

Identifying Transient Hosts in the Rubin Deep Drilling Fields

Josh Weston, Dave Young, Stephen Smartt, Matt Nicholl

Matt Jarvis, Imogen Whittam



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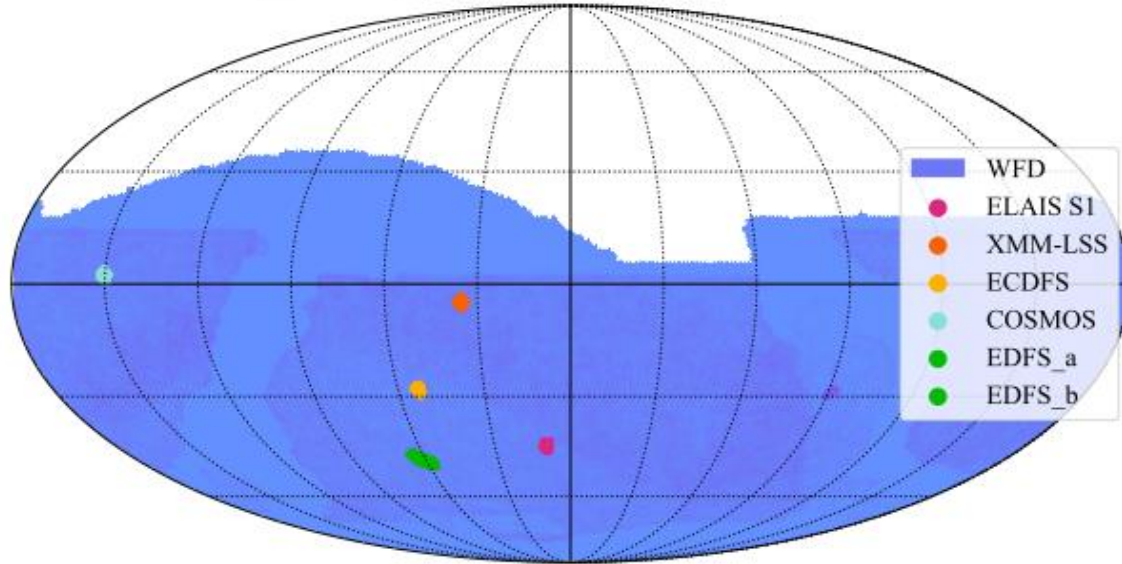
LSST



- 8m telescope on Cerro Pachon, Chile.
- 3.5 gigapixel camera (pretty big) with a real time alert stream and multi-colour deep imaging of the sky.
- 18,000 square degrees observed 825 times over 10 years, with rapid revisit timescale requirements.

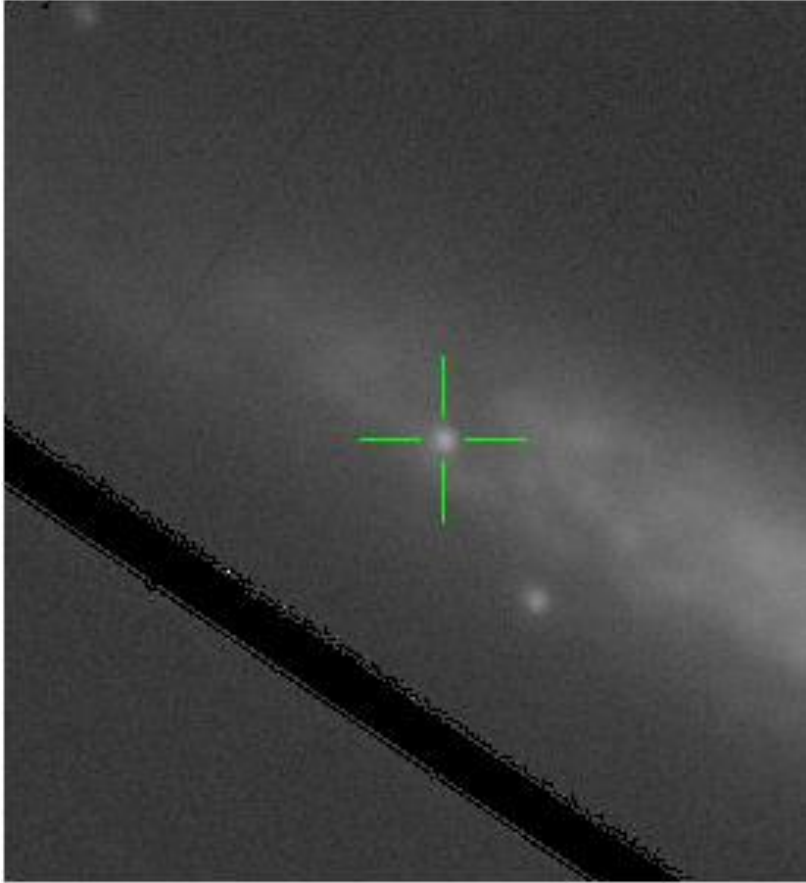
The Deep Drilling Fields

baseline_v5.0.0_10yrs All sky all bands: NVisits



- Five mini-fields to be observed for ten years with a limited survey area, at high cadence, with multiple nightly visits.
- 6-7% of dedicated survey time, with ~120,000 total visits across the five fields.
- Main drivers: determination of the cosmological parameters essential to the LSST Dark Energy Science Collaboration and to provide a training set for LSST photometric redshift determination.

The Deep Drilling Fields



- Identifying host galaxies of transients plays a key role in classification, understanding their evolution, and subsequent cosmological analyses.
- Narrow emission/absorption lines in the spectrum of a host galaxy provide a much more precise measurement of the redshift than the broader lines of the SN spectrum.

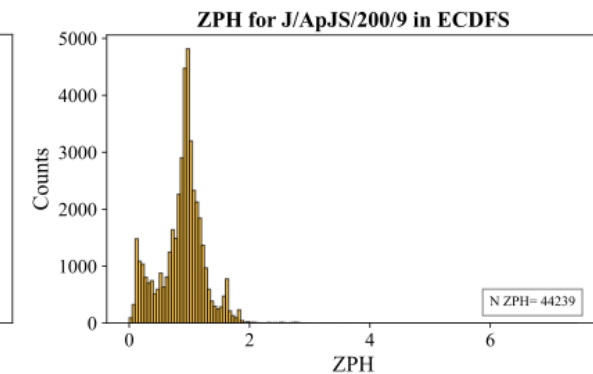
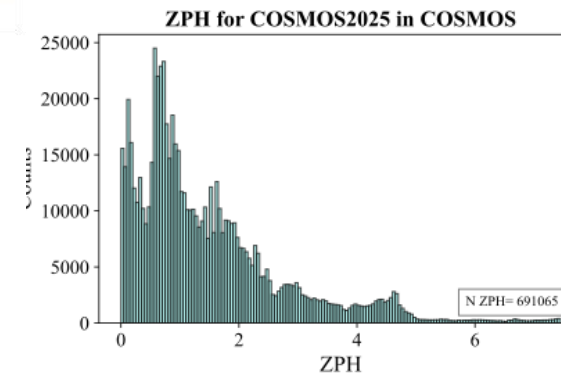
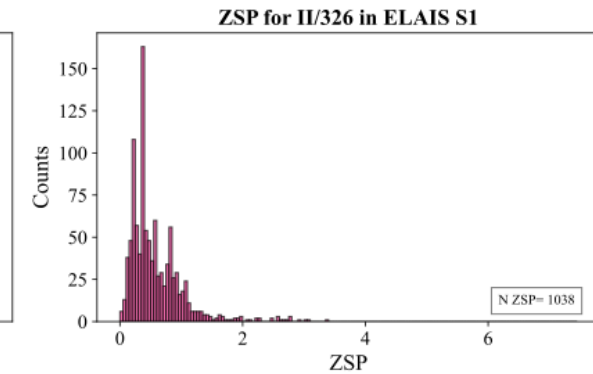
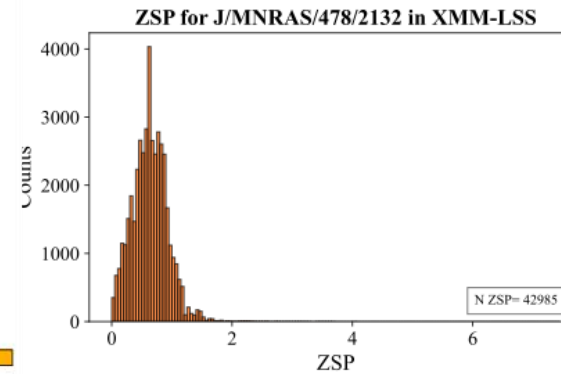
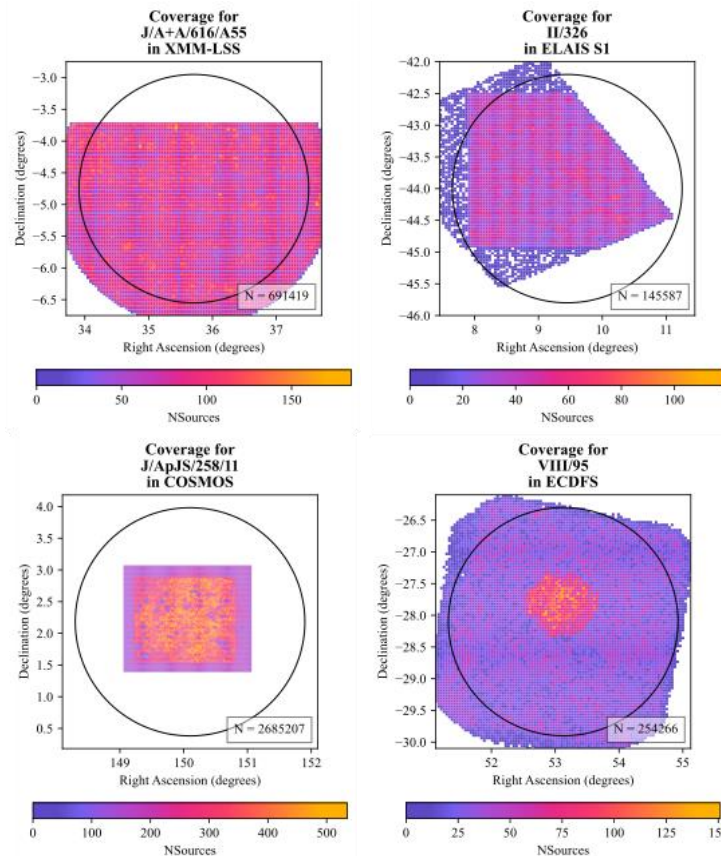
Sherlock

- A boosted decision tree algorithm Sherlock is implemented within the Lasair transient alert broker to mine a library of survey data and determine a suitable association for a given transient.
- Once crossmatches have been found Sherlock can predict the nature of the transient – variable star, CV, AGN, SN etc. – to assist in classification and prioritization for follow-up observations.
- Multi-terabyte MySQL Database containing source-agnostic and source-specific all-sky surveys.
- Utilizes morphological, photometric and redshift-related data to inform best candidate selection.



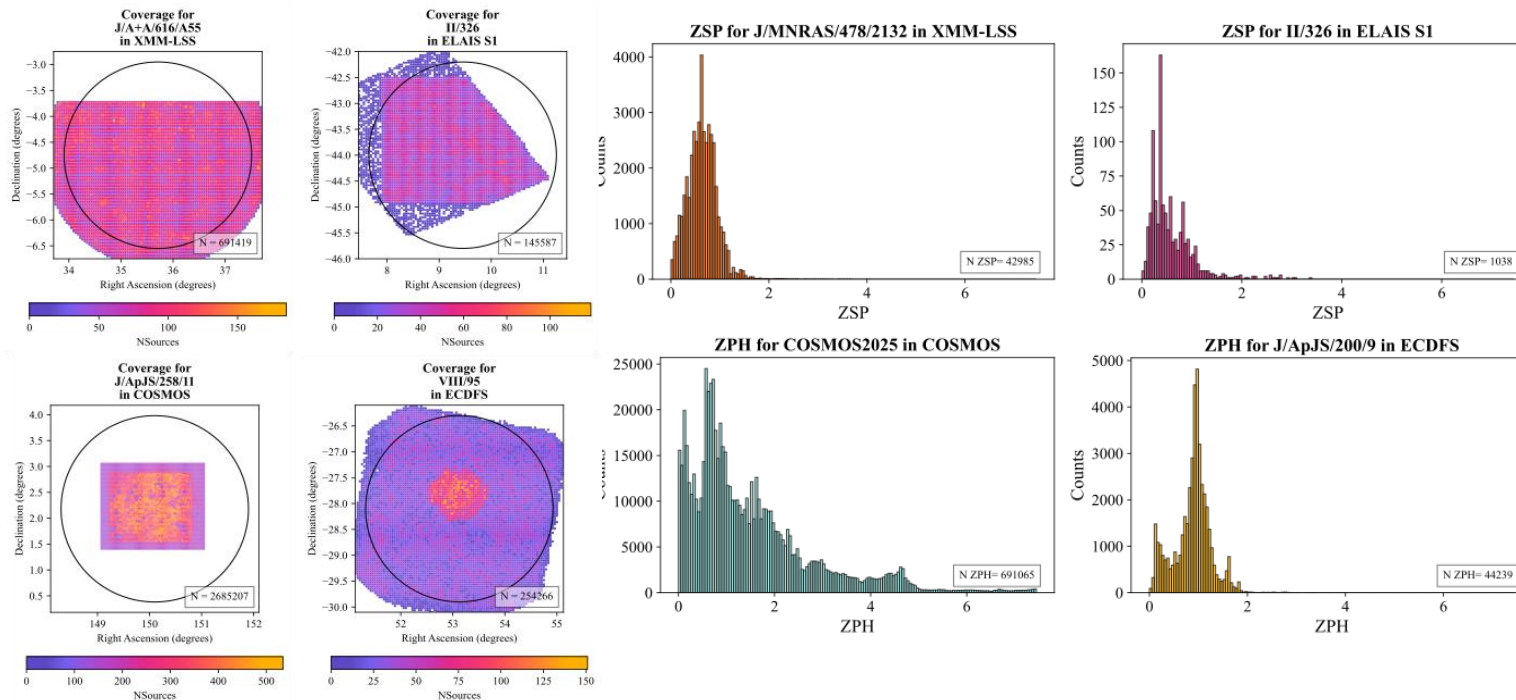
The DDF Catalogues

- We have identified ~70 catalogues focused on the Deep Drilling Fields; of these, 56 have more than 1000 records and 44 more than 10,000. Of these, 28 have redshift measurements (spectroscopic and/or photometric).

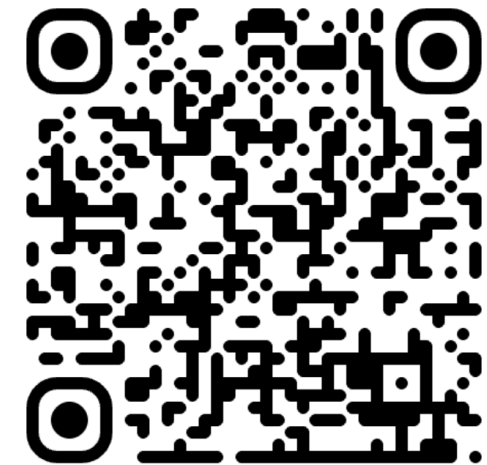


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Lestrade
Autowiki



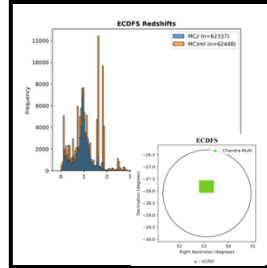
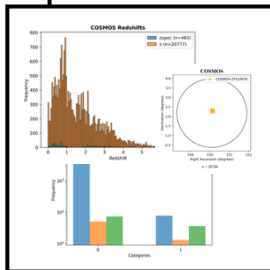
Considerations for Shortlisting

A+

Spectroscopic redshifts
with spatial information and
classifications

A / A-

Spectroscopic redshifts
with no spatial information /
classifications



B+

Photometric redshifts with
spatial information and
classifications

B / B-

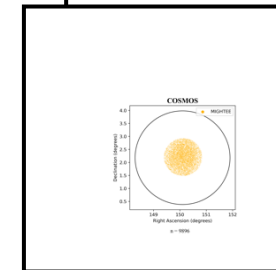
Photometric redshifts with
no spatial information /
classifications

C+

Photometric catalogues with
spatial information and
classifications

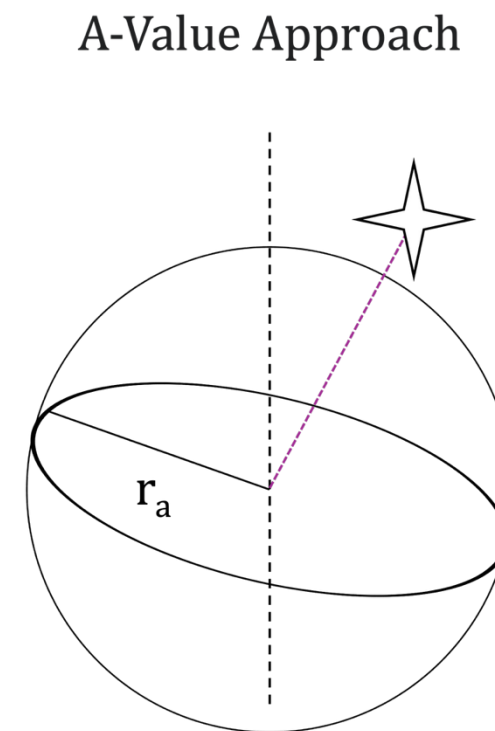
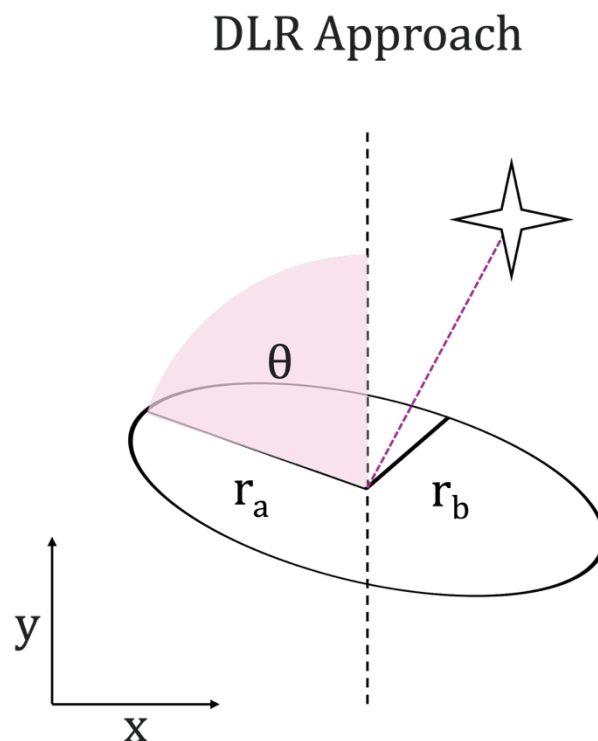
C / C-

Photometric catalogues with
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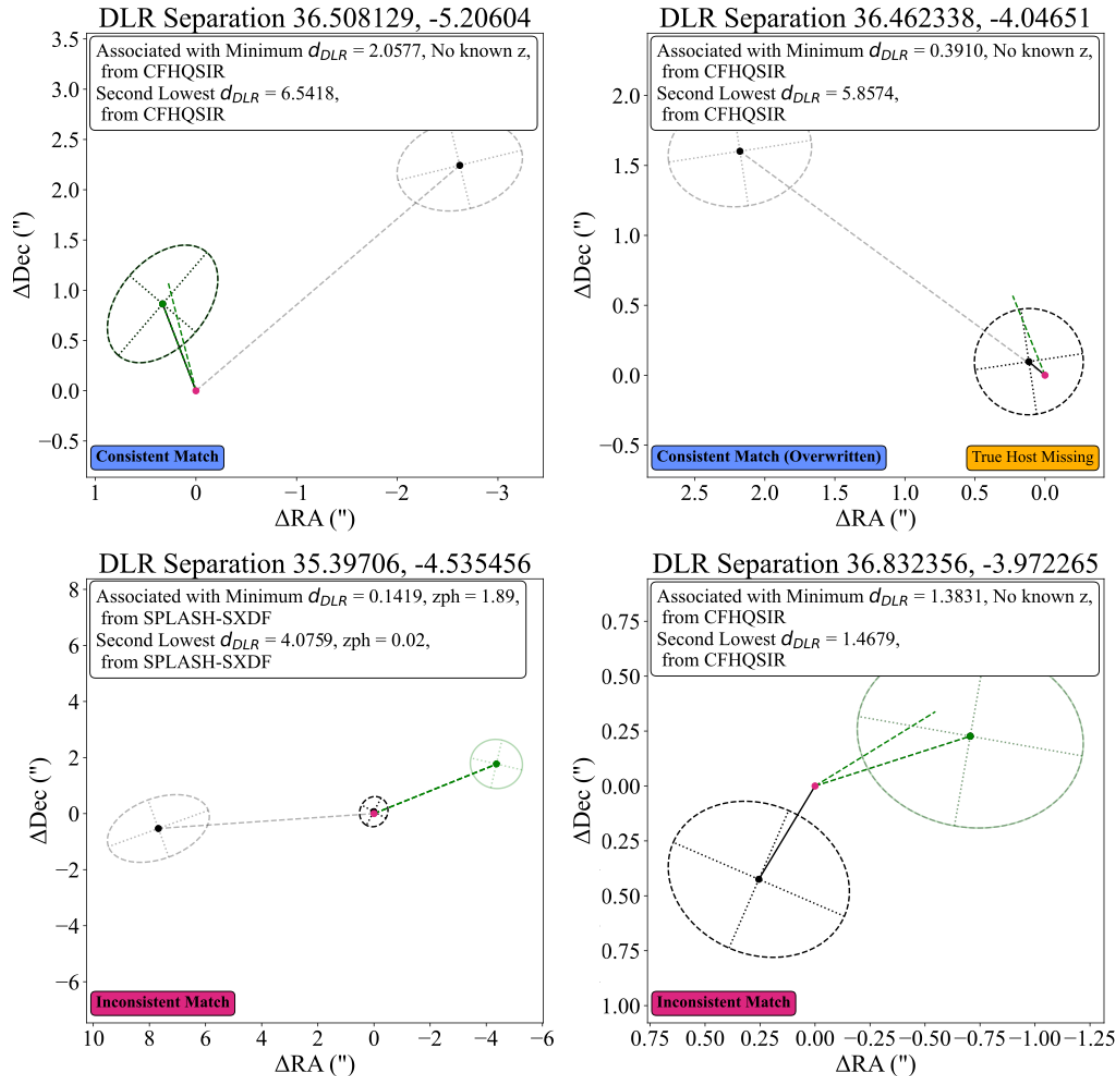
Directional Light Radius

- Direct Light Radius or DLR itself is the elliptical radius of a galaxy in the direction of the SN in units of arcseconds.
- We calculate the separation between the transient and the galaxy, in arcseconds, and normalize it by the DLR.
- Contrast with the 'A-Value' approach where we normalize the separation by the semimajor axis length.



Sullivan M., et al., 2006, ApJ, 648, 868

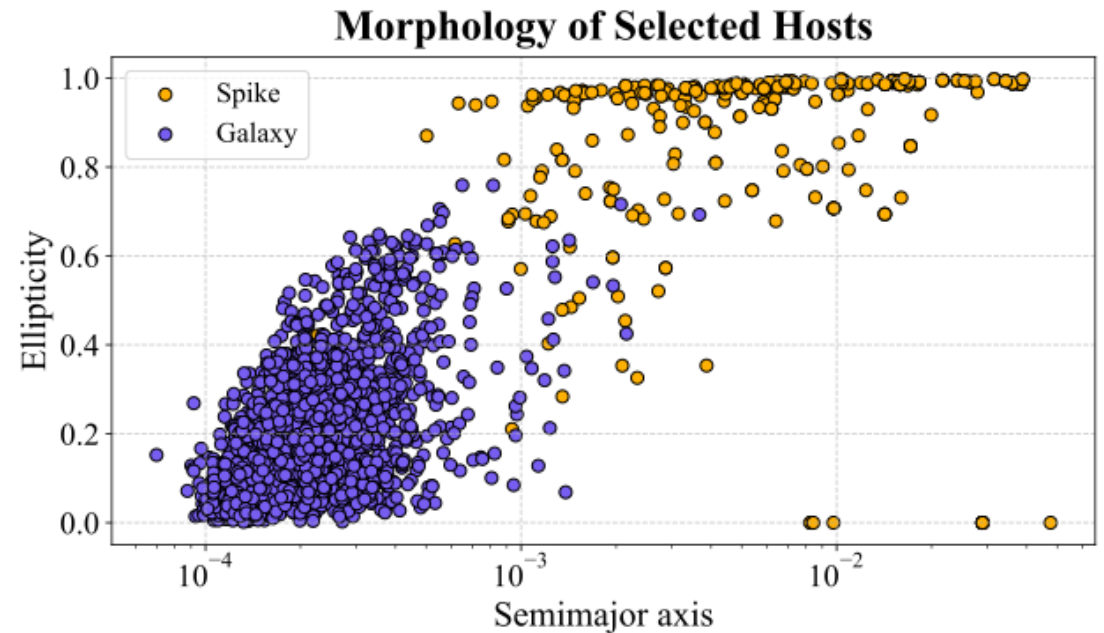
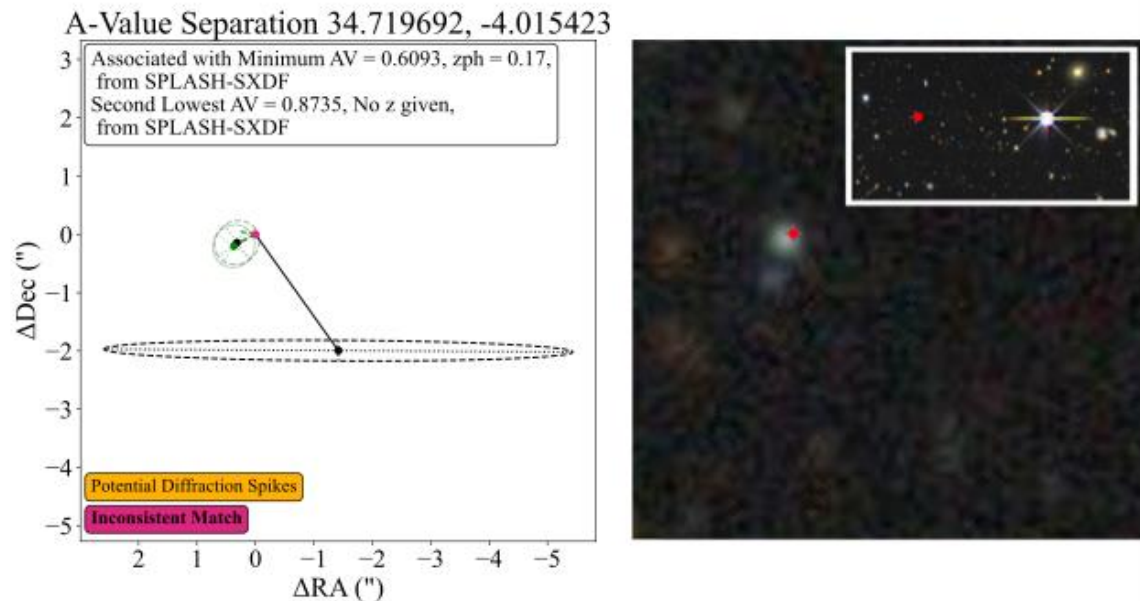
Implementation on XMM-LSS



- We test the DLR method on a Dark Energy Survey (DES) sample of 2664 supernovae within the XMM-LSS deep drilling field with confirmed host associations.
- Utilise an XMM-LSS “Lestrade Catalogue” with morphological information from different sources: SPLASH-SXDF and CFHQSIR.
- For each transient, calculate the d_{DLR} values for each galaxy within a given radius and select the lowest two.

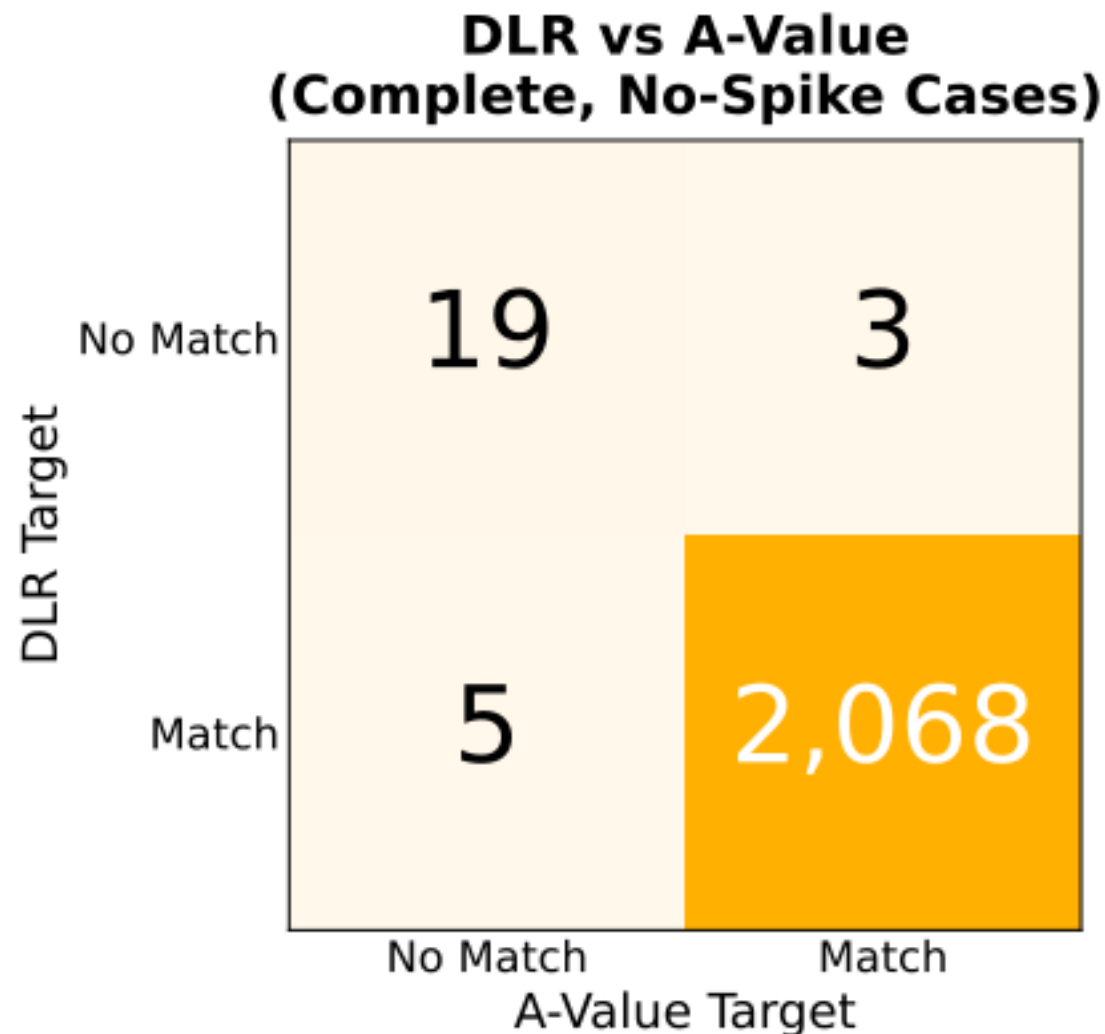
Diffraction Spikes

- Semimajor Conesearch method is biased towards large, thin host candidates. Morphology analysis enables us to identify these diffraction spikes.



Champion/Challenger Analysis

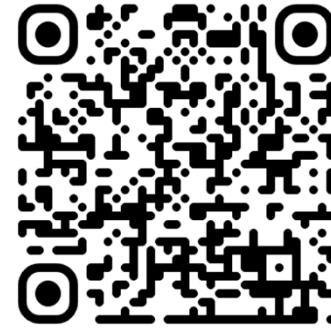
- DLR method outperforms AV method across the entire, unexamined dataset.
- What if we remove cases where the true host doesn't exist in our catalogue? The DLR outperforms, but to less of an extent.
- Removing diffraction spikes brings the two methods to parity – AV method picks these up much easier!
- DLR seems better on contaminated data.



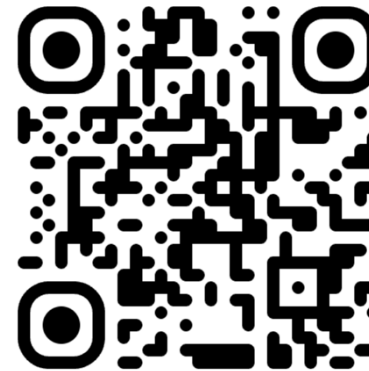
Thank you

- A large amount of unused catalogue data are available for the Rubin Deep Drilling Fields and can be used for a variety of transient contextual classification approaches.
- For morphology-based approaches to 'cleaned' catalogues the DLR and AV methods achieve similar levels of performance, though the DLR method is more robust against contaminants.
- Sherlock 'sprint week' to be held this August where we'll implement many of these catalogues.
- Catalogues will continue to be added to the repository.

Lestrade
Autowiki



Weston et al,
2026



(Hire me)

