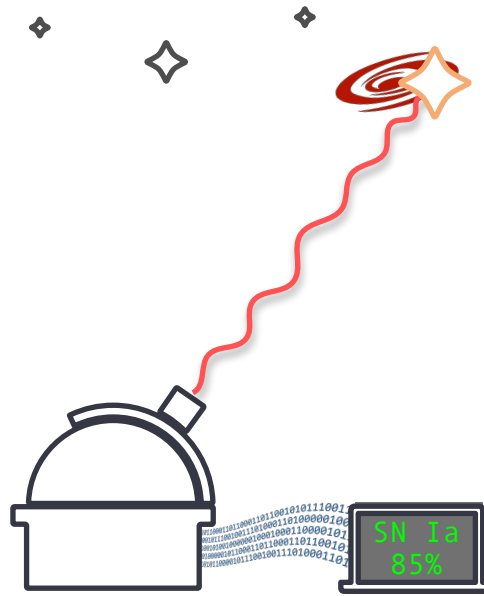
UIUC, CCA PRE-DOCTORAL FELLOW

[*gaglian2@illinois.edu*](mailto:gaglian2@illinois.edu)

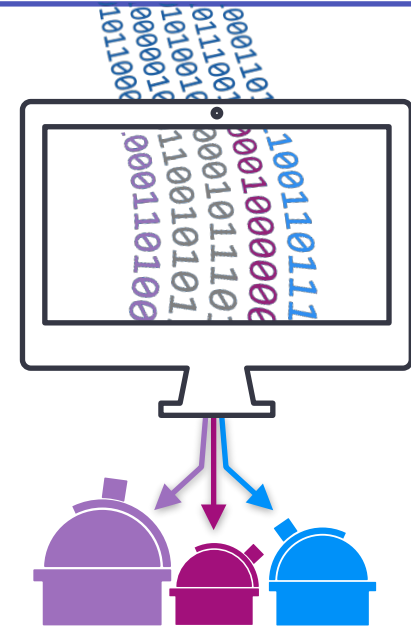
THE VALUE OF CONTEXTUAL INFORMATION FOR TIME-DOMAIN STUDIES



Progenitor Studies



Event Characterization

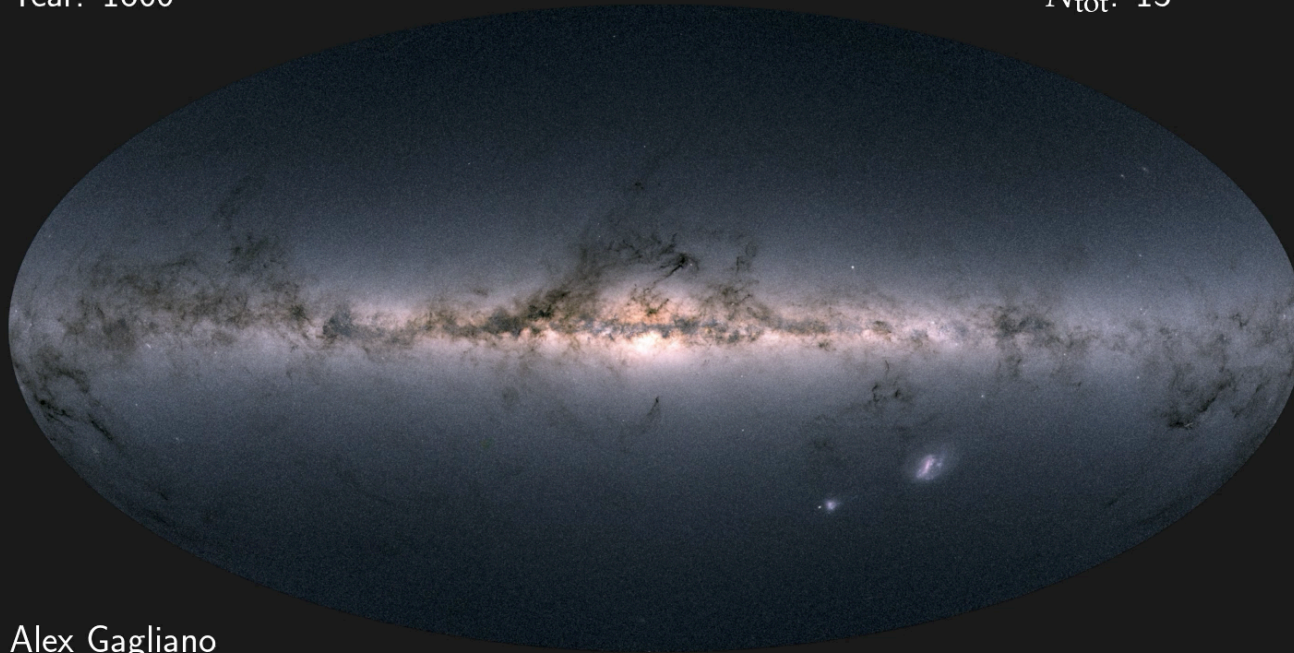


Prompt Follow-up

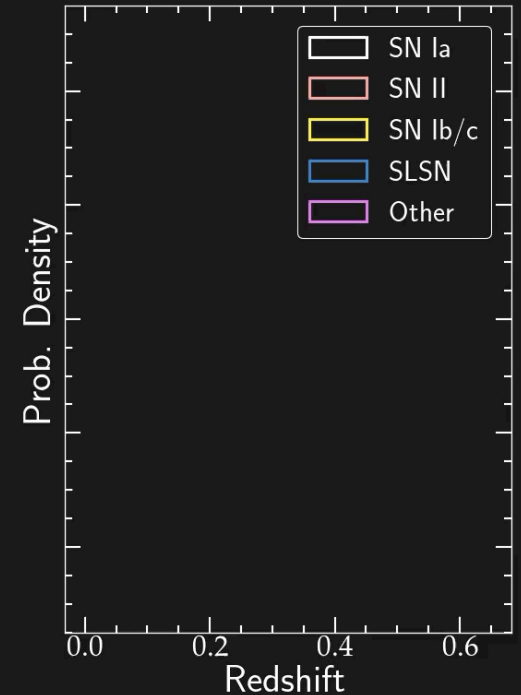
Rapid Event Characterization

Year: 1800

N_{tot} : 13

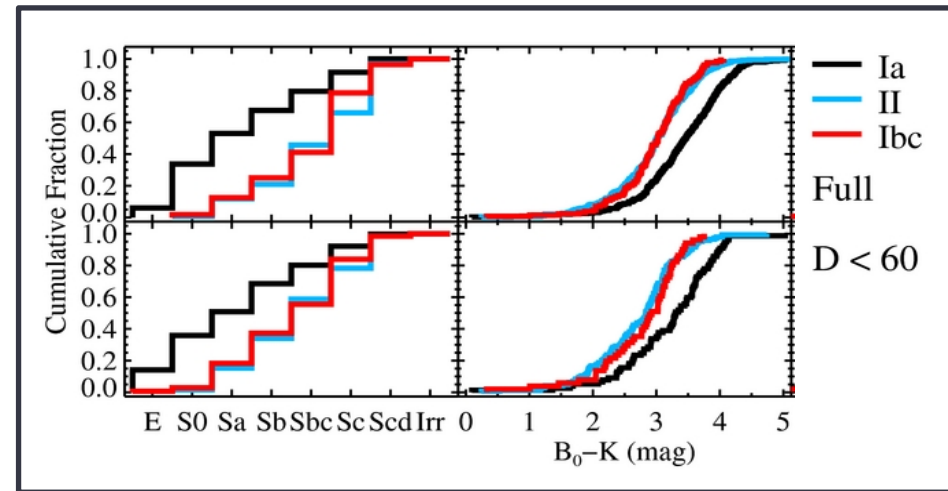
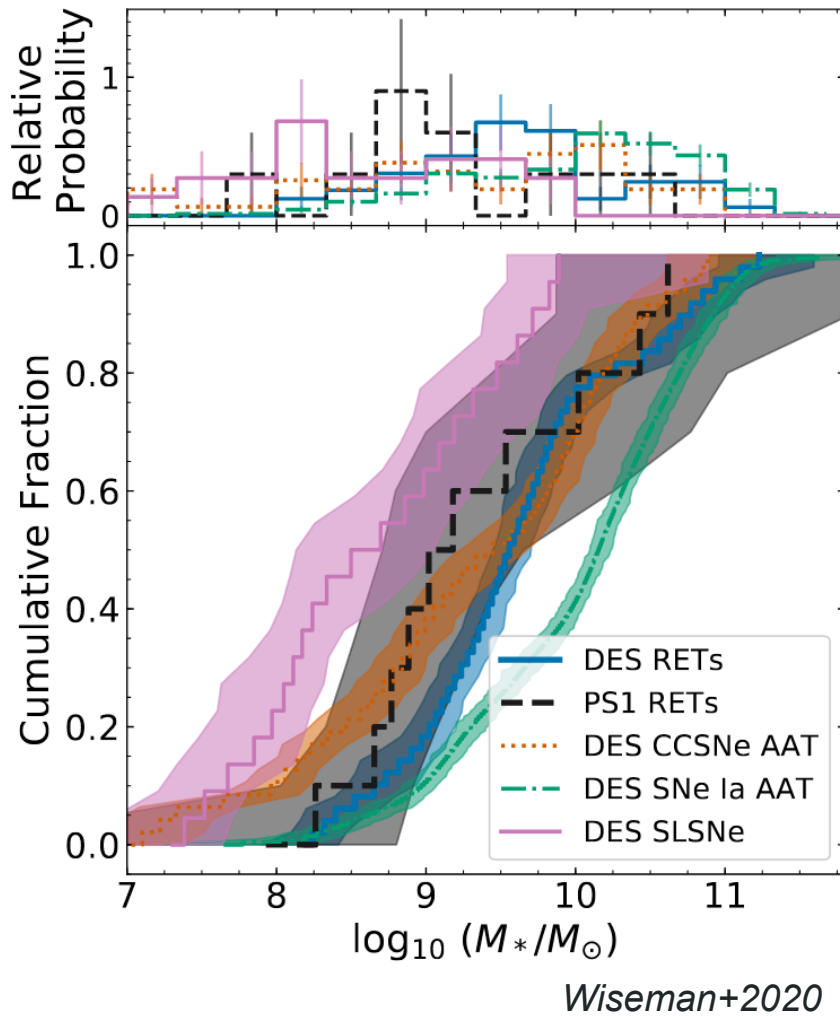


Alex Gagliano



*Rubin will discover ~3M luminous transients in 10 years.
How can we study these systems faster?*

SUPERNOVA-HOST GALAXY CORRELATIONS REFLECT PROGENITORS



Mandel & Foley, 2013

SNe Ia found in **early-type, low sfr, red (old)** galaxies (*Mandel+2013; Anderson+2015*)

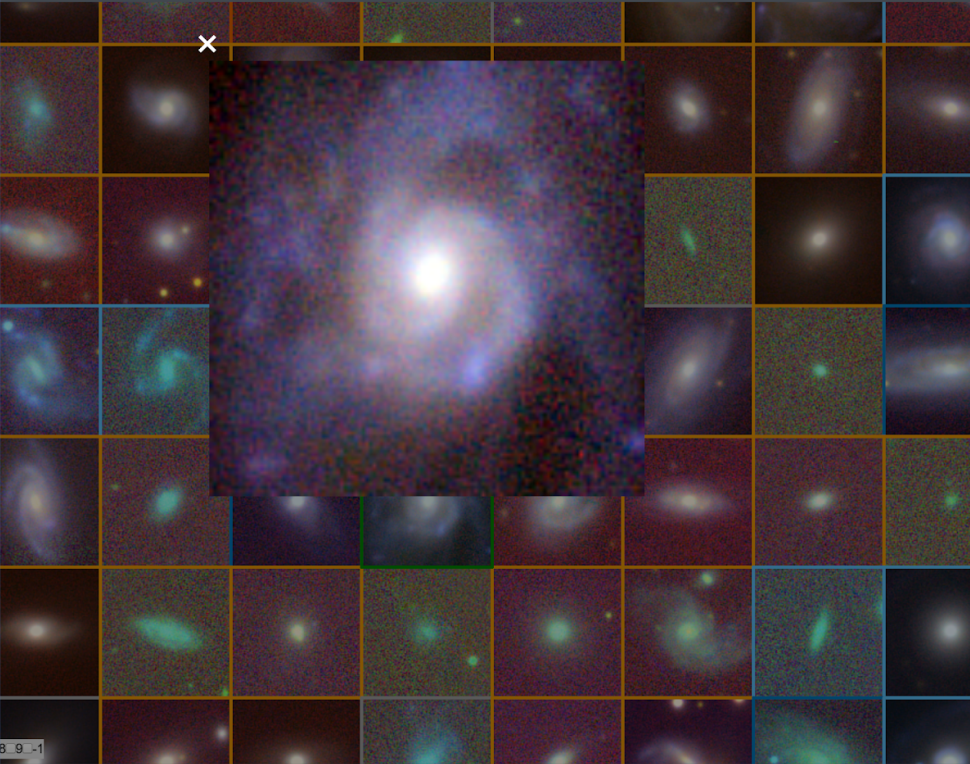
SNe Ic-BL found in **metal-poor galaxies** (*Kelly+2018, Modjaz+2020*);

CC in **star-forming regions** (*Kelly+2012*)

GHOST

GALAXIES HOSTING SUPERNOVAE
AND OTHER TRANSIENTS

GHOS



8 9 -1

Host

Name: IC 1704 **RA,DEC:** 21.7897, 14.7763

Color:

(r - i)	(g - r)	(i - z)	(z - y)
-0.02	0.38	0.28	0.16

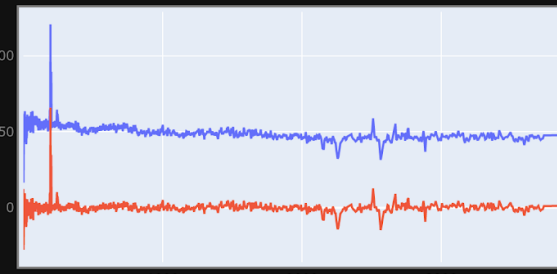
Brightness:

gMag	rMag	iMag	zMag	yMag
17.54	17.16	17.18	16.91	16.75

Type: G **Redshift:** 0.0215

Velocity: 6454 km/s **Aperture Radius:** 3.00

Host Spectra: **Kron Radius:** 16.30



Flux

Rest Wavelength (A)

[Get Host in NED](#)

Supernova

Name: SN2007il **RA,DEC:** 21.7906, 14.7796

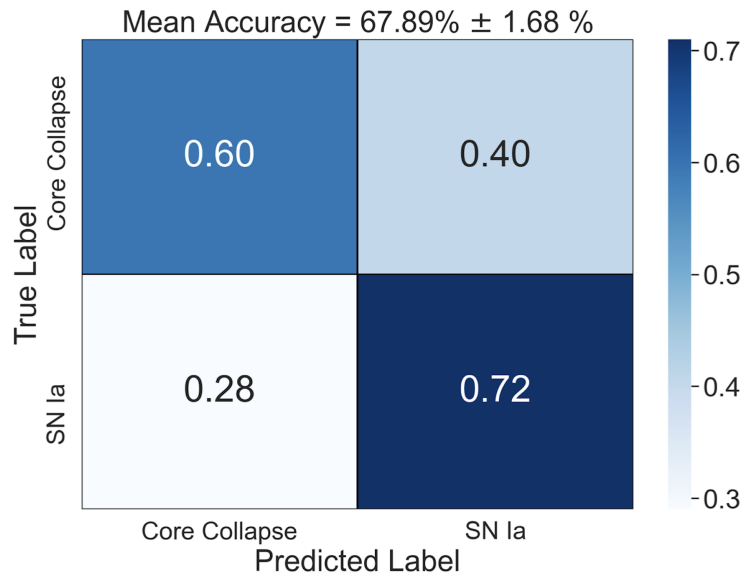
Discovery Date: 2007-09-10 **Redshift:** NaN

Class: II **Discovery Mag:** 18.40

[Get Transient in TNS or OSC](#)

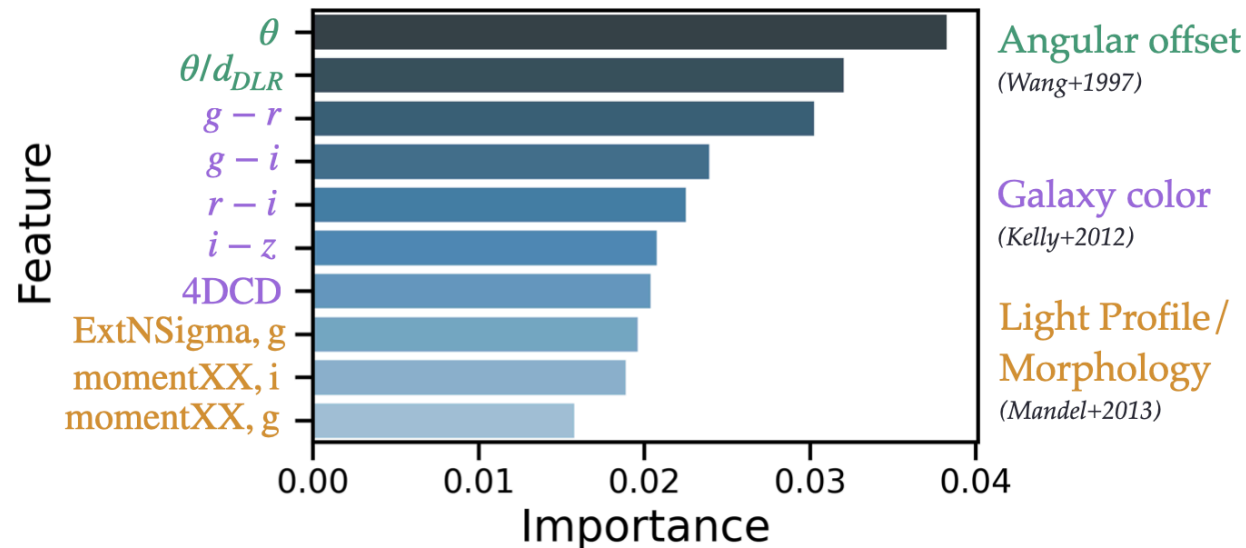
16,228 SNe (78% of events from TNS/OSC) matched to PS1 host galaxies.

BINARY RF CLASSIFICATION USING ONLY PS1 HOST INFO



We predict supernova class with ~70% accuracy *with a single photon from the explosion.*

Homogeneous samples from high-z untargeted searches are needed!



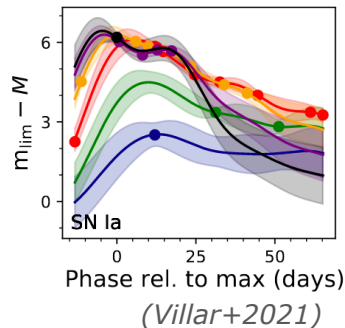
PREPARING ALERT BROKERS FOR WIDER, FASTER, DEEPER DATASETS

PLAsTiCC (2019)

Full-phase light curves to prepare classifiers for LSST

No host-galaxy correlations (photo-zs)

• u • g • r • i • z • y



GHOST

Gagliano+2021a



CosmoDC2

Korytov+2019



ELAsTiCC (2021)

Simulated alert stream with features of most-likely host-galaxy

Transient correlations informed by GHOST database.



Transient-host galaxy correlations will play a vital role in validating software pipelines before VRO first light.

MATCHING GHOST TO COSMODC2

1. *Select redshift-independent properties:*

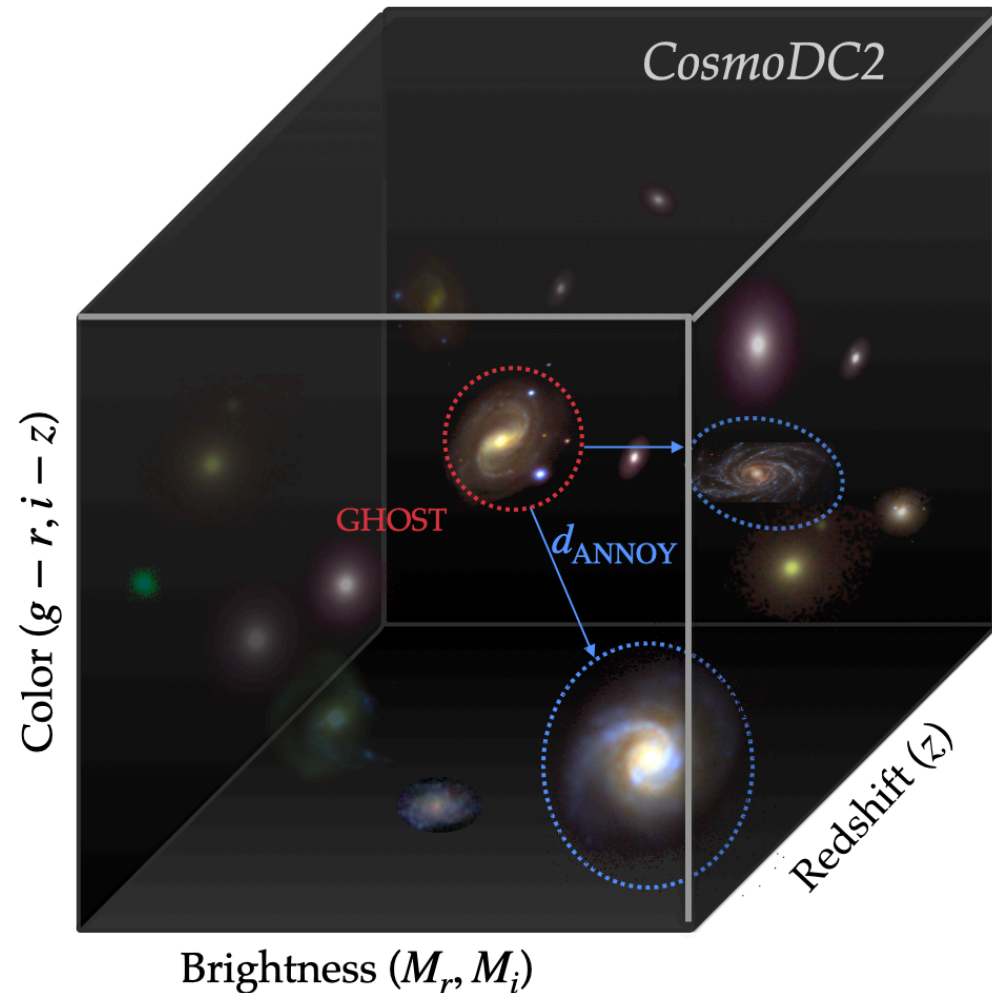
- Rest frame absolute magnitudes (R, I)
- Rest frame colors (g-r, i-z)

2. *Normalize all properties:*

- remove mean and scale to unit variance
- Down-weight redshift

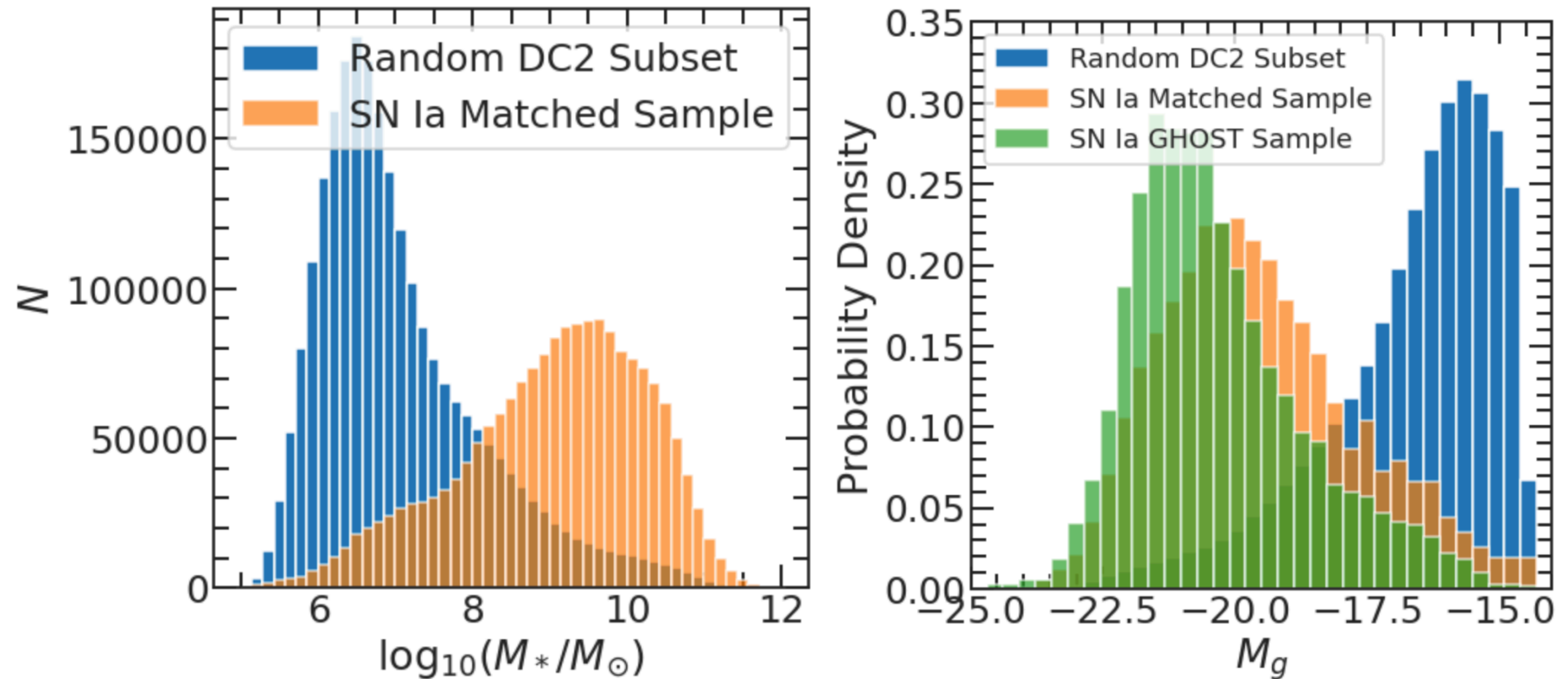
3. *Find k nearest neighbors:*

- Approximate nearest-neighbors (ANNOY) for rapid parallel querying



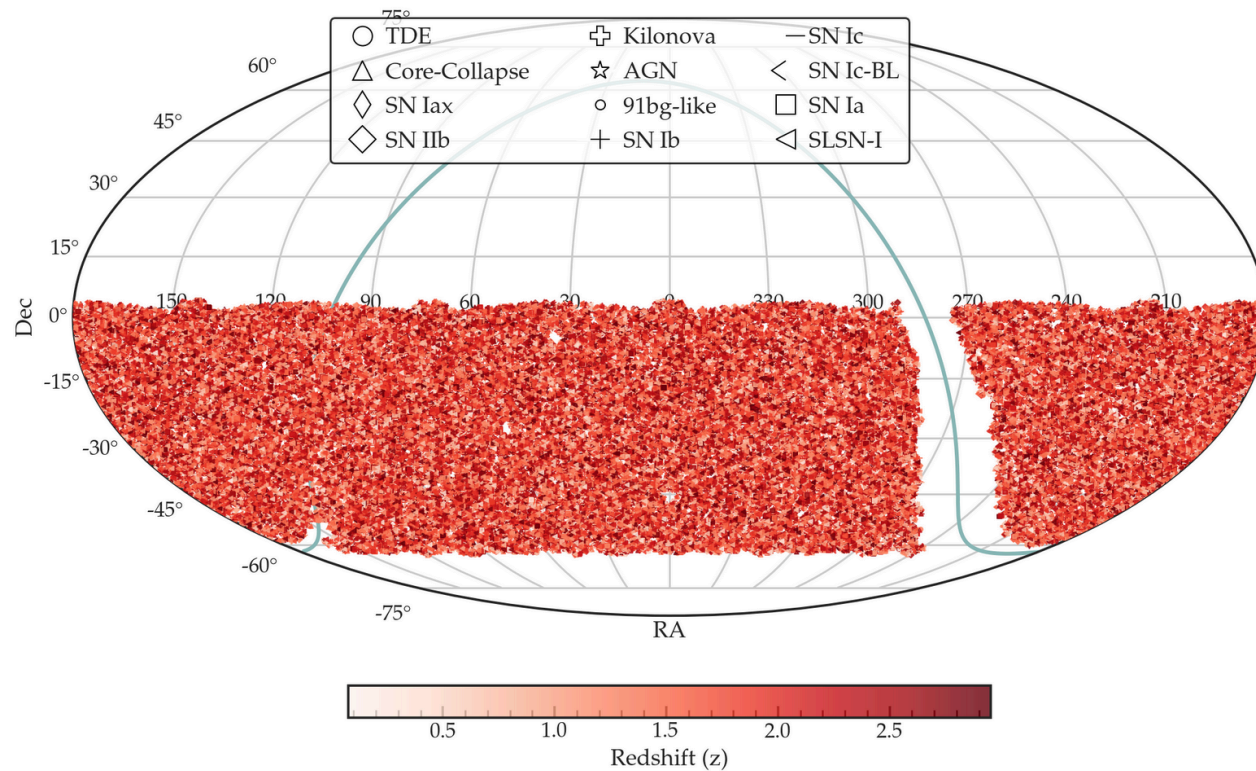
Lokken, Gagliano, et al. (in prep.)

MATCHING EXTENDS GHOST CORRELATIONS TO DERIVED QUANTITIES FOR FAINT, HIGH-Z GALAXIES



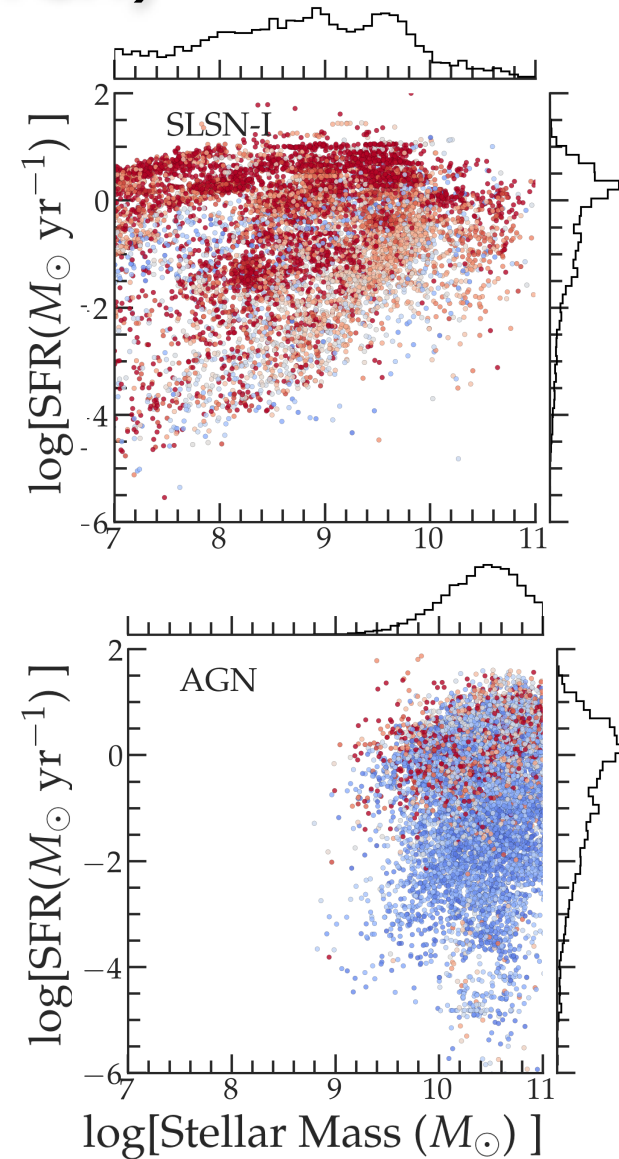
Host-galaxy libraries created for SNe Ia, Ibc, and SLSNe (6M) in 12 min

THE SIMULATED CATALOG OF OPTICAL TRANSIENTS AND CORRELATED HOSTS (SCOTCH)



Truth catalog of 5M explosive transients (to $z \sim 3$) and realistic host galaxy properties (observed + derived).

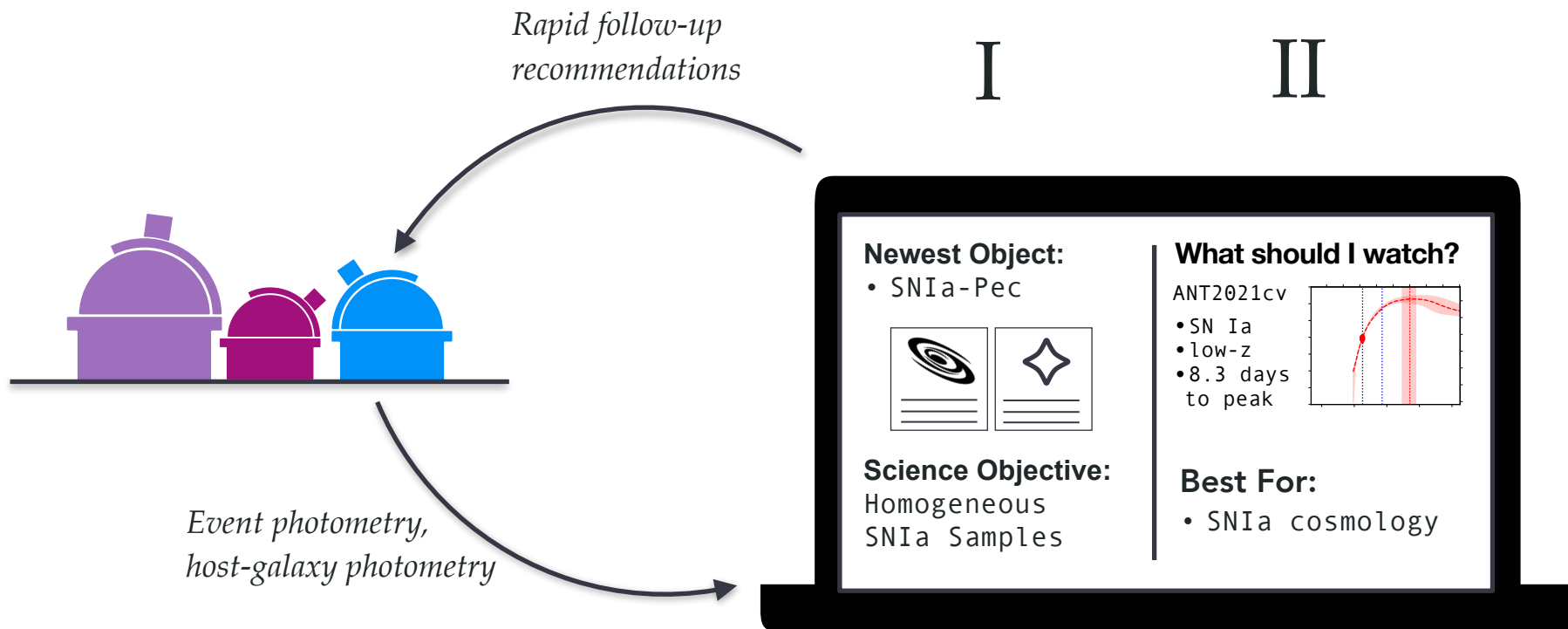
Lokken, Gagliano, et al. (in prep.) entering DESC internal review today and out soon on arxiv!



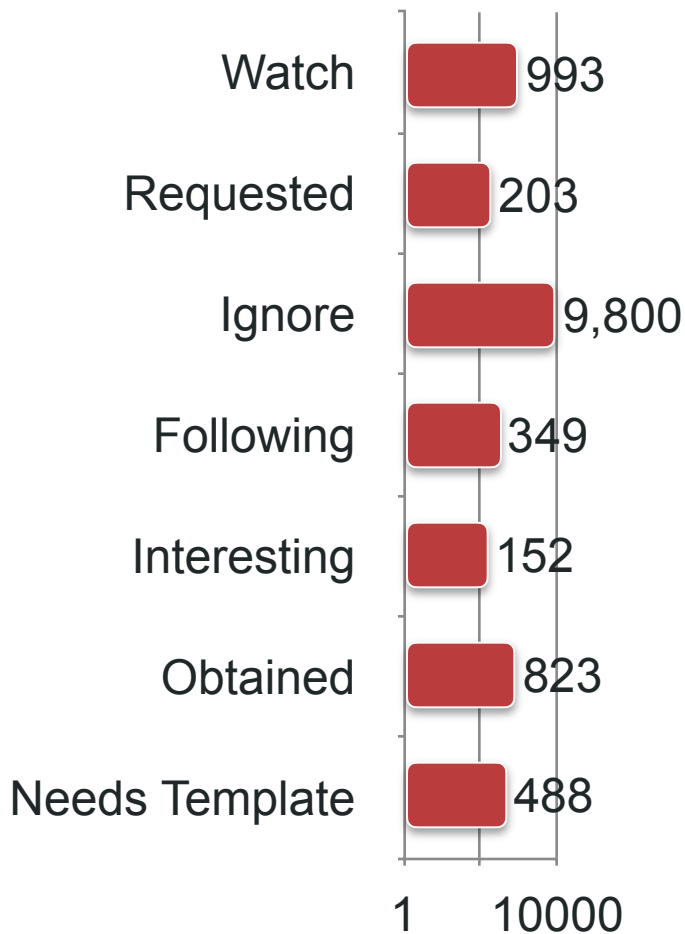
CCA Work: AUTOMATING FOLLOW-UP FOR TARGETED STUDIES OF INTERESTING TRANSIENTS

I. ELAsTiCC+SuperRAENN* Classifier

II. Learning Science-Specific Interests for Follow-Up



CCA WORK: WHAT MAKES A TRANSIENT INTERESTING?

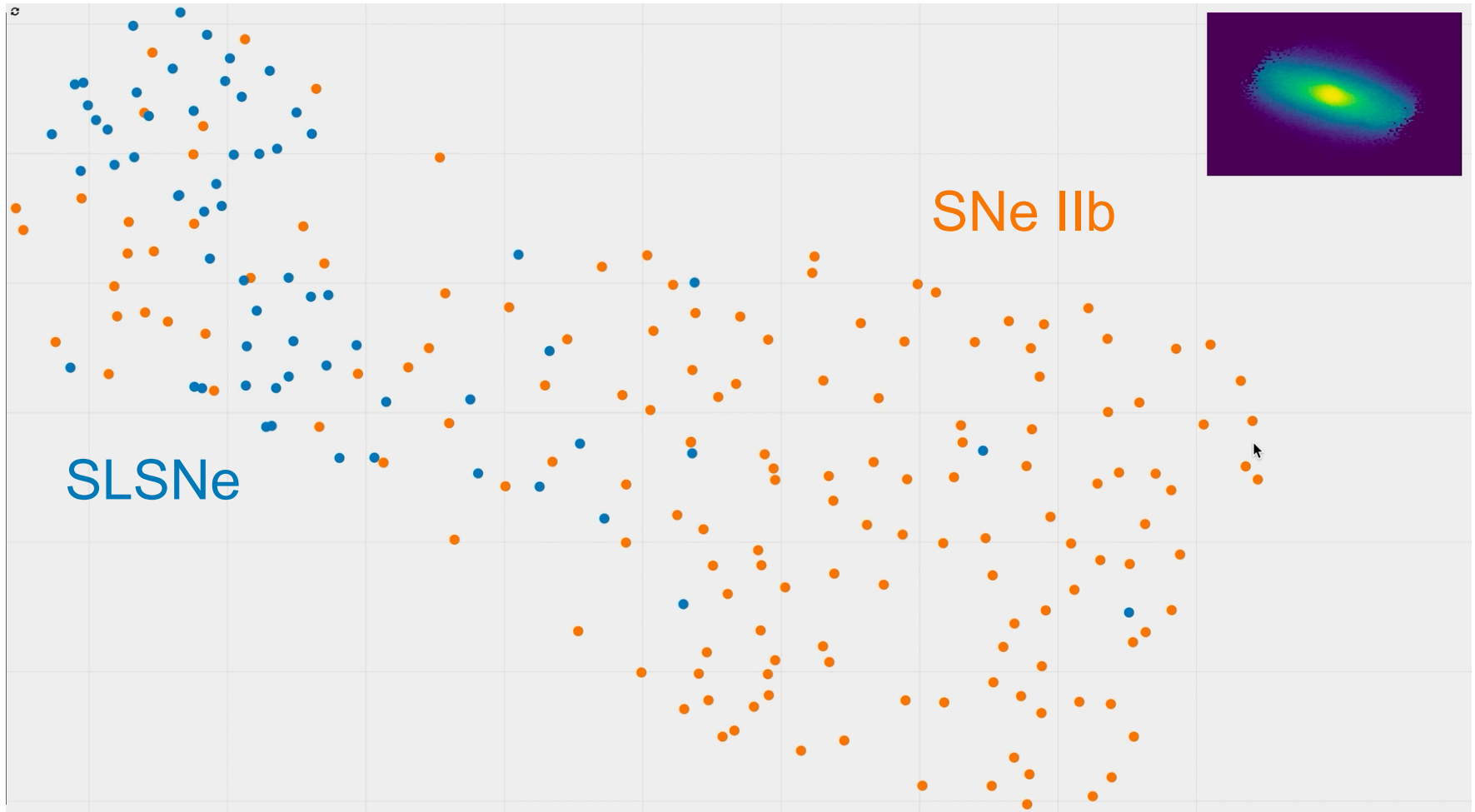


The screenshot shows the YSEPZ web interface. On the left is a dark sidebar with navigation options: Main Dashboard, Alex's Dashboard, Follow Requests, On-Call Calendar, Observing Calendar, Search By Tag, Admin, Query Explorer, Survey Home, Help/How-to, and Follow-up Guidelines. The main content area is titled '2022jo (YSE)' and includes a 'Back' link. Below this are tabs for Summary, Follow-up, Resources, Detailed Photometry, and Spectra. The 'Summary' tab is active, displaying 'Transient Detail (Edit)'. The details are organized into a grid:

R.A./Dec (2000) 13:00:37.67 +28:03:25.77 195.1569405 28.0571589	Disc. Date (UTC) Jan. 10, 2022, midnight	Status: FollowupRequested <input type="button" value="Following"/> <input type="button" value="Watch"/> <input type="button" value="Interesting"/> <input type="button" value="Ignore"/> <input type="button" value="▼"/>
Redshift 0.0265	Best Spec. Class SN II	TNS Spec. Class SN II
Galactic l/b 57.9835747 87.7620179	MW E(B-V) 0.009	QUB Status CONFIRMED

Investigating event features (host + SN) that correlate most strongly with follow-up requests.

ENCODING PIXEL-LEVEL INFORMATION INTO REAL-TIME CLASSIFICATION



Adapted from Prof. Carlos Scheidegger

ALERCE BROKER USES PIXEL-LEVEL HOST INFORMATION; OTHERS WILL SOON FOLLOW SUIT!

The screenshot displays the ALERCE ZTF Explorer interface. On the left is an object list with 'ZTF21aawogdl' selected. The main panel shows details for this object, including its discovery date (Mon, 19 Apr 2021) and last detection (Sat, 05 Jun 2021). A 'Light Curve' plot shows magnitude versus Modified Julian Dates, with data points for g, r, and non-detections. A 'Stamp Classifier' is highlighted with a red box, showing a radar chart with 'SN' as the most likely classification. Below the classifier are three images: Science, Template, and Difference, each with a 'DOWNLOAD' button. The interface also includes a 'Magnitude Statistics' table and various navigation and control buttons.

stat	g	r
stellar	false	false
corrected	false	true
ndet	9	12
ndubious	0	6
magmean	19.596	19.076

<https://alerce.online/>

CONCLUSIONS

Host galaxies are an underutilized resource for early studies of transient events.

The **astro_ghost** (pip-installable!) package provides new tools for **associating transients** and consolidating host properties (Gagliano+2021).

Embedding realistic host correlations within **ELAsTiCC data** is crucial for **validating analysis pipelines** for upcoming surveys (Lokken & Gagliano, in prep).

Contextual information + ML can enable fast follow-up for specific science goals (CCA).