ELAsTiCC: The Extended LSST Astronomical Time-Series Classification Challenge

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Motivation and Goals

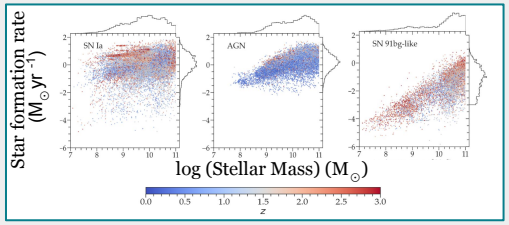
- Vera C. Rubin Observatory LSST will observe transients and their host galaxies at **unprecedented rates**
- Need simulations at high-z and with Rubin depth
- First set of LSST simulations *(PLAsTiCC; Kessler et al. 2017)* helped develop machine-learning classification algorithms

ELAsTiCC goals: to improve realism for **classifier testing** & create realistic data stream for **broker testing.**

Simulation Methodology

Class-dependent host association is implemented through the **SNANA** simulation code, with:

- **Rest-frame SED models** for galactic and extragalactic transients (see Figure at right)
- Realistic line-of-sight extinction and atmospheric noise
- **Class-specific correlations** with rest-frame color, magnitude, mass, star formation rate (see *Lokken, Gagliano et al. 2023* for details)



High-Level Summary

ELAsTiCC presents the first simulation of LSST alerts, with millions of synthetic transient light curves and host galaxies. The data is being used to test broker alert systems and classifiers, and develop the infrastructure for LSST's Dark Energy Science Collaboration Time-Domain needs.

Extragalactic Models

- Kilonovae*
- Active Galactic Nuclei
- Calcium-Rich Transients
- Intermediate Luminosity Optical Transients
- Tidal Disruption Events
- Supernovae (Types Ia/Iax/Ib*/Ic*/Ic-BL*/II/IIb/IIn, Pair-Instability, Superluminous)

Realistic host associations

Galactic Models

- M-dwarf flares
- RR-Lyrae
- Eclipsing Binaries
- Cepheid Variables*
- Dwarf Novae*
- δ-Scuti*
- Microlensing Events

Now streaming to participating Rubin brokers!

- Alerce
- AMPEL
- ANTARES
- Fink

*Updated from PLAsTiCC Challenge *(Kessler et al., 2019)*

Image Credit: ESO/S. Brunier

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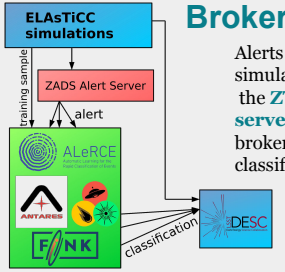
Brokers & Alerts

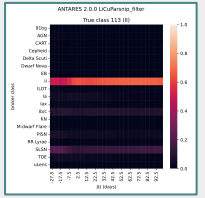


Alerts generated from simulations are streamed to the **ZTF alert distribution server**, and from there to brokers. DESC ingests classifications into a database which also holds truth tables from the original simulation.

Metrics and Taxonomy

ELAsTiCC implements an **extensible, tree-based taxonomy**. We have built:

- A dashboard to **monitor broker performance daily**, including performance, uptime, and how classification evolves with observations.
- The taxonomy together with brokers, allowing for a **common format and language for the user-community.**



Above: *reported probabilities for all SNe II for one classifier relative to peak light.*

Results

- SNIa classification is **50-60%** after **10-20 days** - sufficient for DESC SNIa cosmology, w/ early classification **~40%**
- Anomaly detection at **~70% accuracy for SLSN/TDE etc**