Optimizing the Search for Exotic Transients

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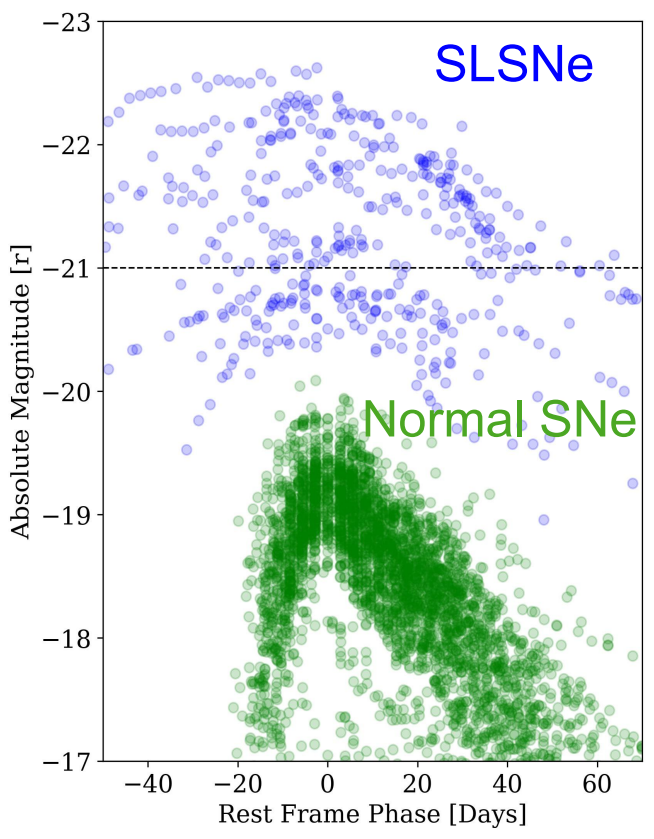
Exploring the Transient Universe with *Roman*
February 2022

Past: Used machine learning to find Superluminous Supernovae

Present: Applying methods to Tidal Disruption Events

Future: Predictions for transients with *Roman*

Superluminous Supernovae

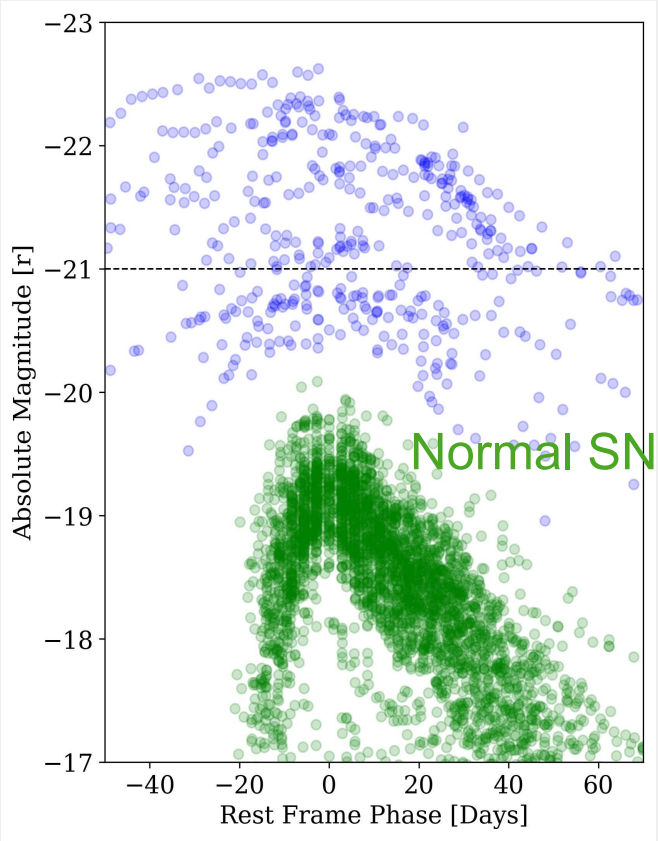


They were designated as superluminous if brighter than -21 mag

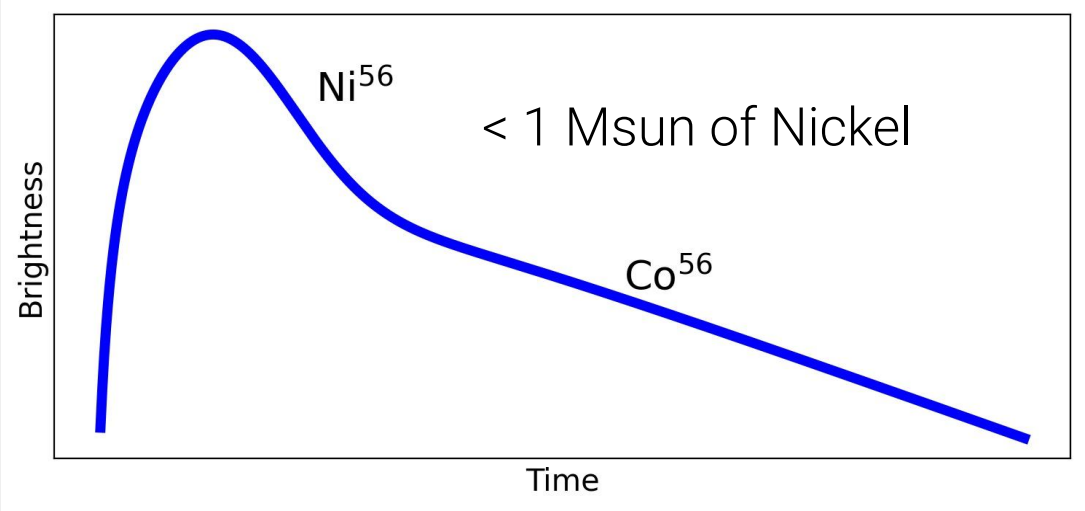
Now, they are classified by their spectra

Chomiuk+ 2011 Quimby+ 2011

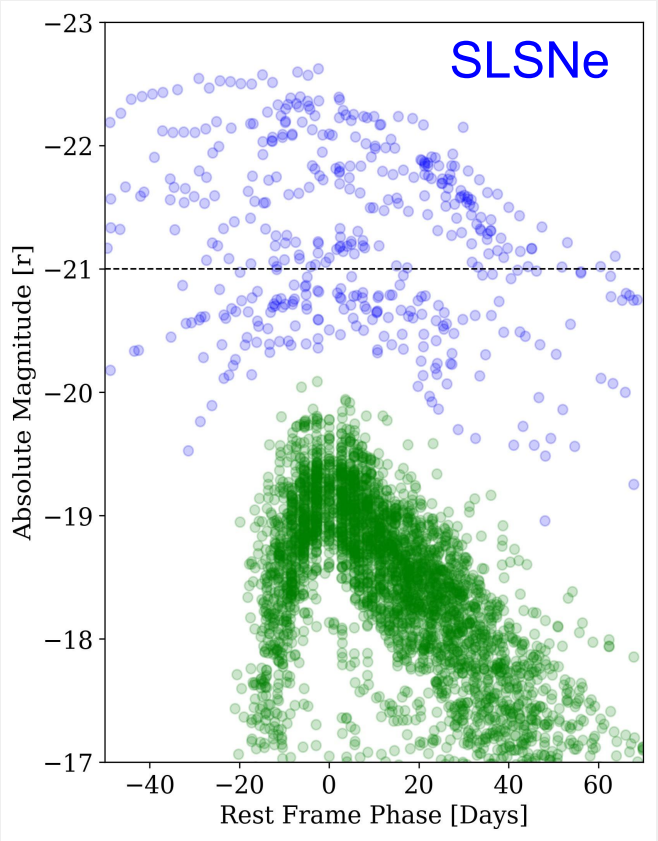
What makes them so bright?

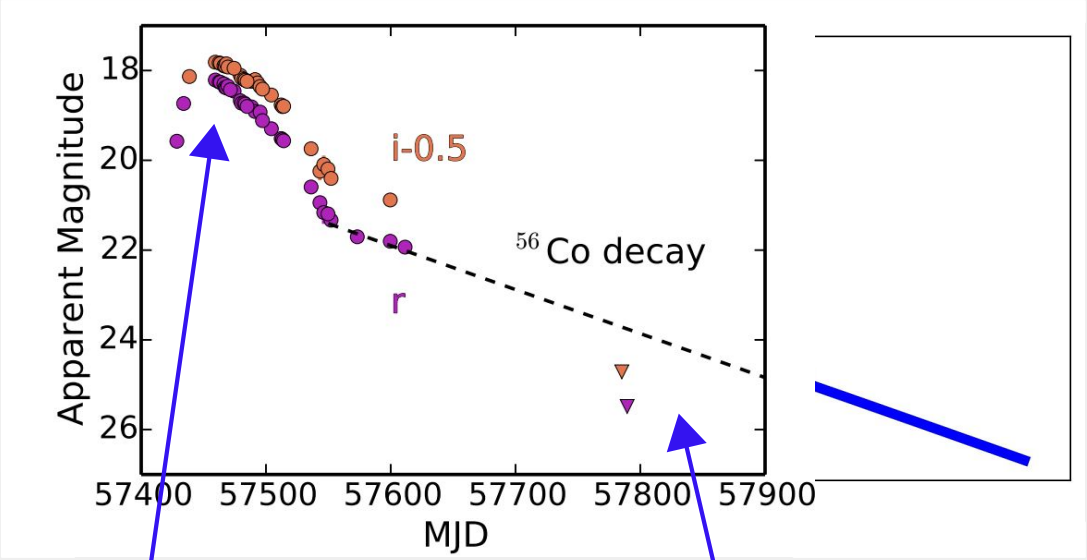


Normal SNe are powered by radioactive decay



What makes them so bright?



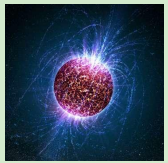


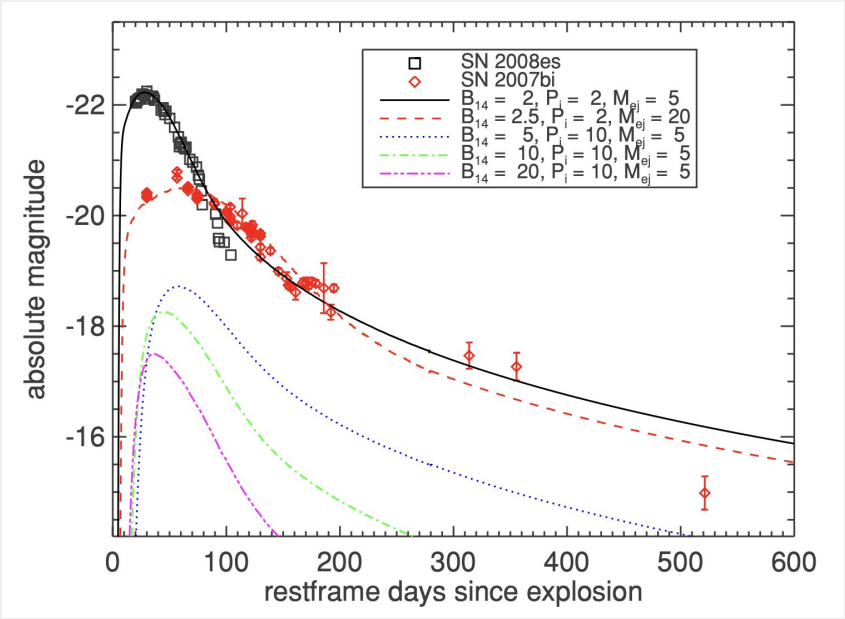
Blanchard+ 2018

28 Msun of Nickel to power the peak

Limit of < 0.35 Msun of Nickel

Central Engine

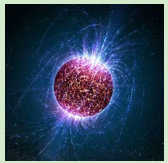


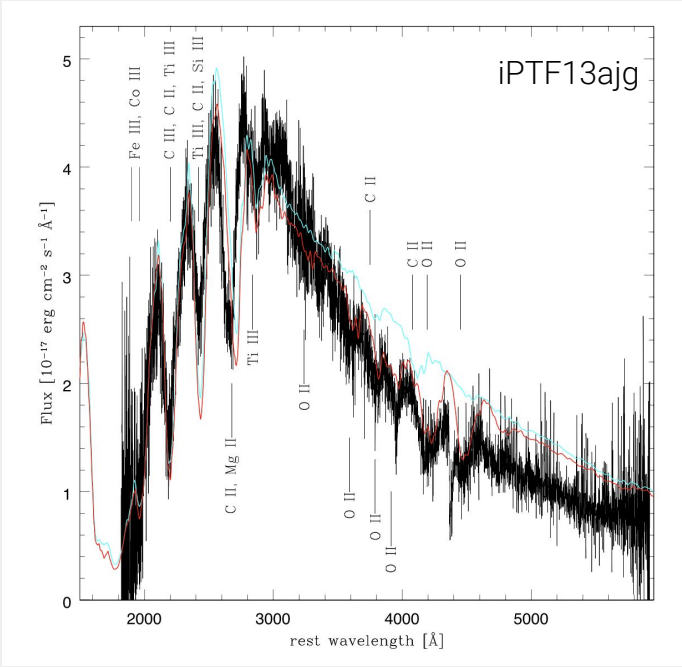


Kasen & Bildsten 2010

Metzger+ 2015

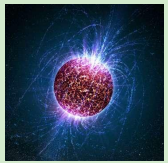
Central Engine

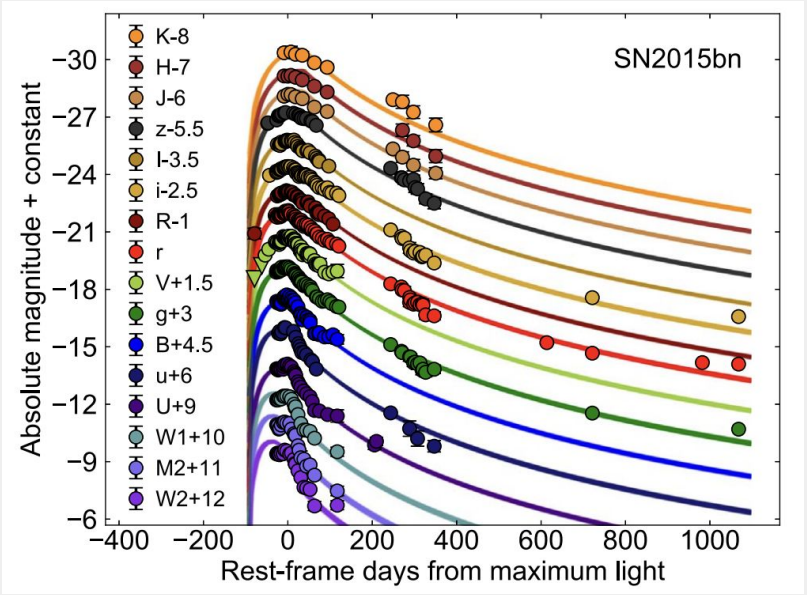




Mazzali+ 2016

Central Engine

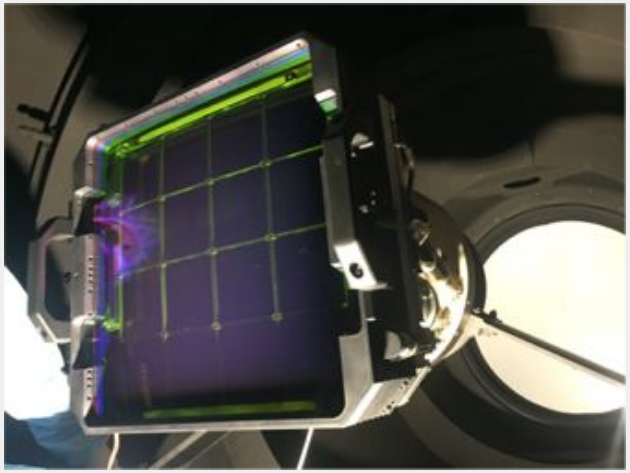




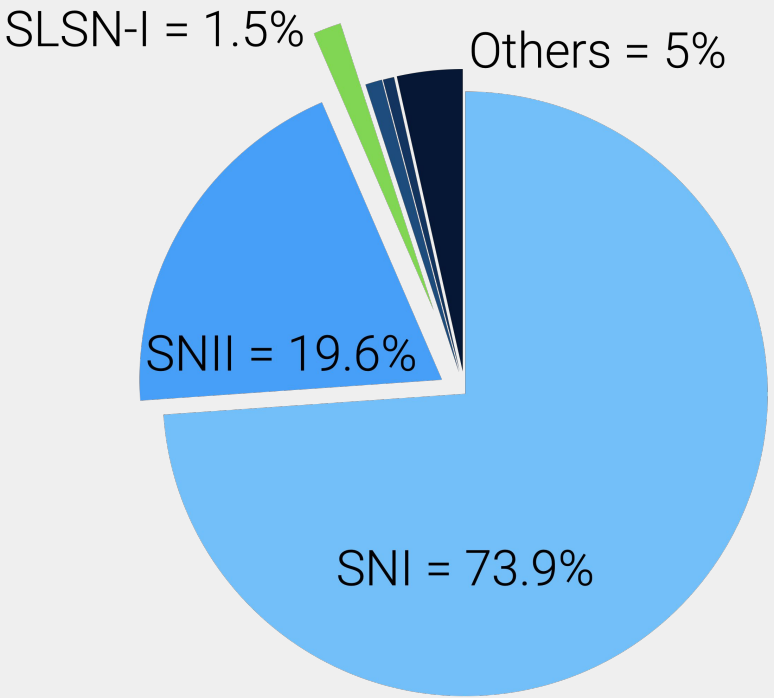
Nicholl+ 2017

How do we find them?

Unbiased Surveys

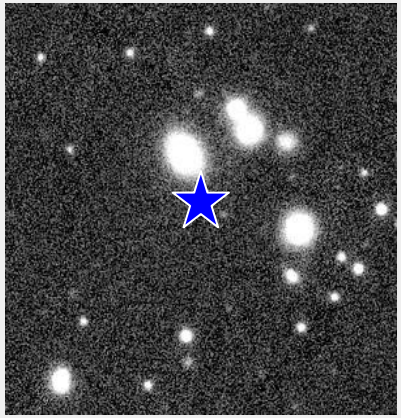


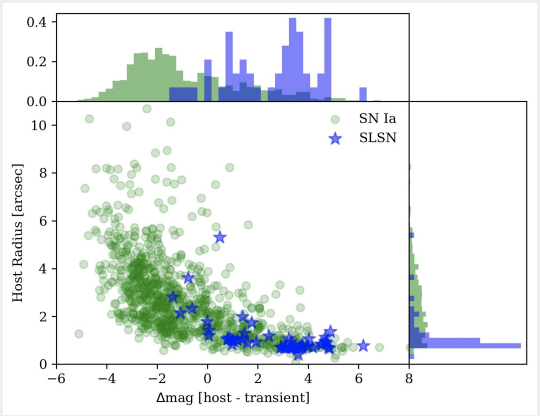
ZTF ~ 1500 Transients / month



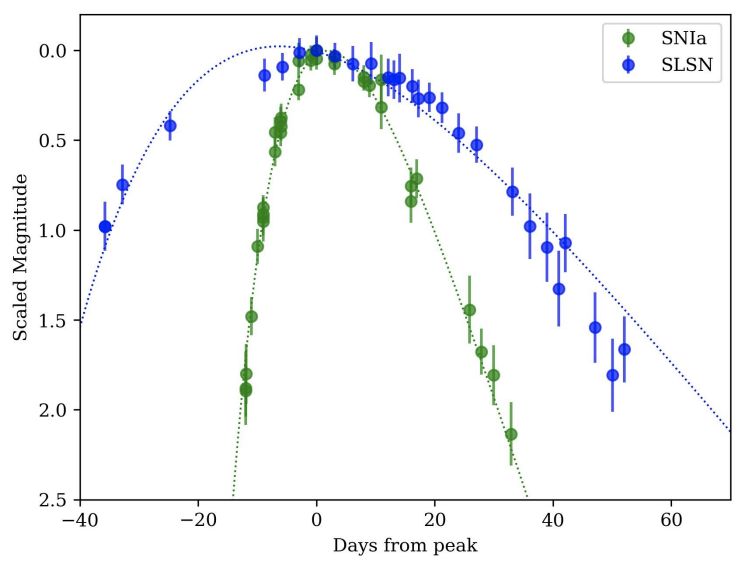
FLEET Algorithm

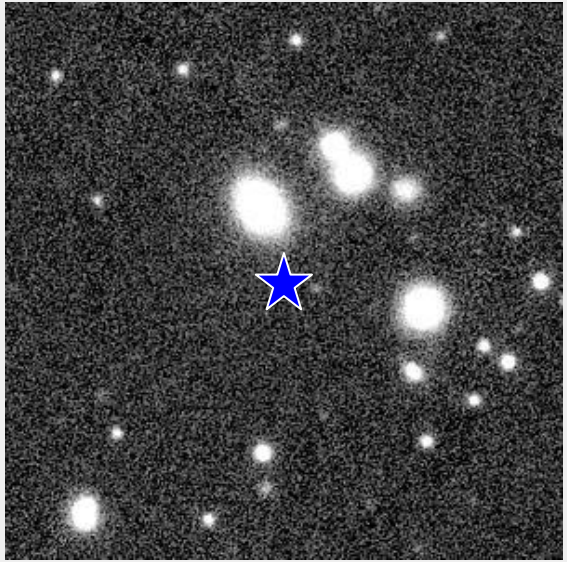
Finding Luminous and Exotic Extragalactic Transients





Features

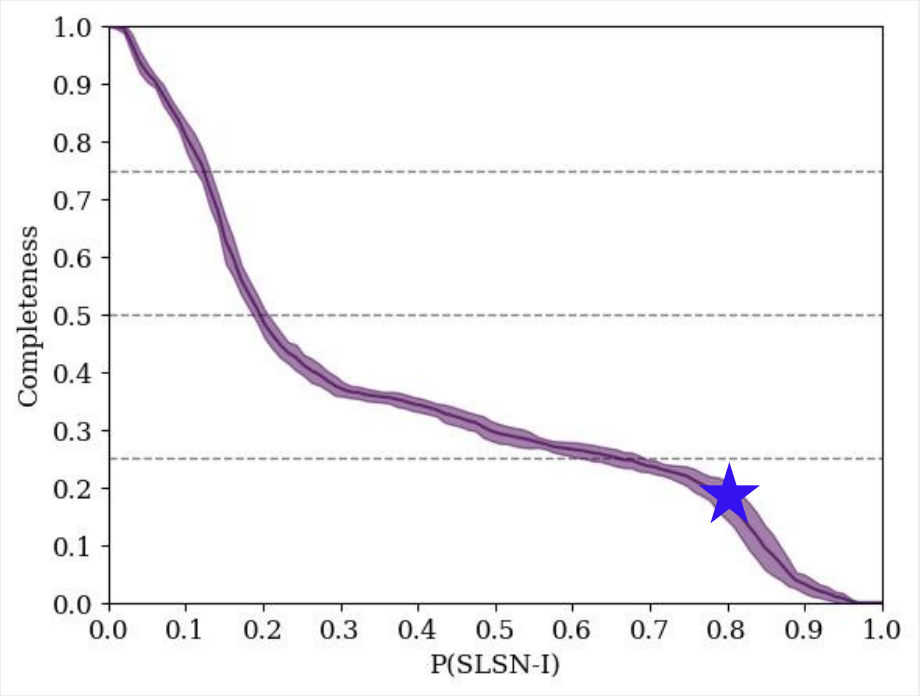


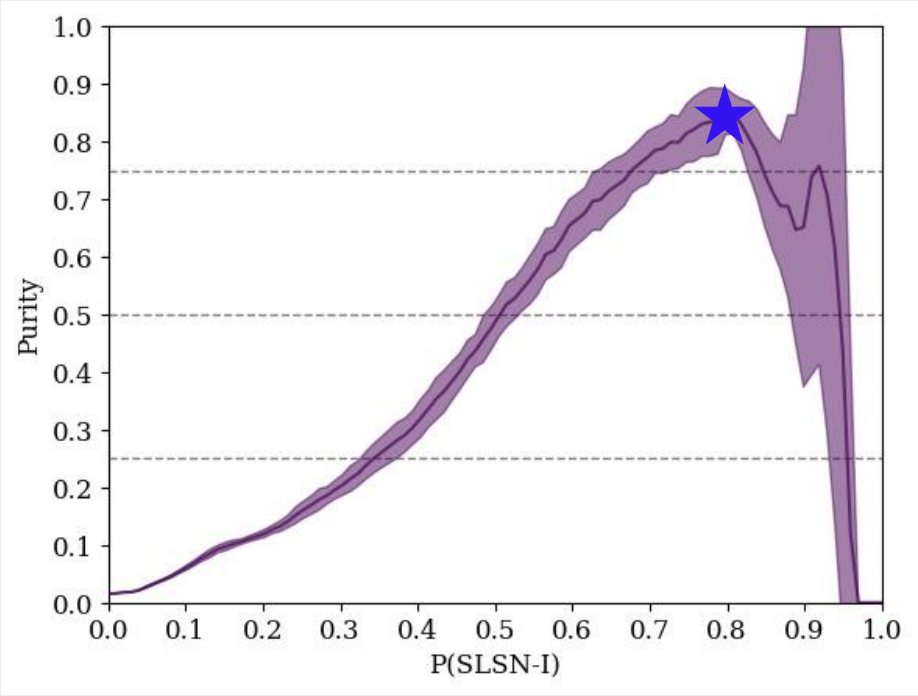


1. Width of the light curve
2. Time to peak
3. Color
4. Normalized host separation

No Redshift Needed

Predictions

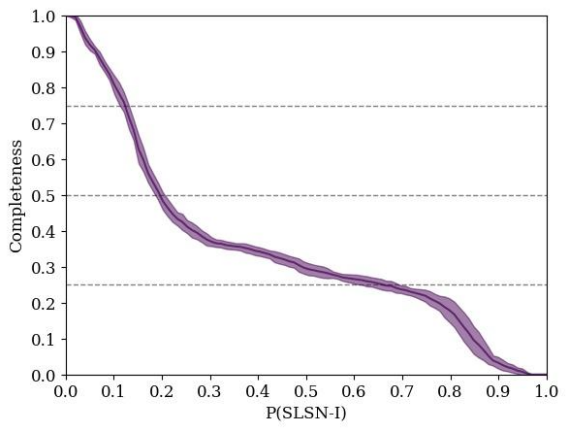


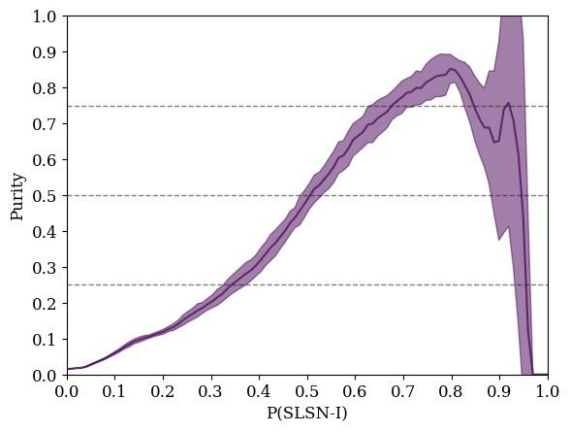


1500 Transients = 23 SLSN-I = 5 Candidates = 4 SLSN-I / Month

50x better than random selection

Results



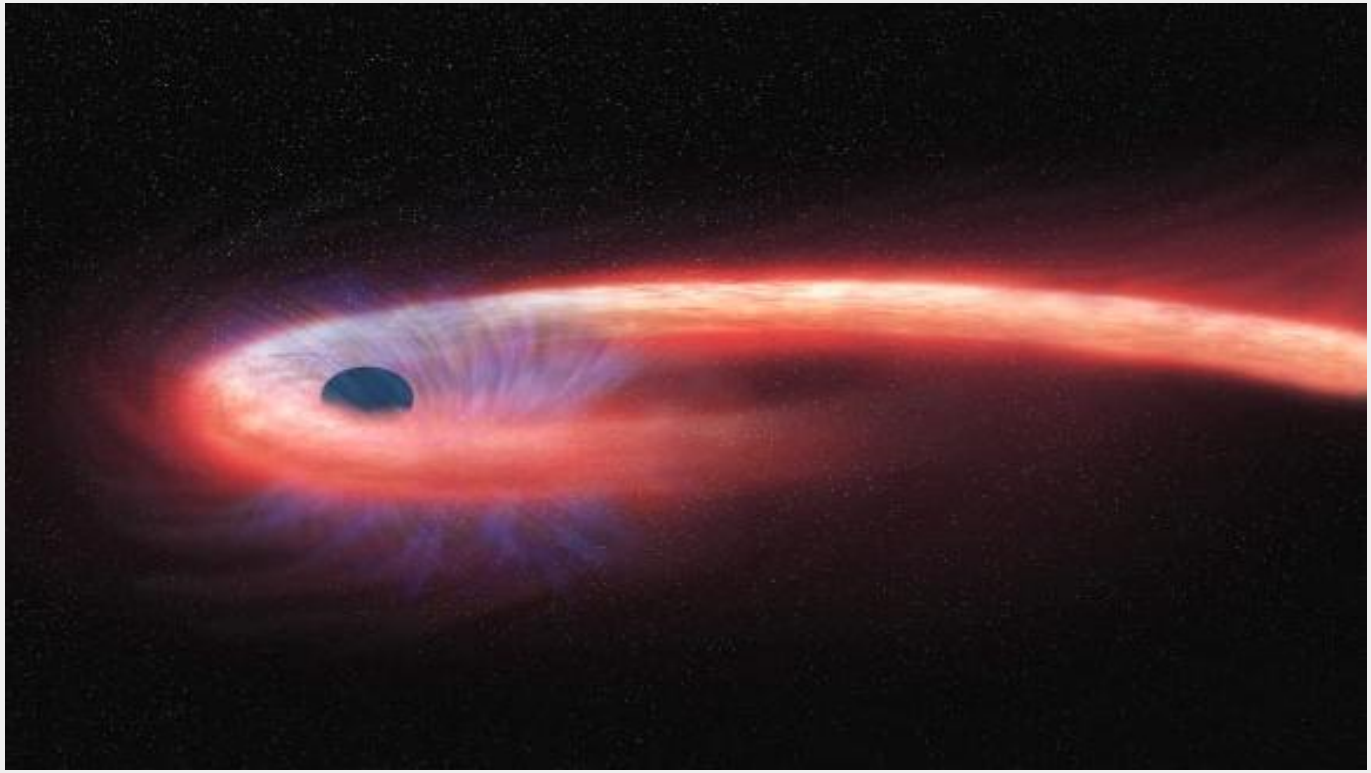


37 SLSNe found worldwide since Nov 2020

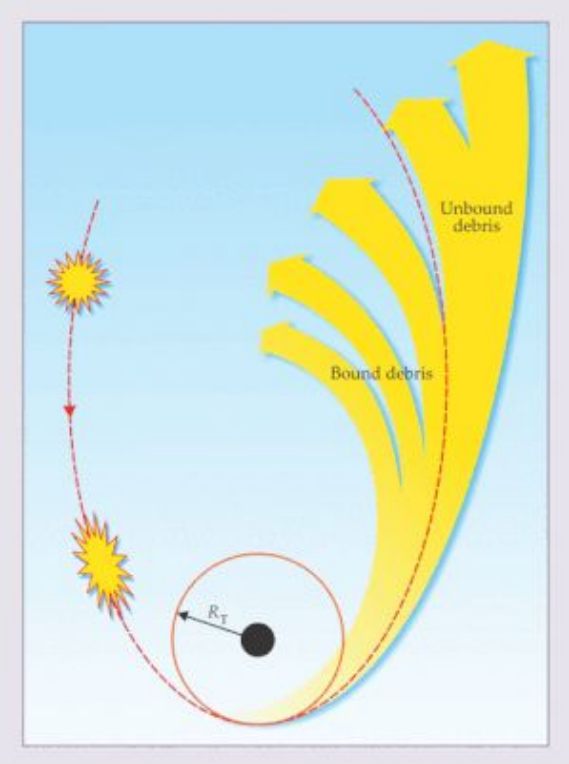
13 classified by FLEET

P(SLSN-I) > 50% = (18/37) ~ 50% of all SLSN-I recovered

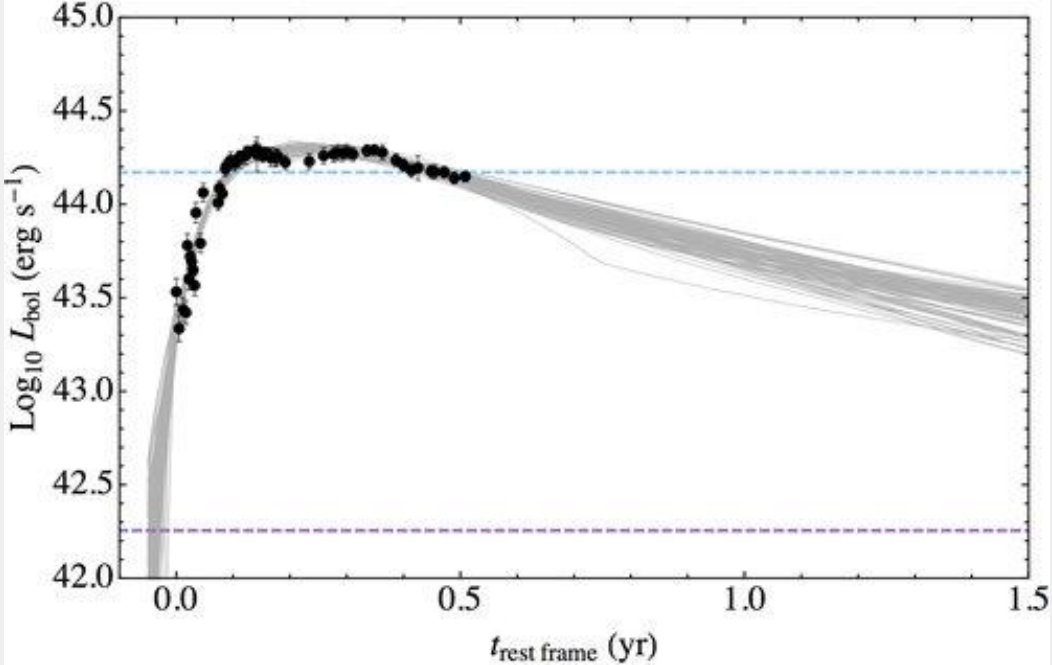
Tidal Disruption Events



Tidal Disruption Events

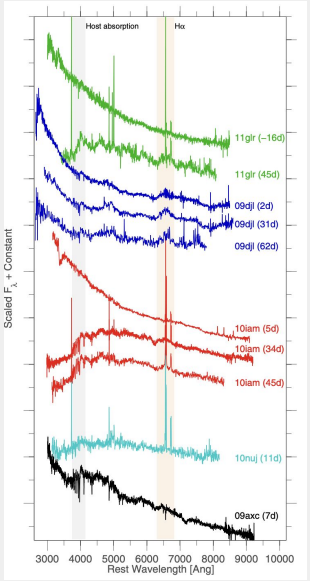


S. Gezari, Physics Today.

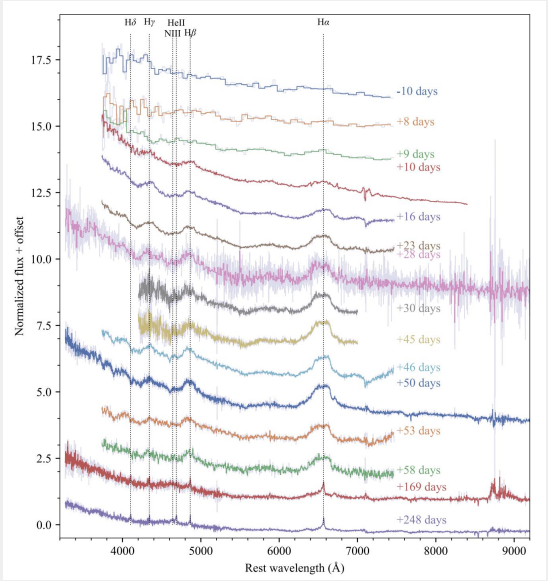


Blanchard+ 2017

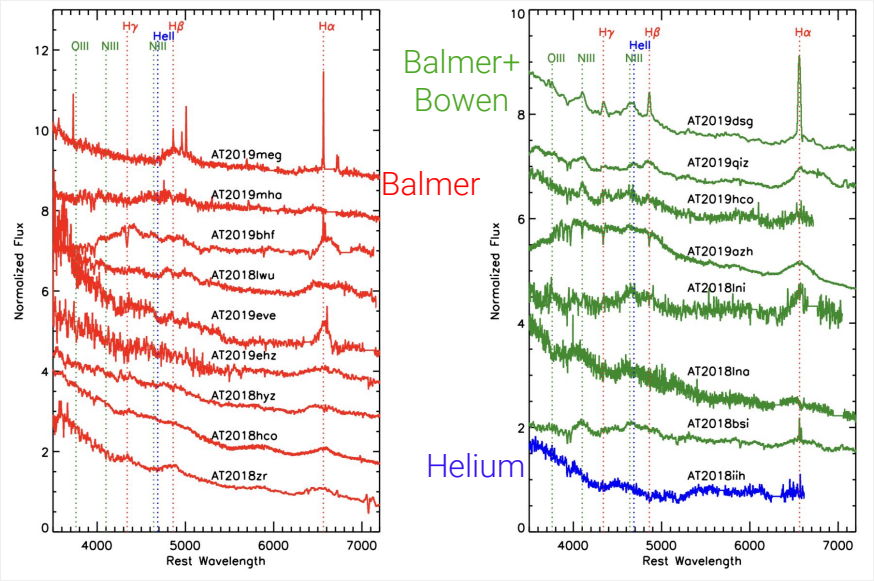
Tidal Disruption Events



Arcavi+ 2014



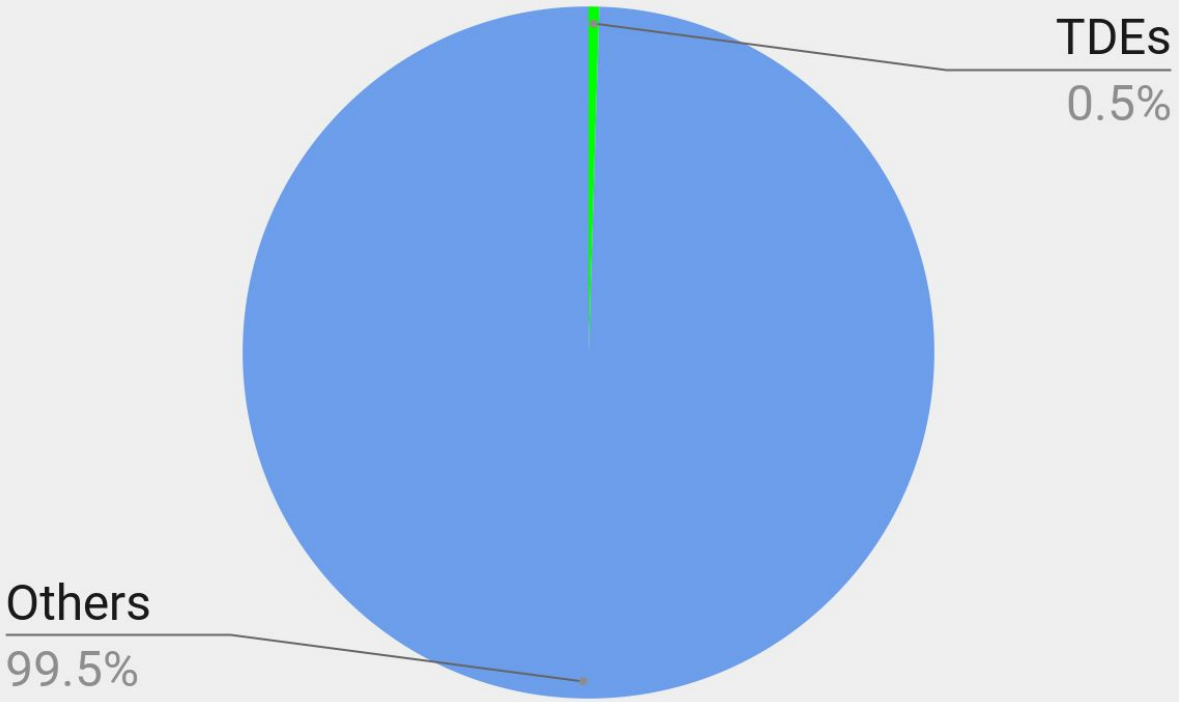
Nicholl+ 2019



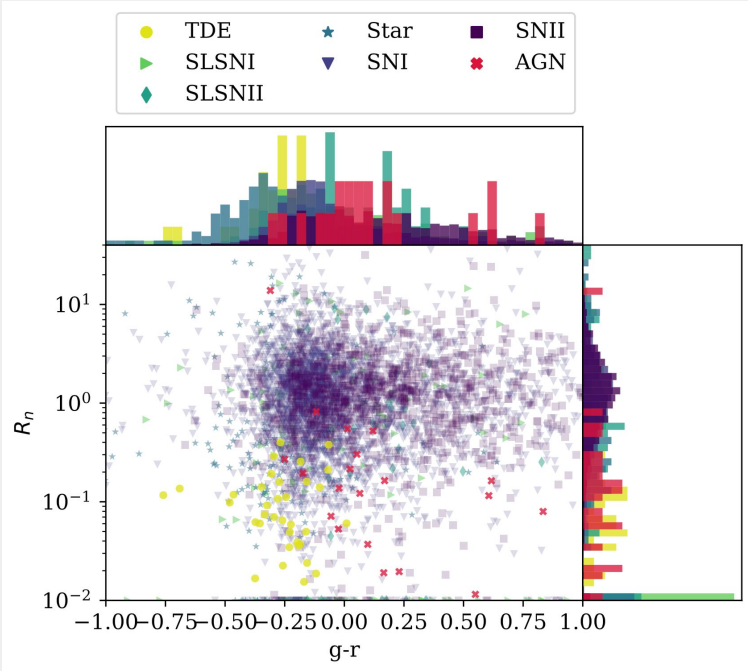
Van Velzen+ 2020

Wide diversity of features
Only ~40 well characterized TDEs

Tidal Disruption Events



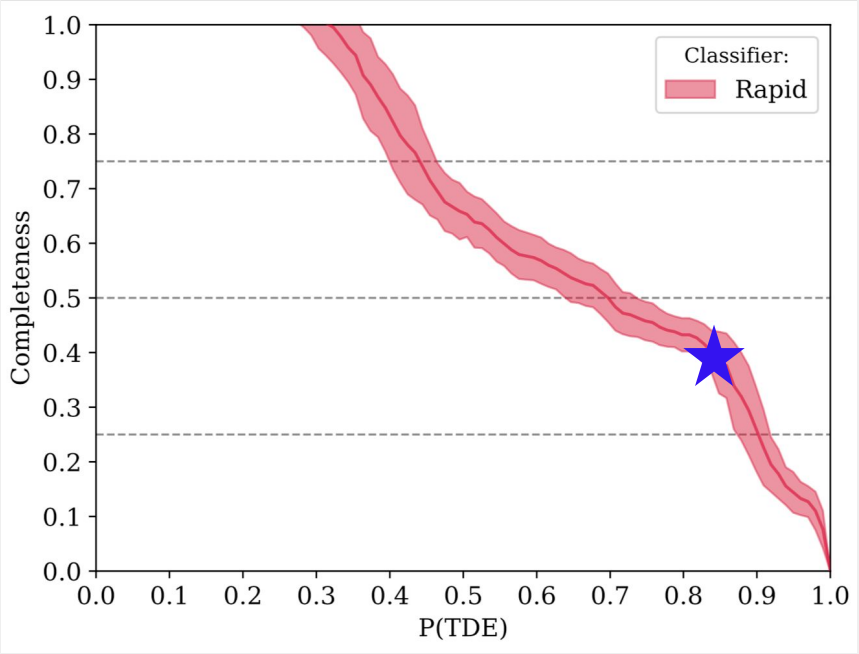
Features

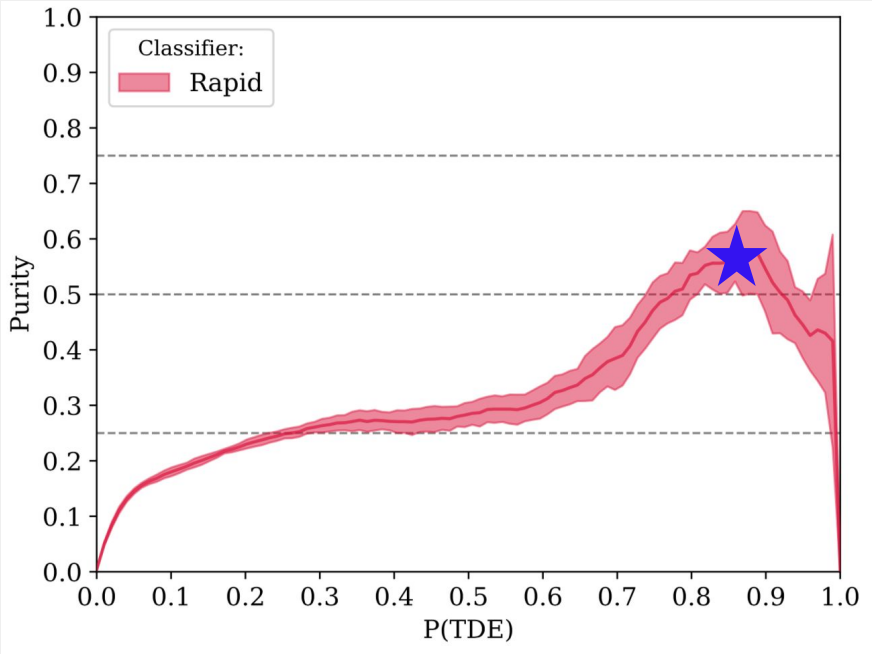


- Color
- Rise time
- Light curve duration
- Host color
- Host separation

TDEs are blue and nuclear

Tidal Disruption Events

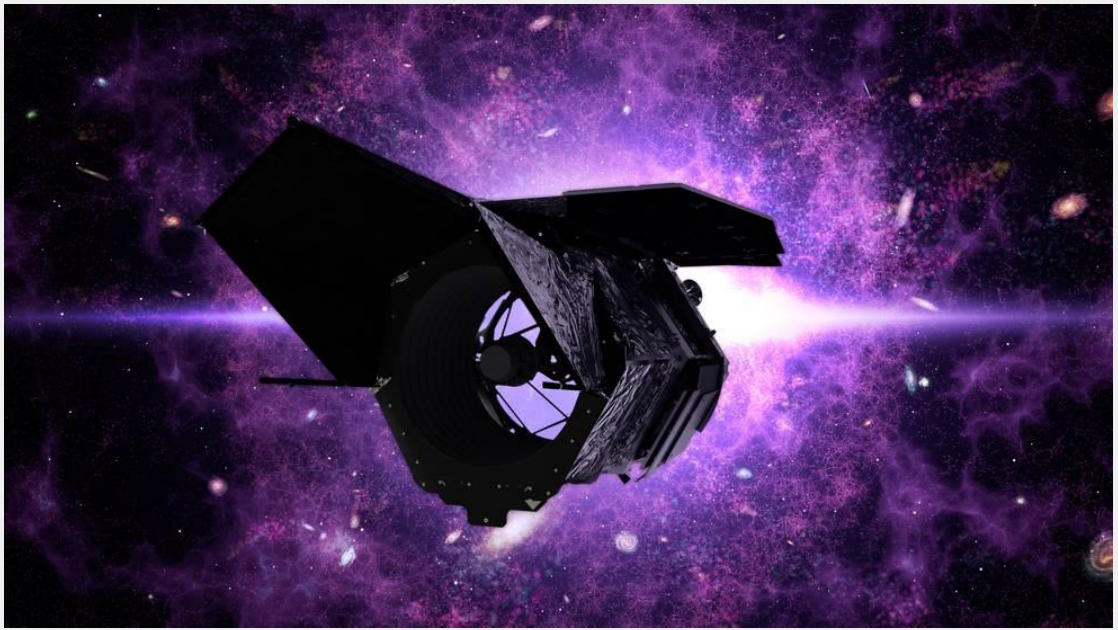




1500 Transients = 8 TDEs = 3 Candidates = 1-2 TDEs / Month

100x better than random selection

Roman Survey

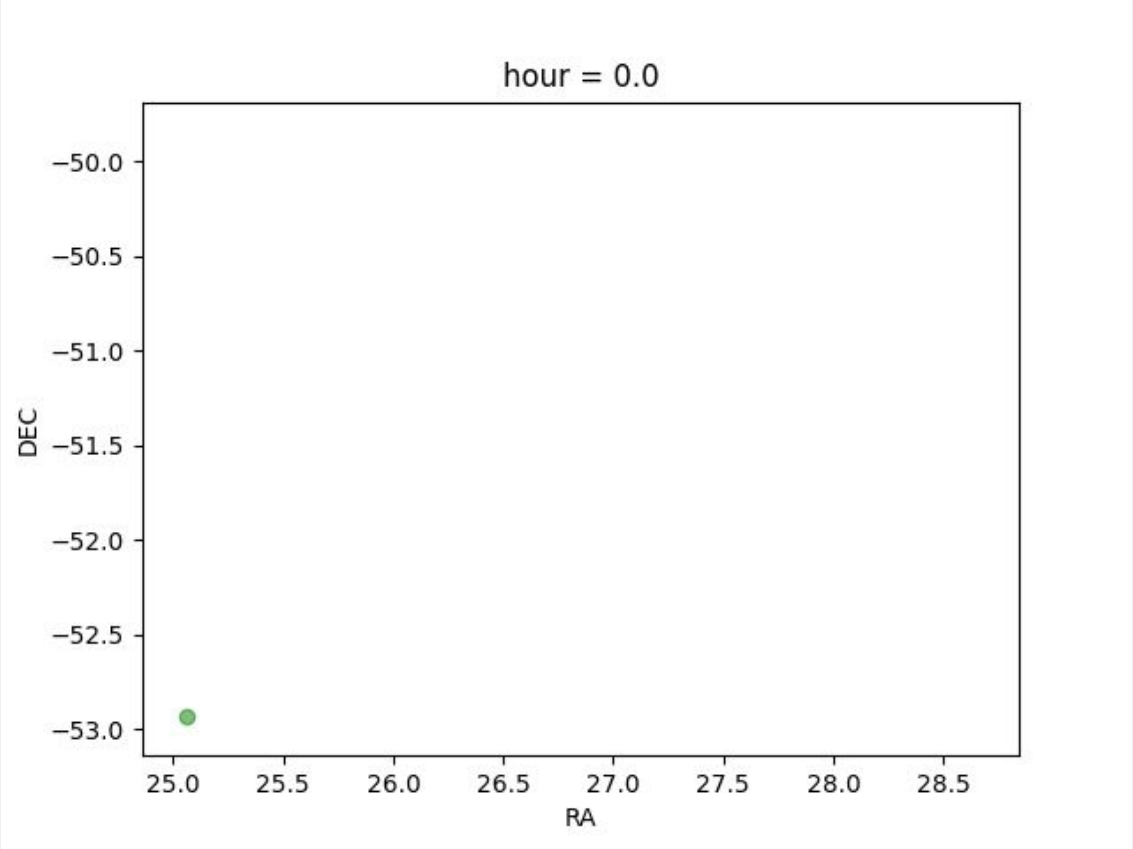


NASA, Rose+, Supernovae SIT

High Latitude Time Domain Survey

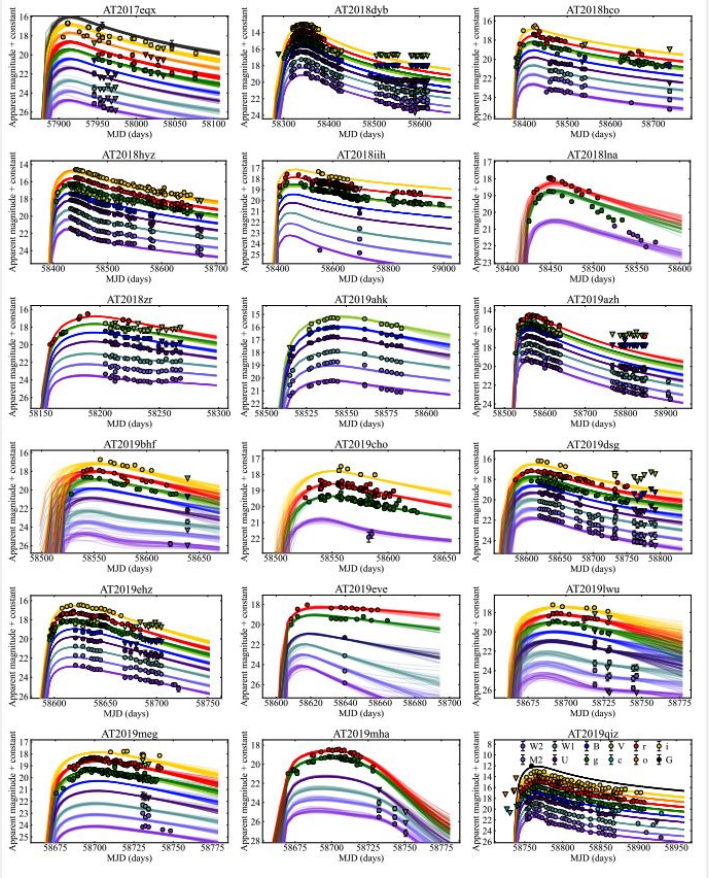
16 sq. deg.
5 day cadence
2 year duration
6 filters (4 per mode)

Roman Survey



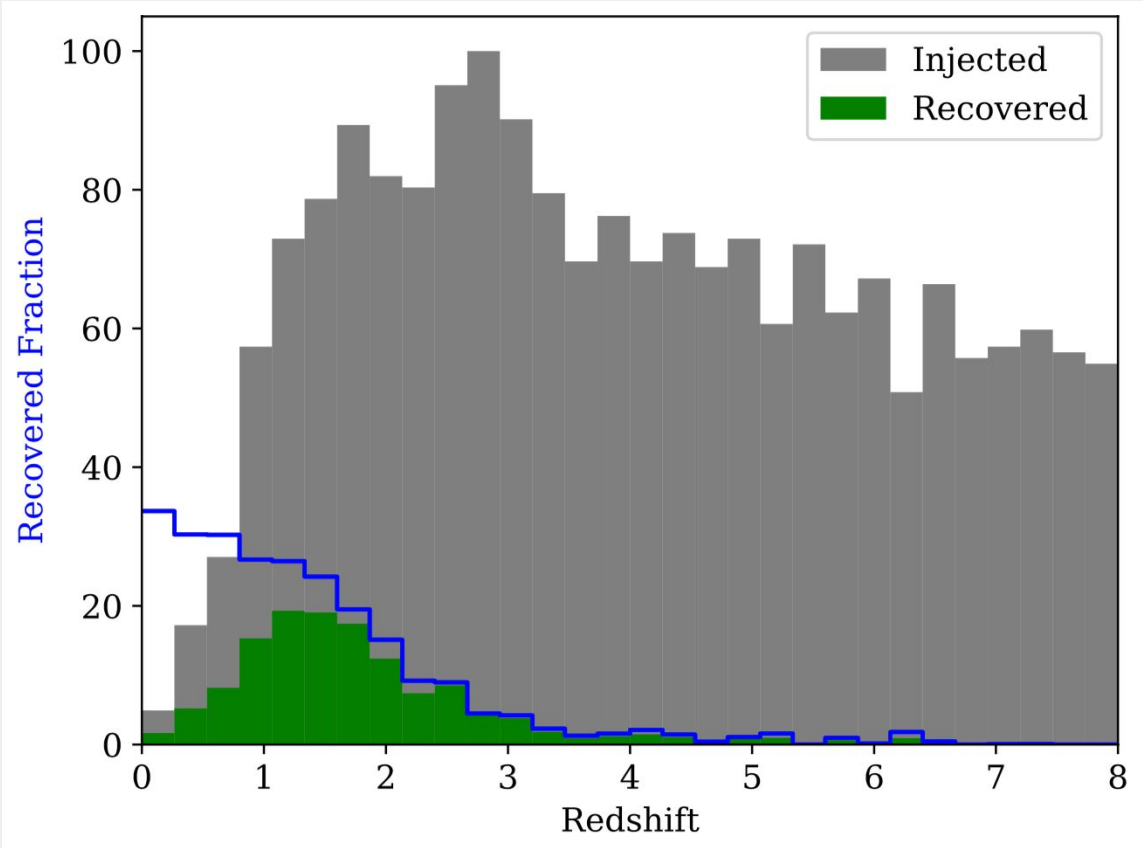
Wide mode
+
Deep mode

Roman Survey

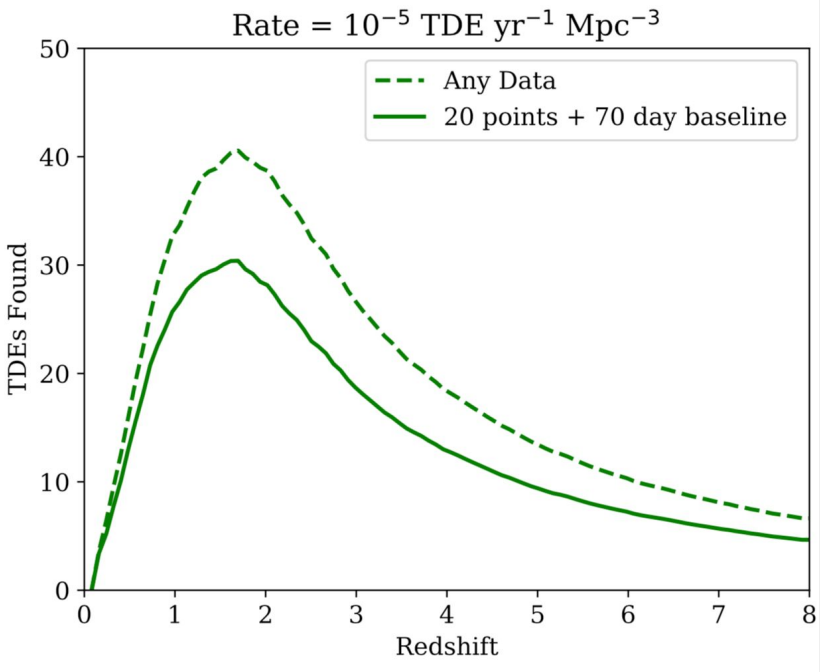


Nicholl+

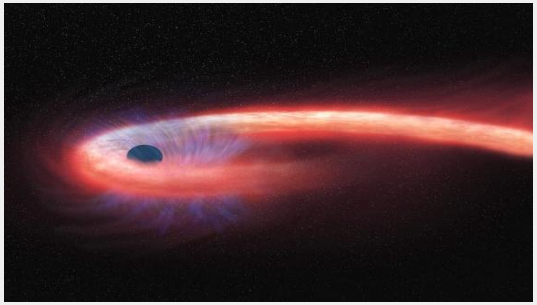
TDEs from *Roman*

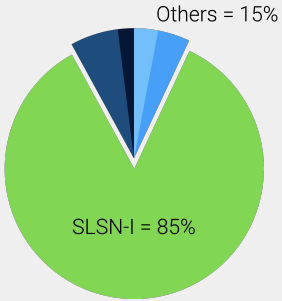


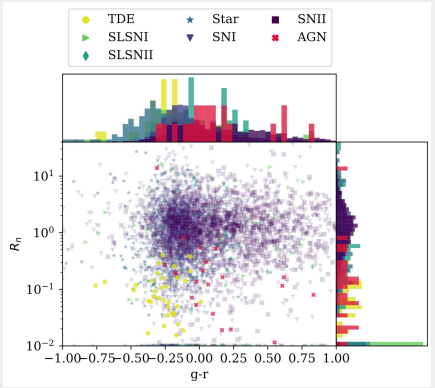
Applications to *Roman*

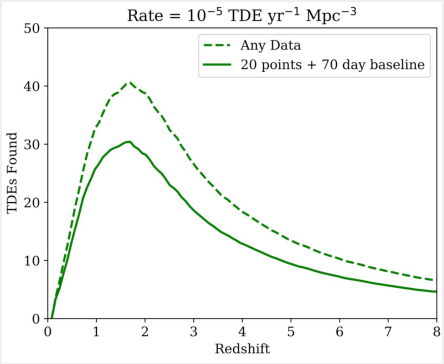


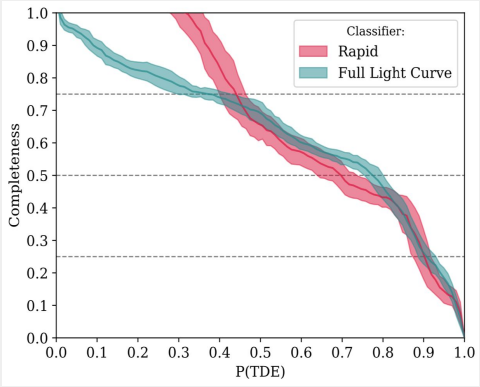
FLEET: 30 x (0.4 Completeness) x (0.6 Purity) = 7 TDEs / year

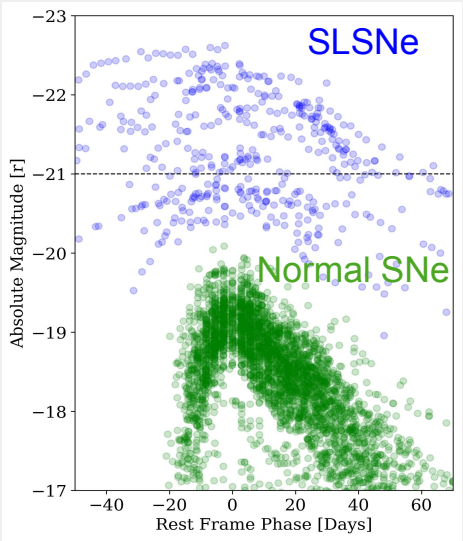


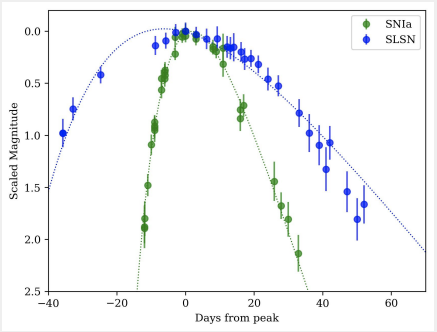
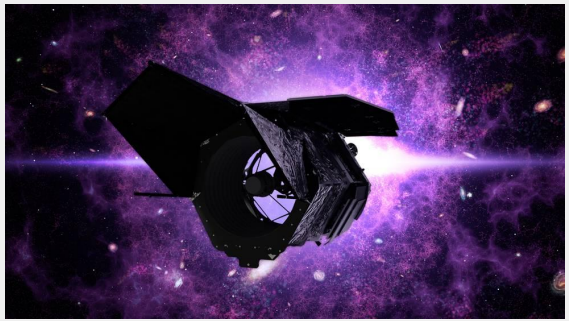

Others = 15%
SLSN-I = 85%


TDE
SLSNI
SLSNII
Star
SNI
SNII
AGN
R_n
g-r


Rate = 10^{-5} TDE yr^{-1} Mpc^{-3}
Any Data
20 points + 70 day baseline
TDEs Found
Redshift


Classifier:
Rapid
Full Light Curve
Completeness
P(TDE)


SLSNe
Normal SNe
Absolute Magnitude [r]
Rest Frame Phase [Days]


SNIa
SLSN
Scaled Magnitude
Days from peak