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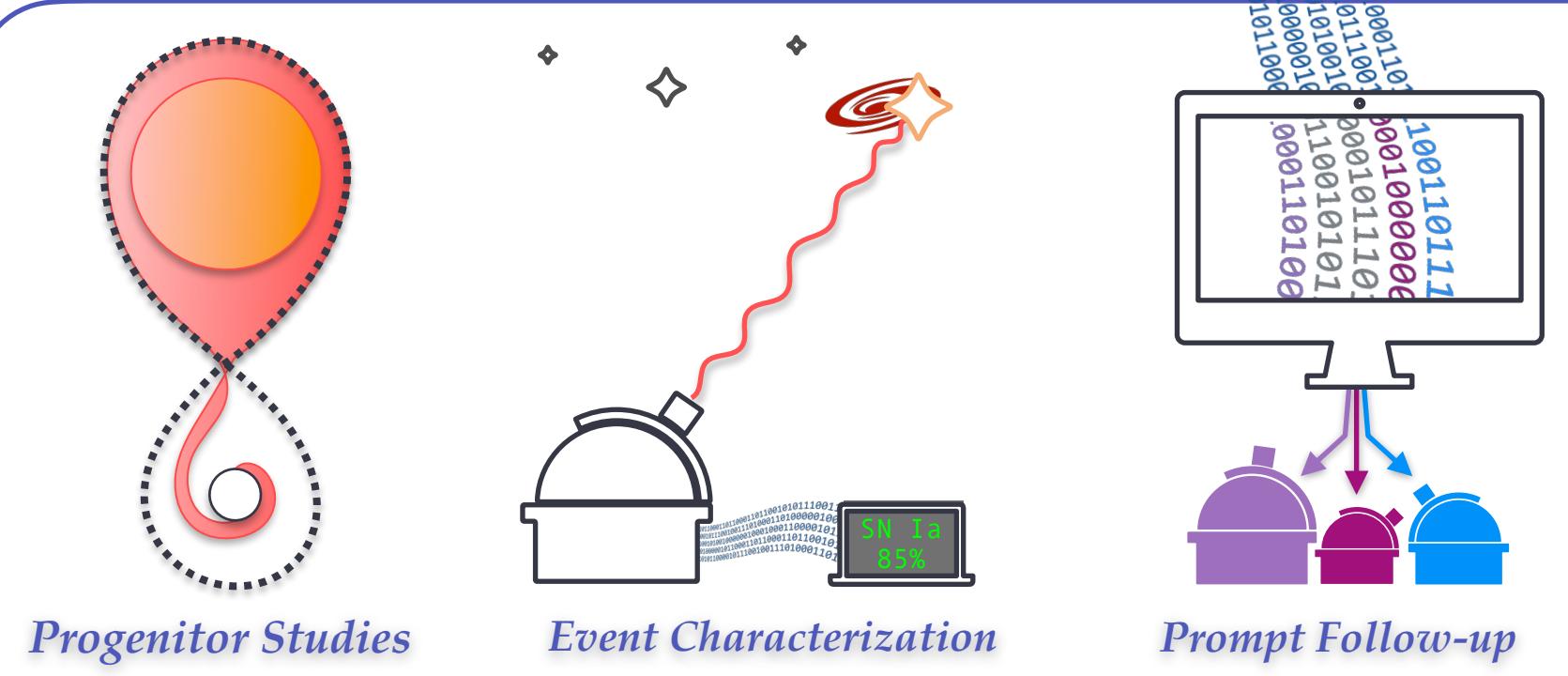
HOST-GALAXY CORRELATIONS AND MACHINE LEARNING FOR TRANSIENT STUDIES WITH UPCOMING SURVEYS

ALEX GAGLIANO

UIUC, CCA PRE-DOCTORAL FELLOW

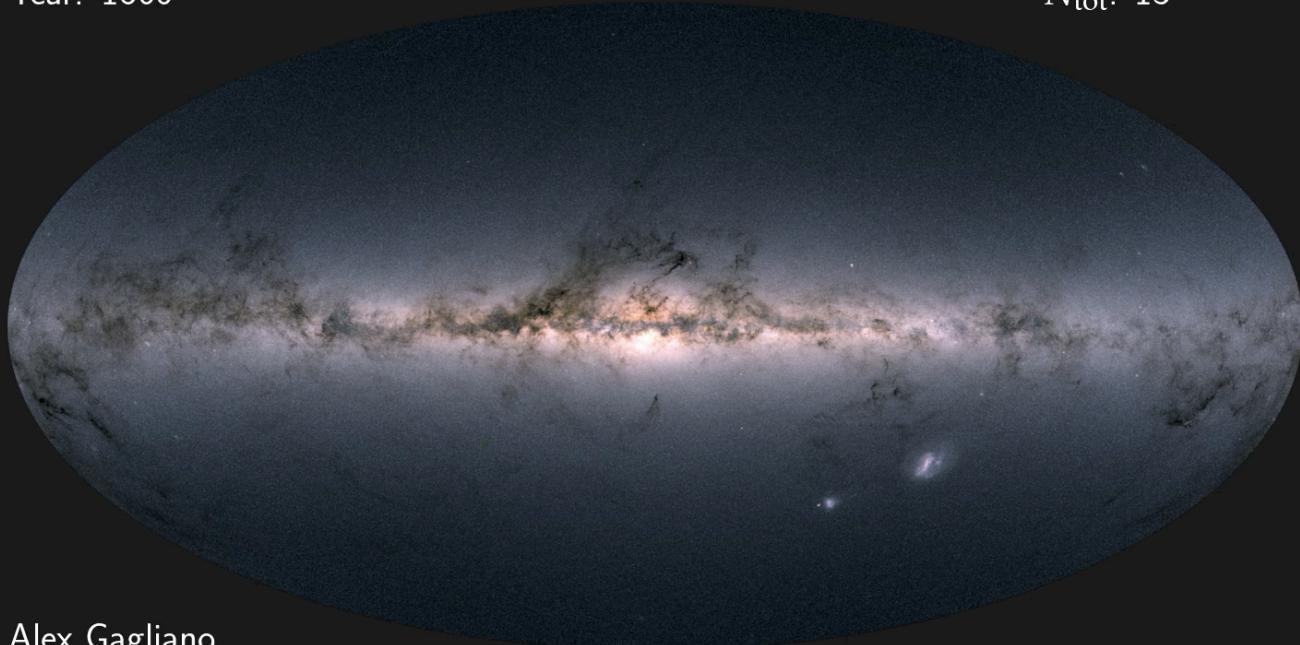
gaglian2@illinois.edu

THE VALUE OF CONTEXTUAL INFORMATION FOR TIME-DOMAIN STUDIES

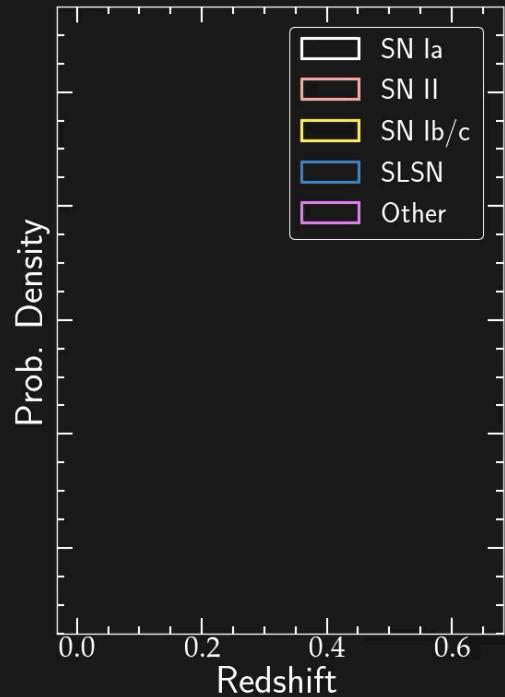


Rapid Event Characterization

Year: 1800



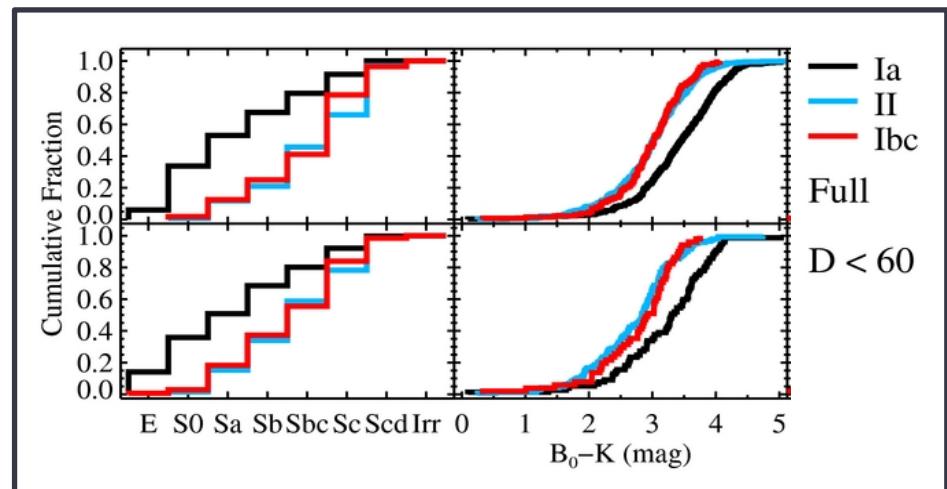
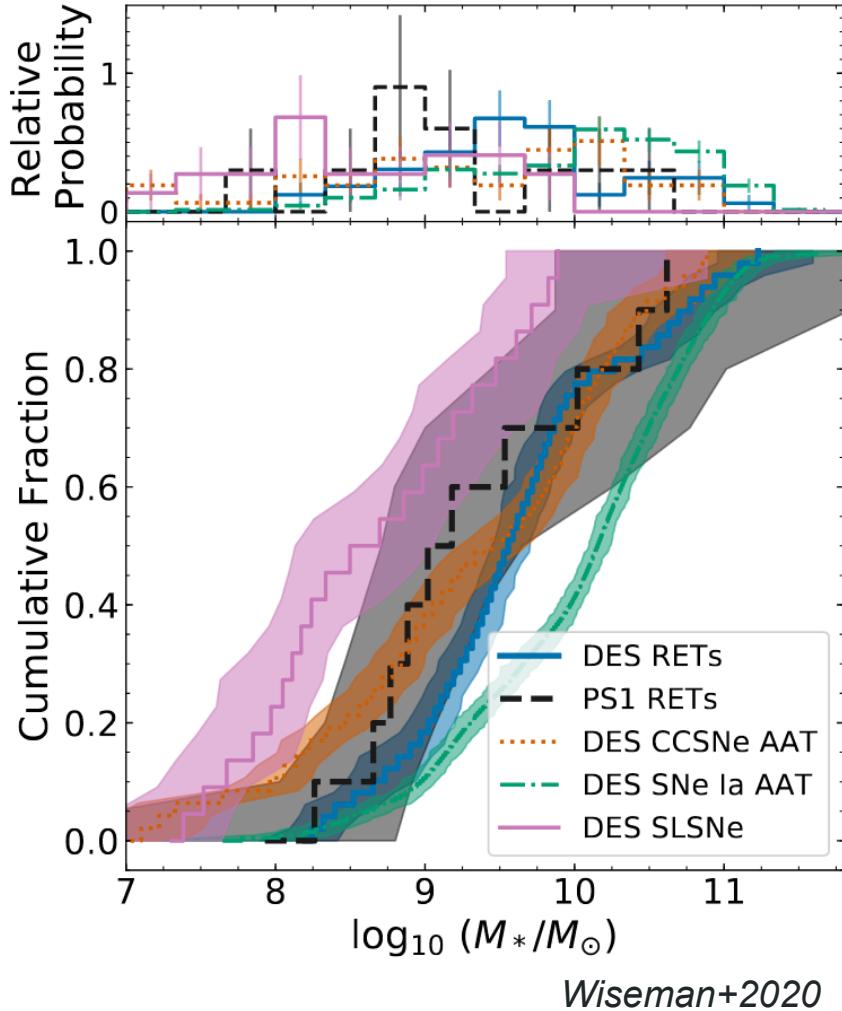
N_{tot} : 13



Alex Gagliano

*Rubin will discover $\sim 3M$ 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)

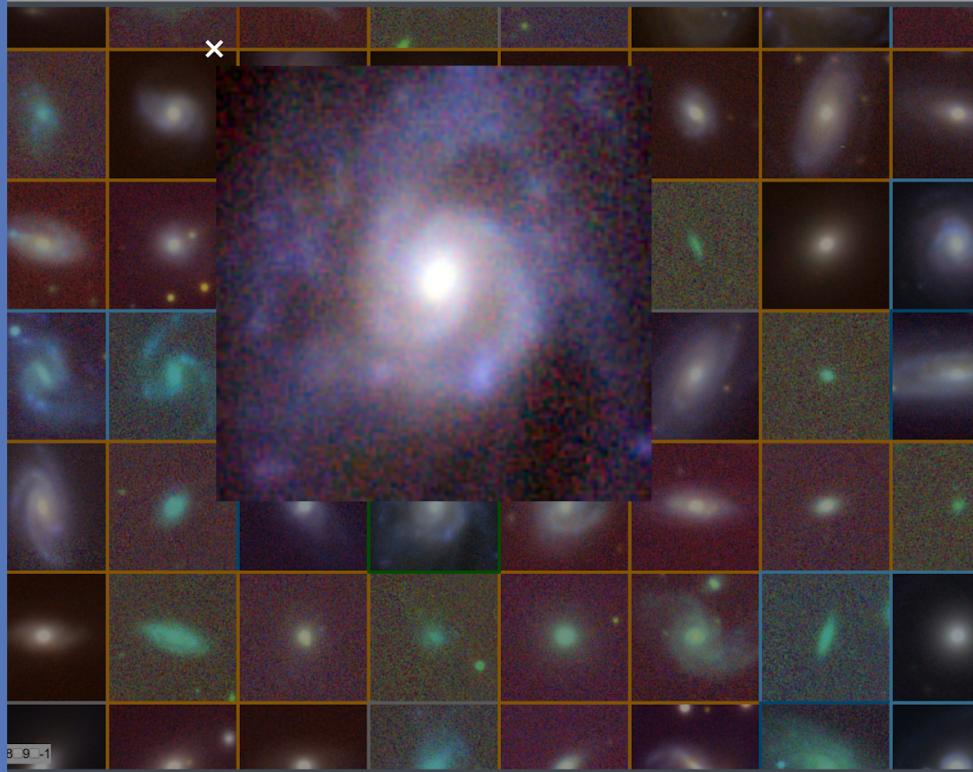
SNe Ic-BL found in **metal-poor galaxies** (Kelly+2018, Modjaz+2020);

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

GHOST

GALAXIES HOSTING SUPERNOVAE
AND OTHER TRANSIENTS

GHOS



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

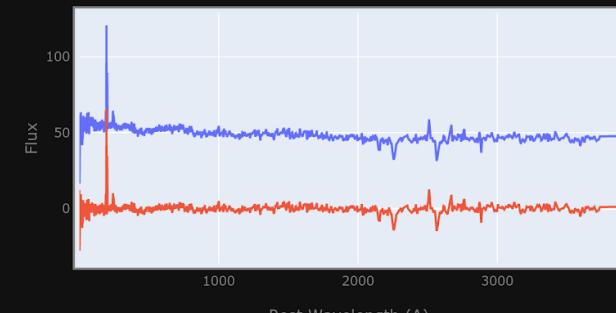
Redshift: 0.0215

Velocity: 6454 km/s

Aperture Radius: 3.00

Host Spectra:

Kron Radius: 16.30



[Get Host in NED](#)

Supernova

Name: SN2007il

RA,DEC: 21.7906, 14.7796

Discovery Date:

Redshift: NaN

2007-09-10

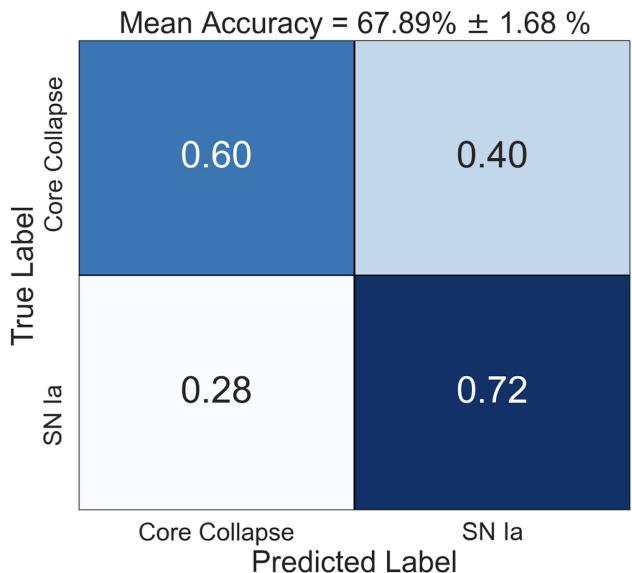
Discovery Mag: 18.40

Class: II

[Get Transient in TNS or OSC](#)

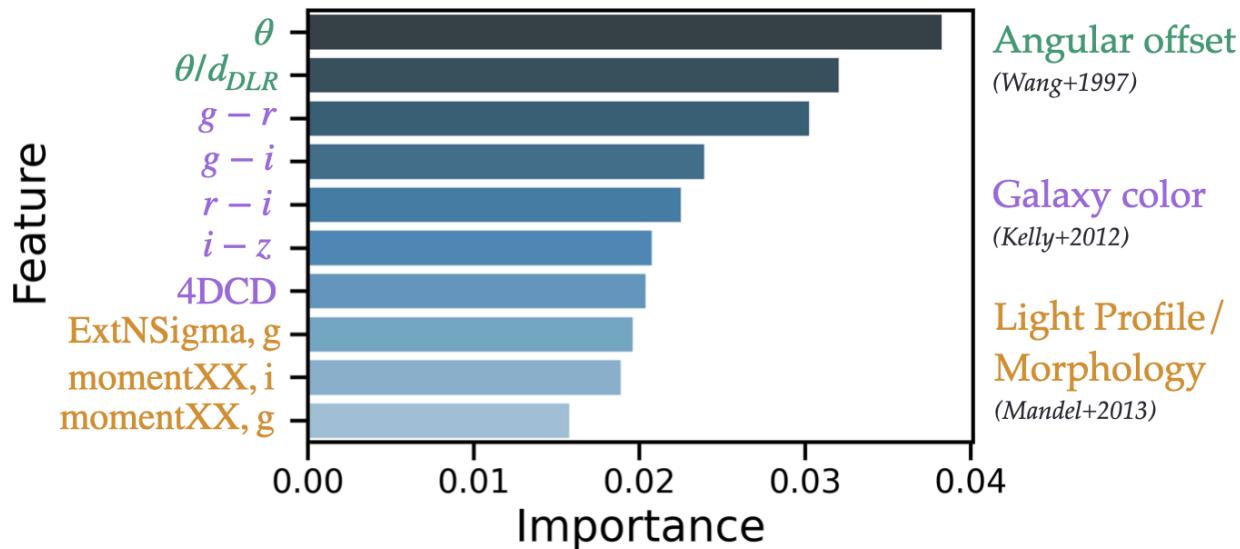
16,228 SNe (78% of events from TNS/OSC) matched to PS1 host galaxies.

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!

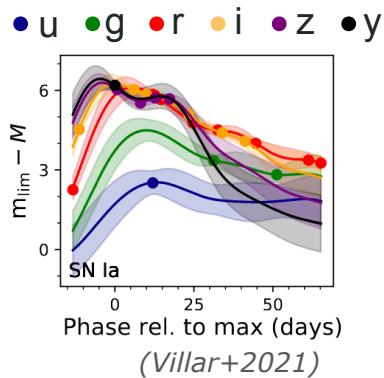


PREPARING ALERT BROKERS FOR WIDER, FASTER, DEEPER DATASETS

PLAsTiCC (2019)

Full-phase light curves to prepare classifiers for LSST

No host-galaxy correlations (photo-zs)



GHOST

Gagliano+2021a



ELAsTiCC (2021)

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

Transient correlations informed by GHOST database.



CosmoDC2

Korytov+2019



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

MATCHING GHOST TO COSMO DC2

1. Select redshift-independent properties:

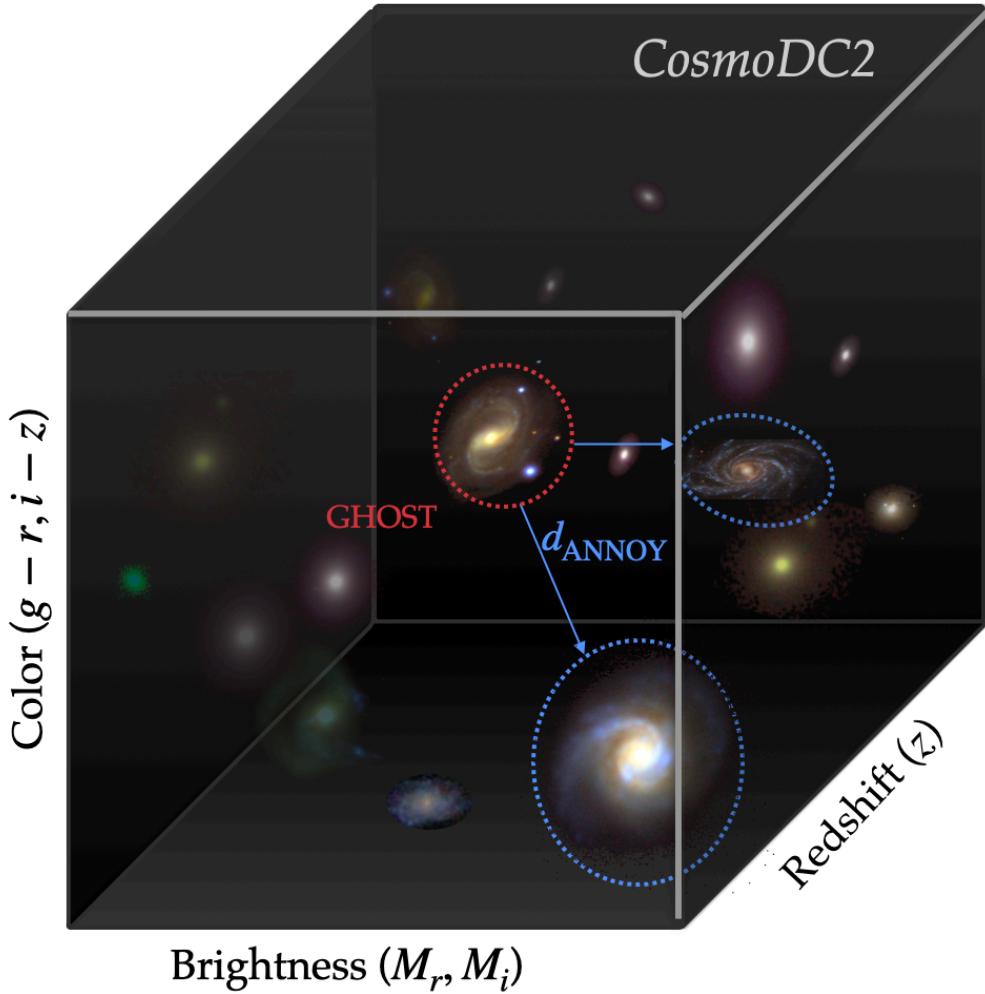
- Rest frame absolute magnitudes (R, I)
- Rest frame colors ($g-r$, $i-z$)

2. Normalize all properties:

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

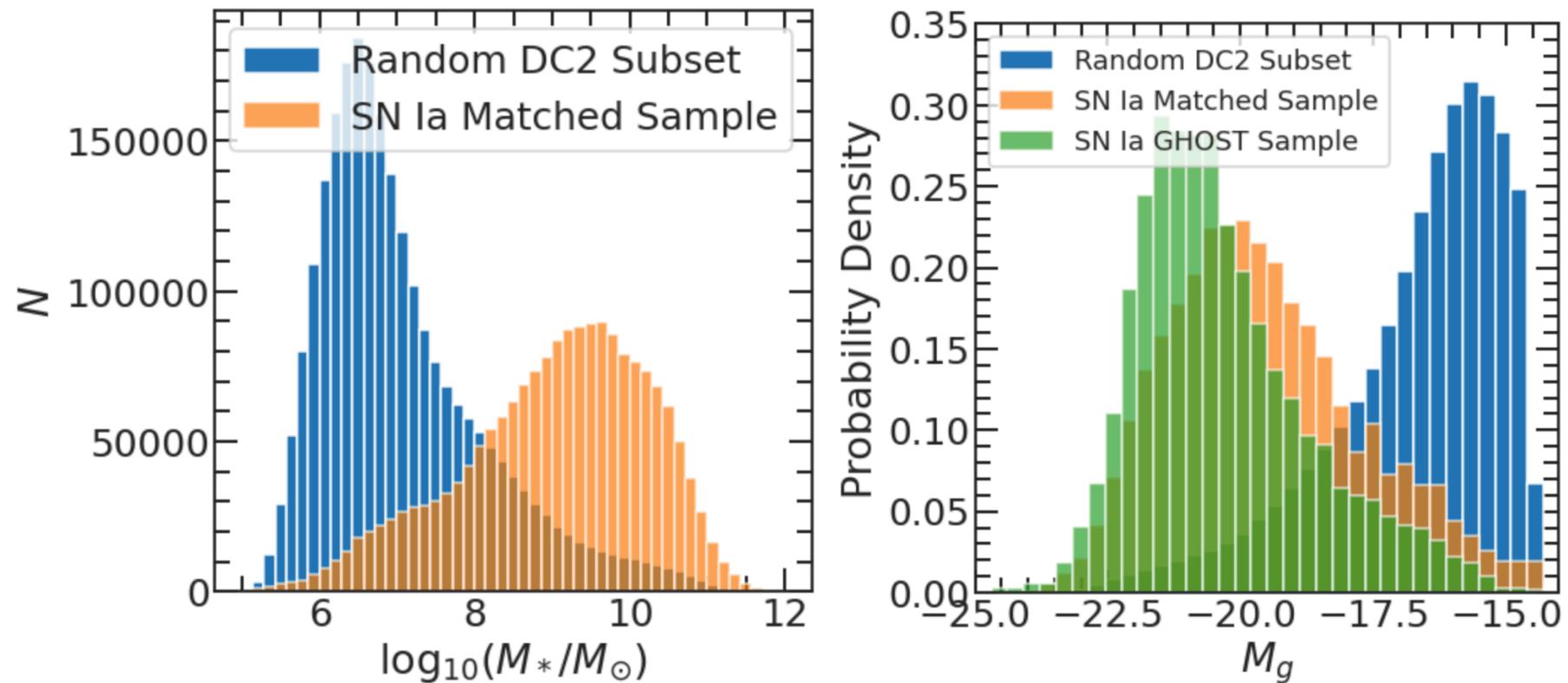
3. Find k nearest neighbors:

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



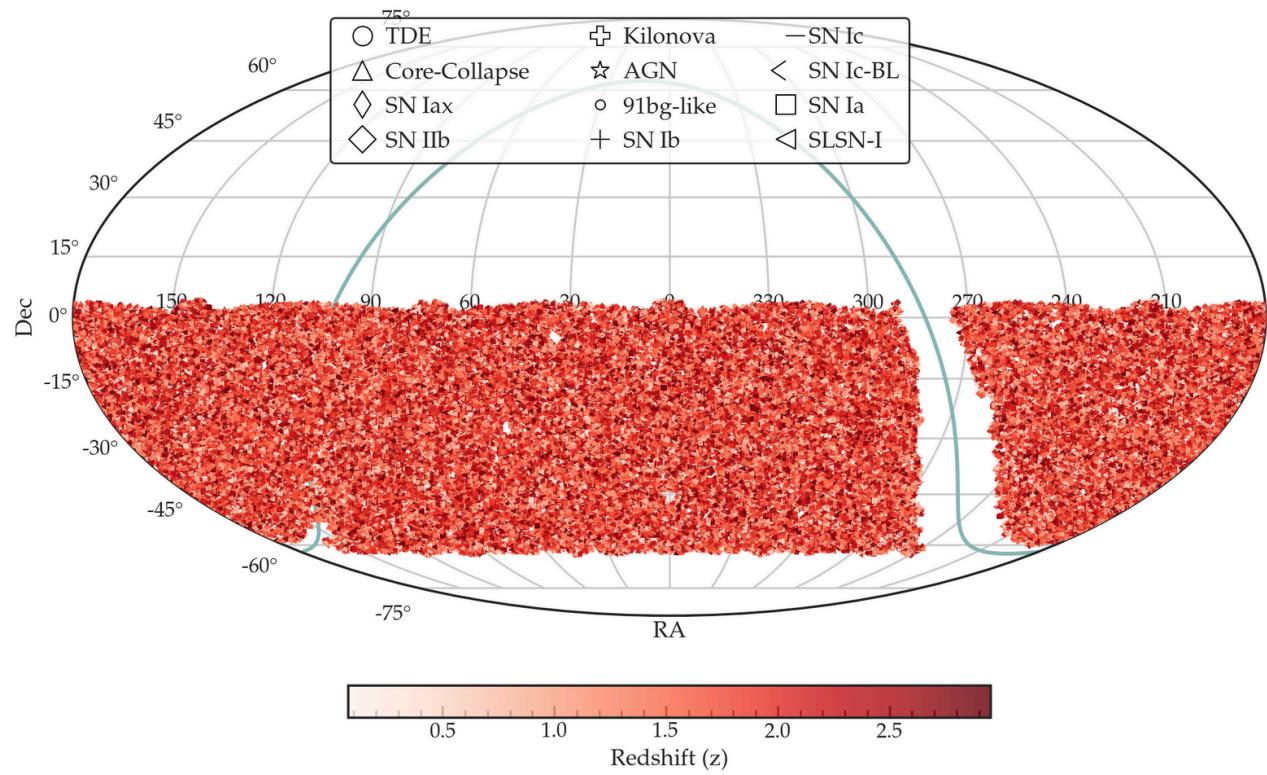
Lokken, Gagliano, et al. (in prep.)

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



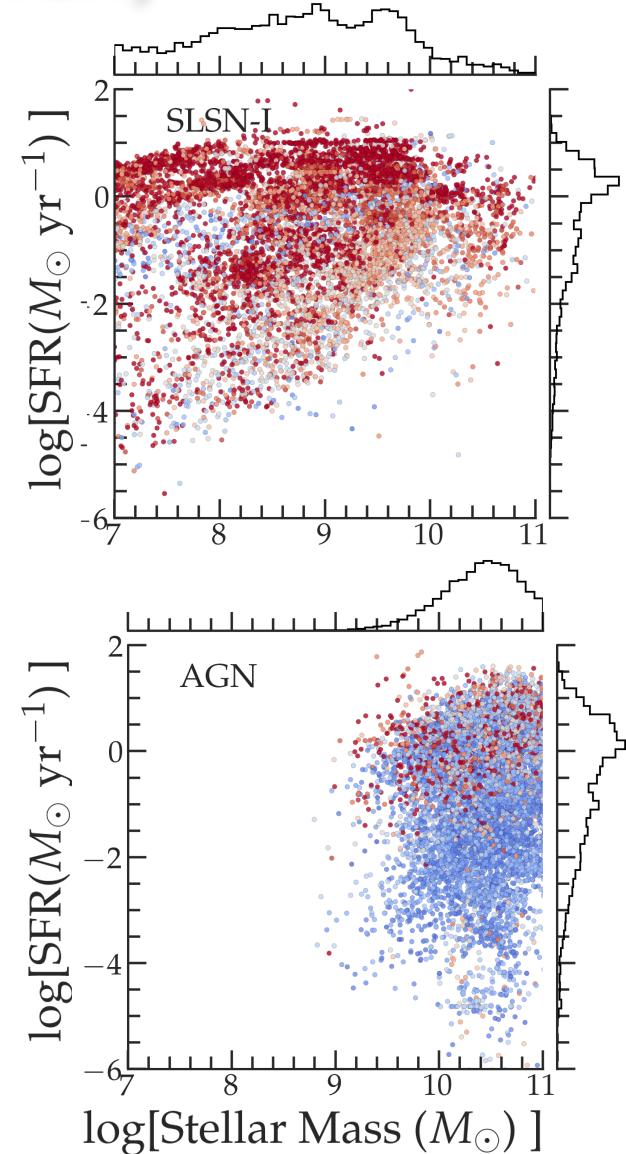
Host-galaxy libraries created for SNe Ia, IbC, and SLSNe (6M) in 12 min

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).

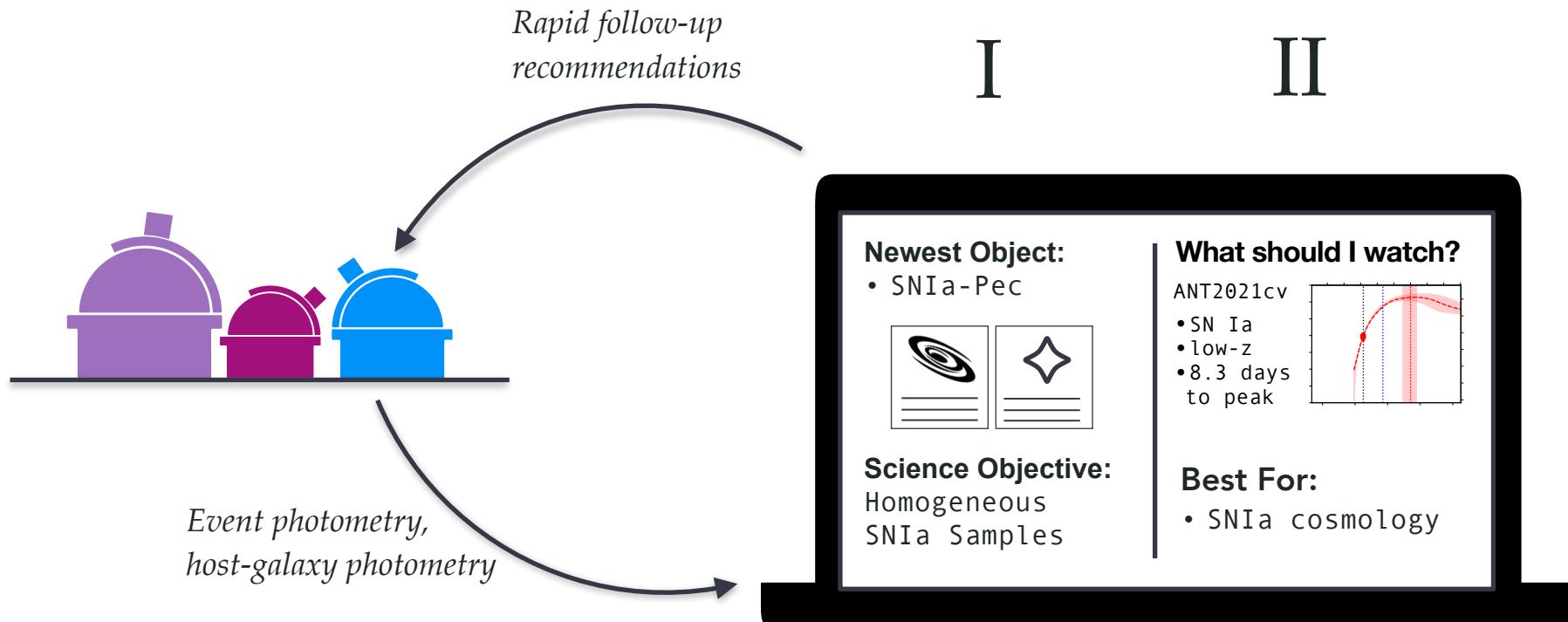
Lokken, Gagliano, et al. (in prep.) entering DESC internal review today and out soon on arxiv!



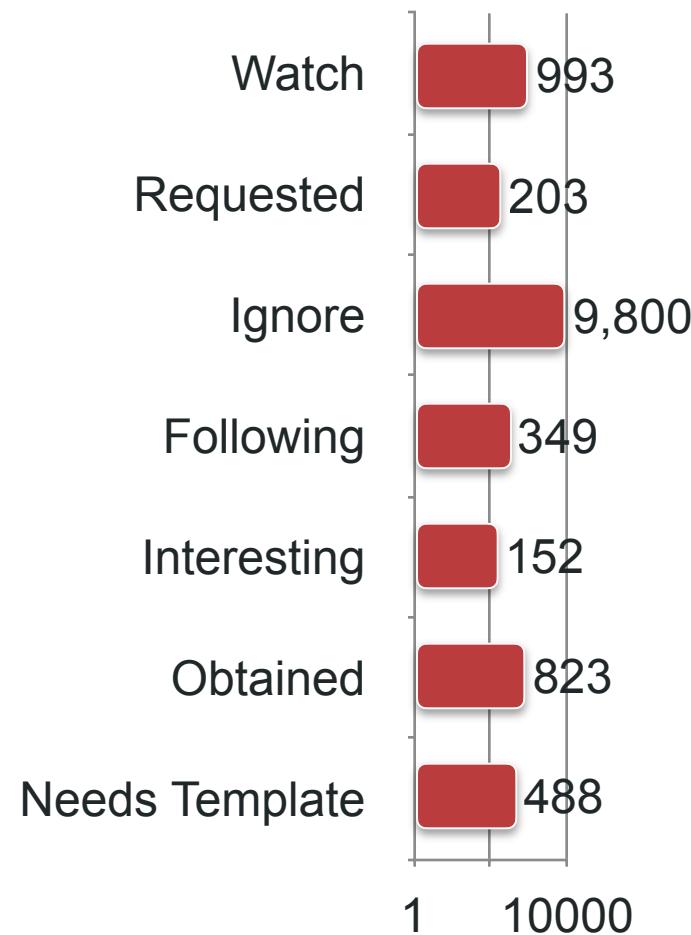
CCA WORK: AUTOMATING FOLLOW-UP FOR TARGETED STUDIES OF INTERESTING TRANSIENTS

I. ELAsTiCC+SuperRAENN* Classifier

II. Learning Science-Specific Interests for Follow-Up



CCA WORK: WHAT MAKES A TRANSIENT INTERESTING?

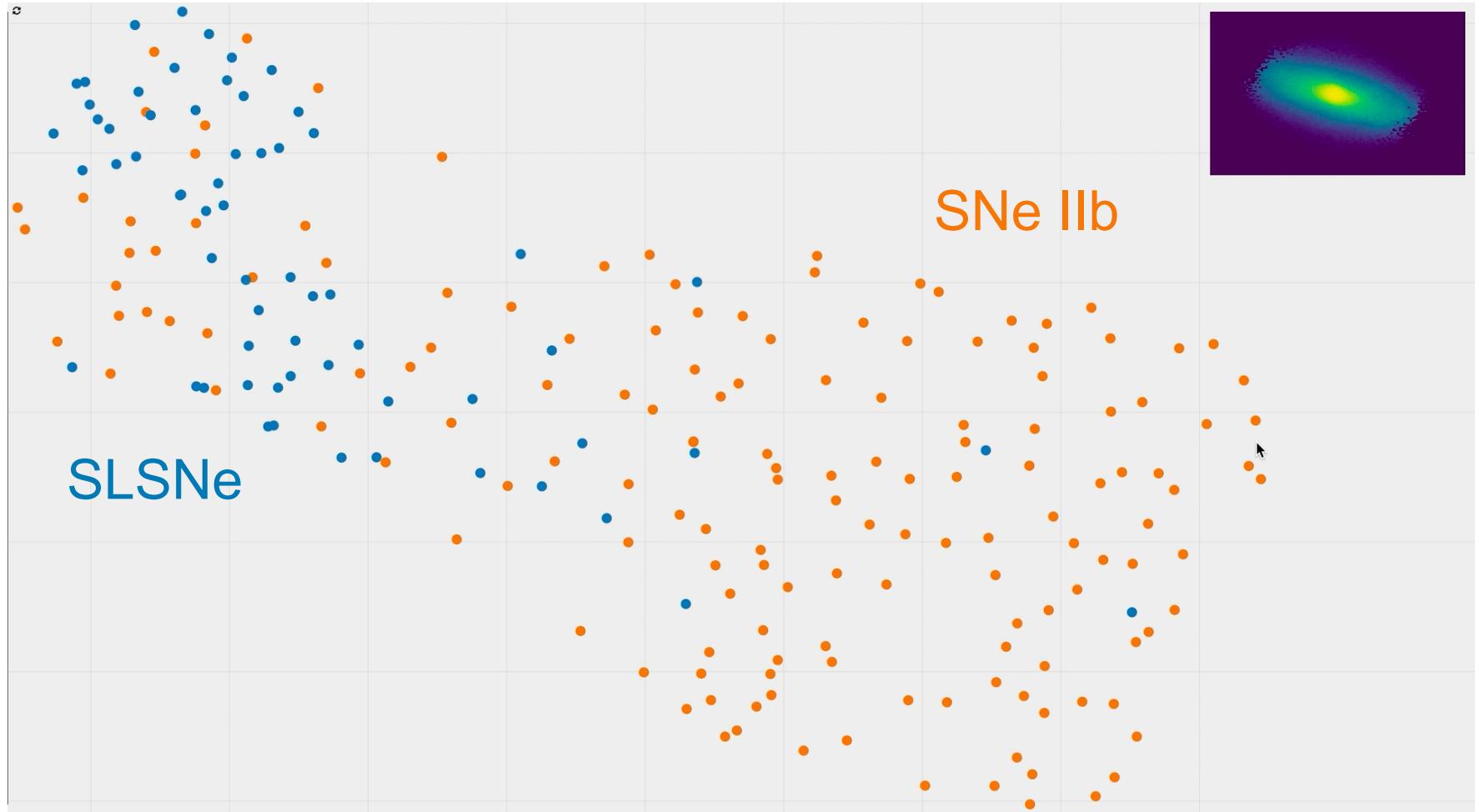


The screenshot shows the YSEPZ web application. The left sidebar has a dark theme with white text and icons. It includes links for Main Dashboard, Alex's Dashboard, Follow Requests, On-Call Calendar, Observing Calendar, Search By Tag, Admin, Query Explorer, Survey Home, Help/How-to, and Follow-up Guidelines. The main content area is titled "2022jo (YSE)". It displays the following details:

- 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
- Redshift**: 0.0265
- Best Spec. Class**: SN II
- TNS Spec. Class**: SN II
- Galactic I/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, a sidebar lists various astronomical objects. The main area shows a "Light Curve" plot with magnitude on the y-axis (ranging from 16.7 to 21.2) and Modified Julian Dates on the x-axis. The plot includes data points for g, r, and non-detections. Below the plot are buttons for "Difference Magnitude", "Apparent Magnitude", and "Folded". To the right of the light curve is a "Stamp Classifier" interface, which is highlighted with a red box. This interface features a 5-pointed star plot with axes labeled AGN, VS, SN, bogus, and asteroid. A red arrow points from the center of the star towards the "VS" axis. Further right is a "Host Image" section showing a color composite image of the field with the object's position marked. At the bottom, there are download buttons for Science, Template, and Difference images.

<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).