Lens searches with Gaia and variability

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COSMICLENS

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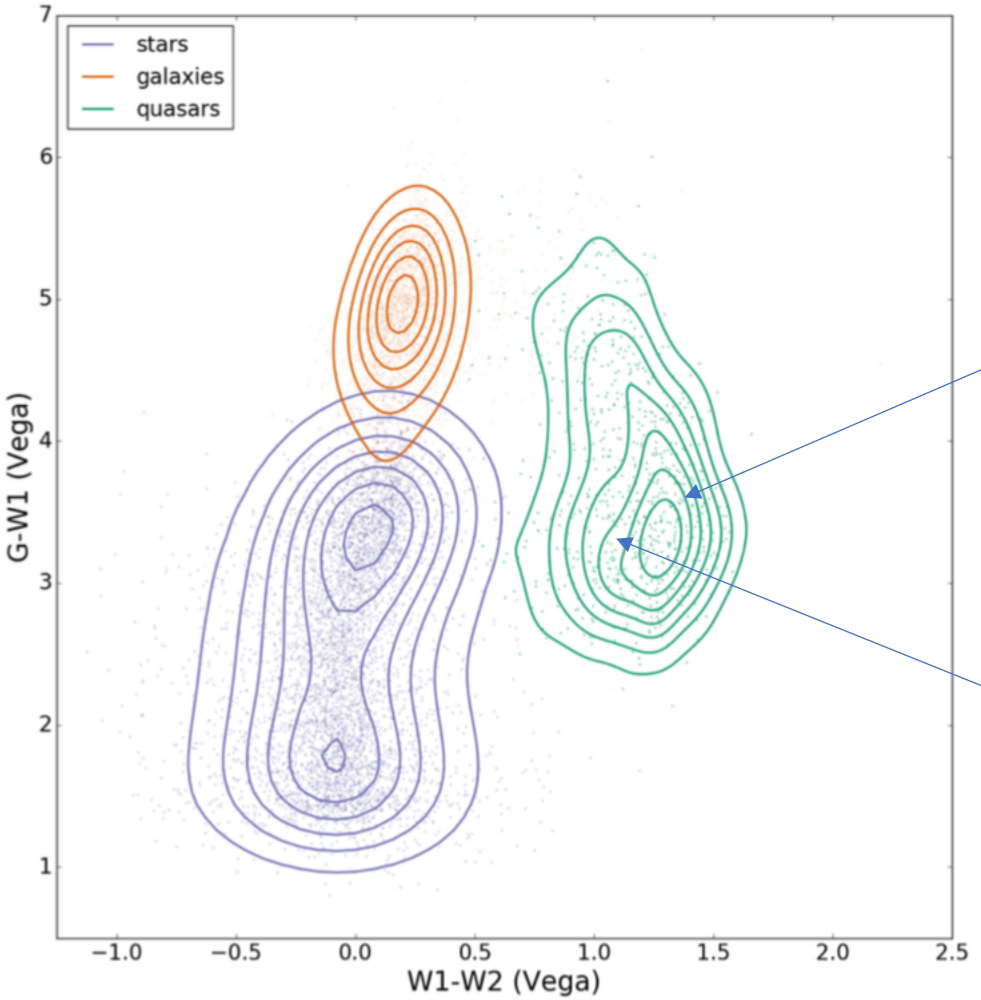
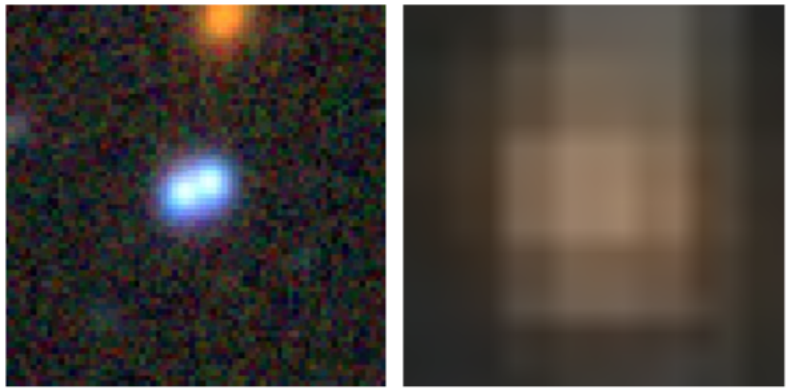
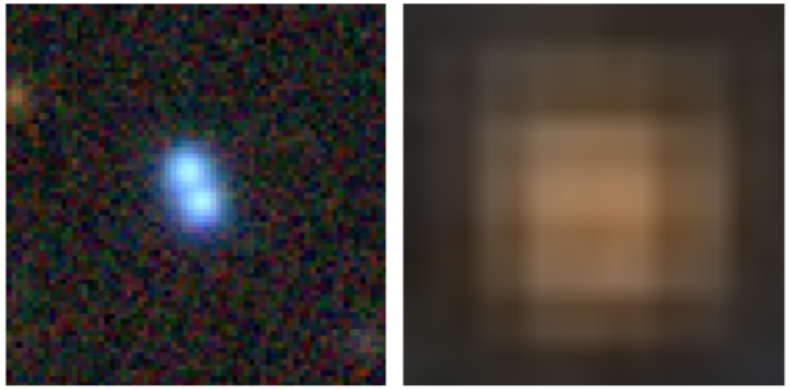
Multiplets around quasars



lensed z=2.70 quasar

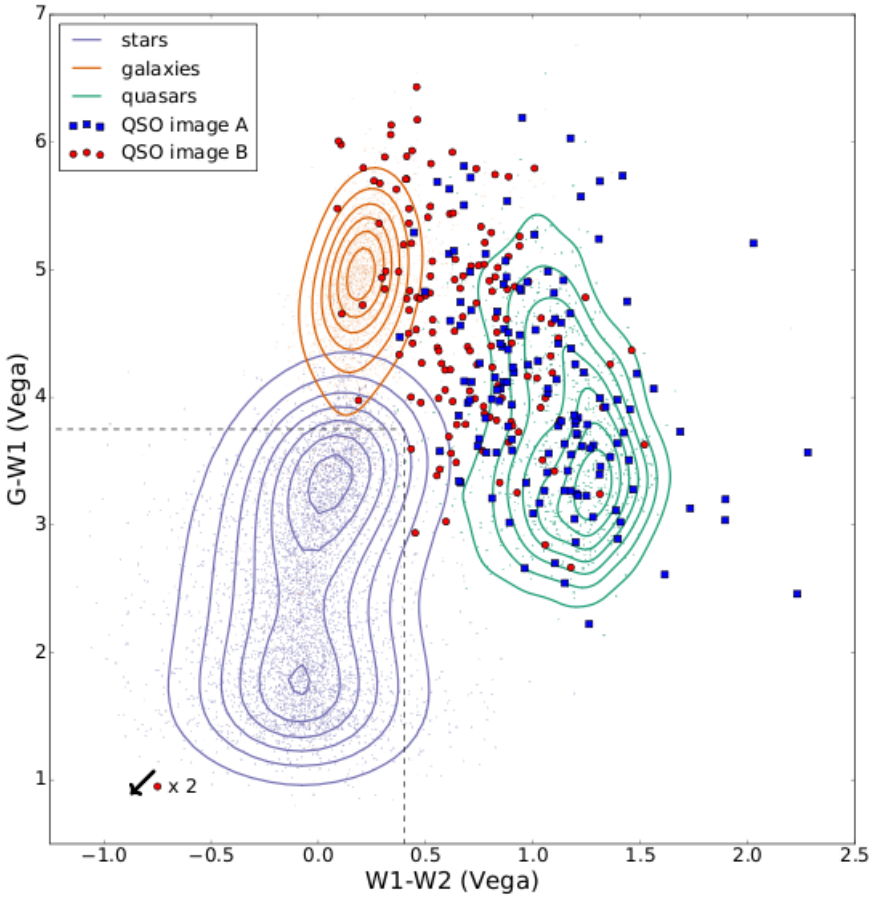


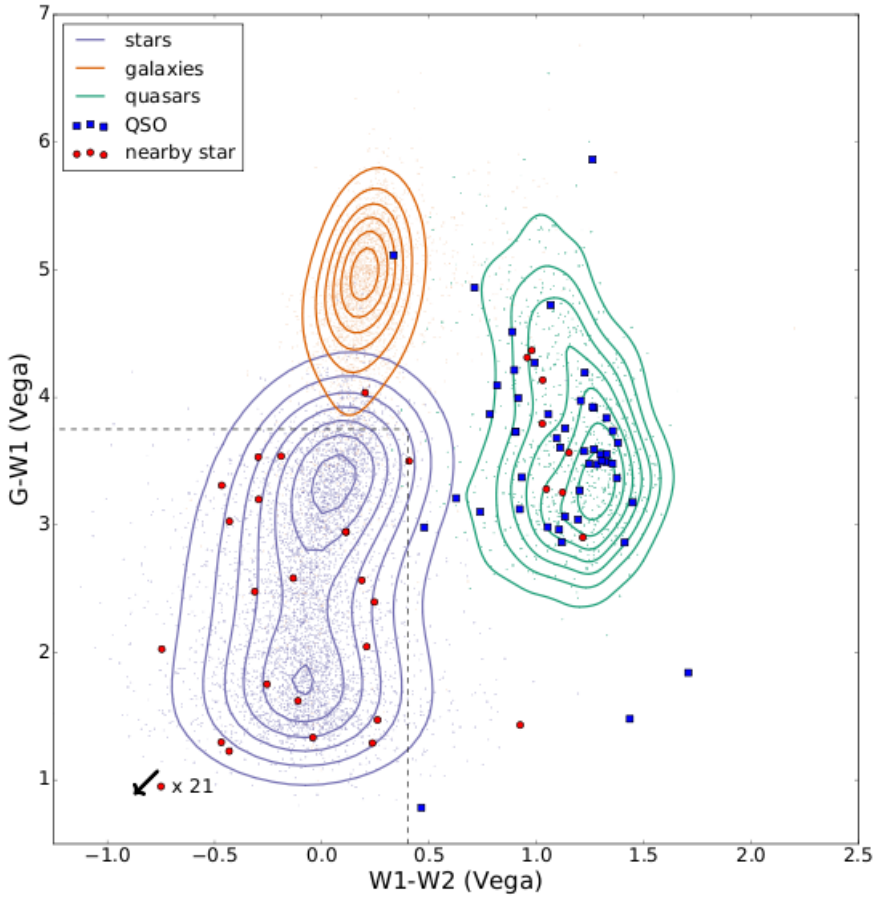
z=2.90 QSO + star



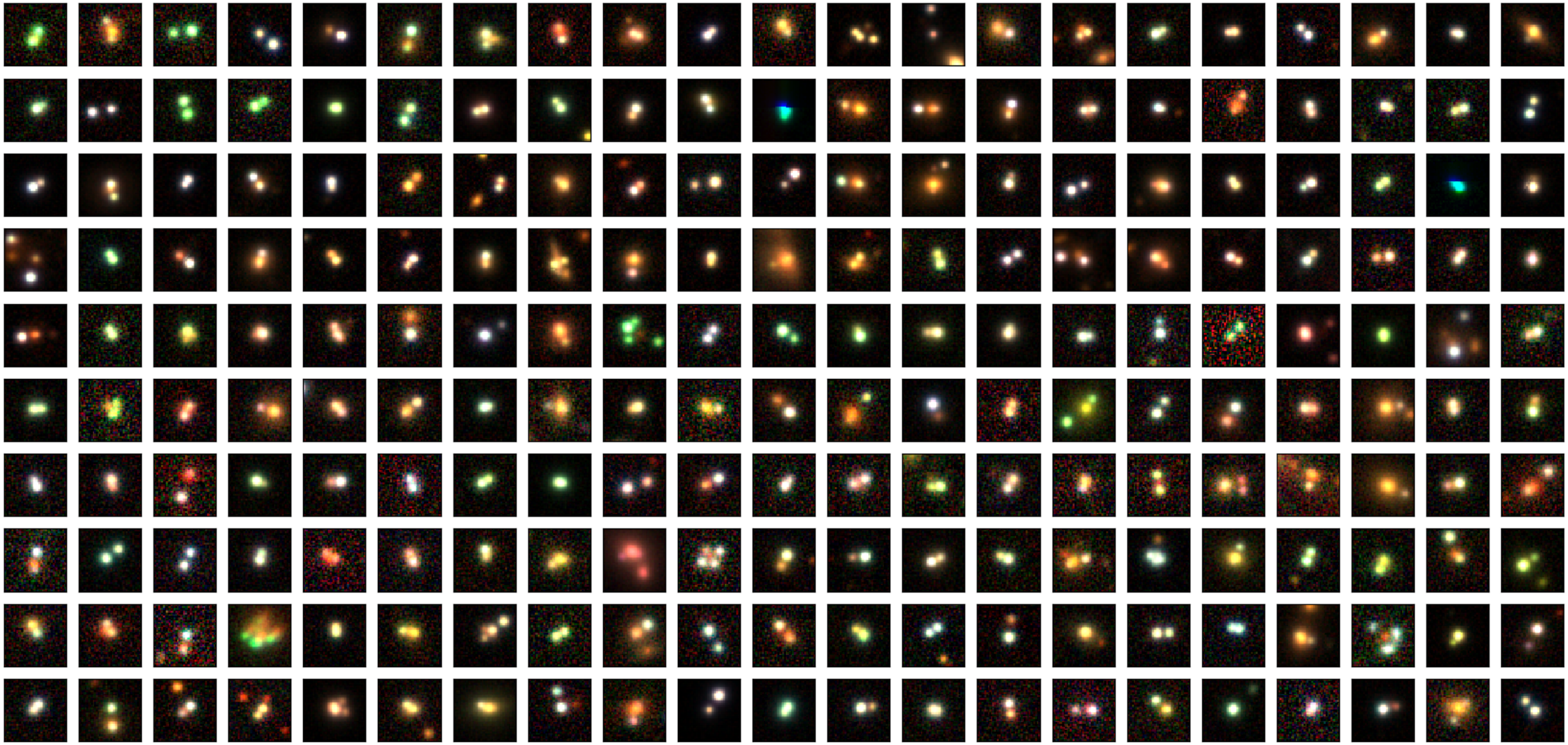
Model unWISE data with Gaia positions

- extract W1, W2 magnitudes from unblurred coadds (unWISE, Lang et al. 2014) at positions of Gaia detections
- possible thanks to well-known WISE PSF and great absolute astrometry of WISE data
- remove 80% of contaminants, and keep 99% of known lenses (Lemon et al. 2019)

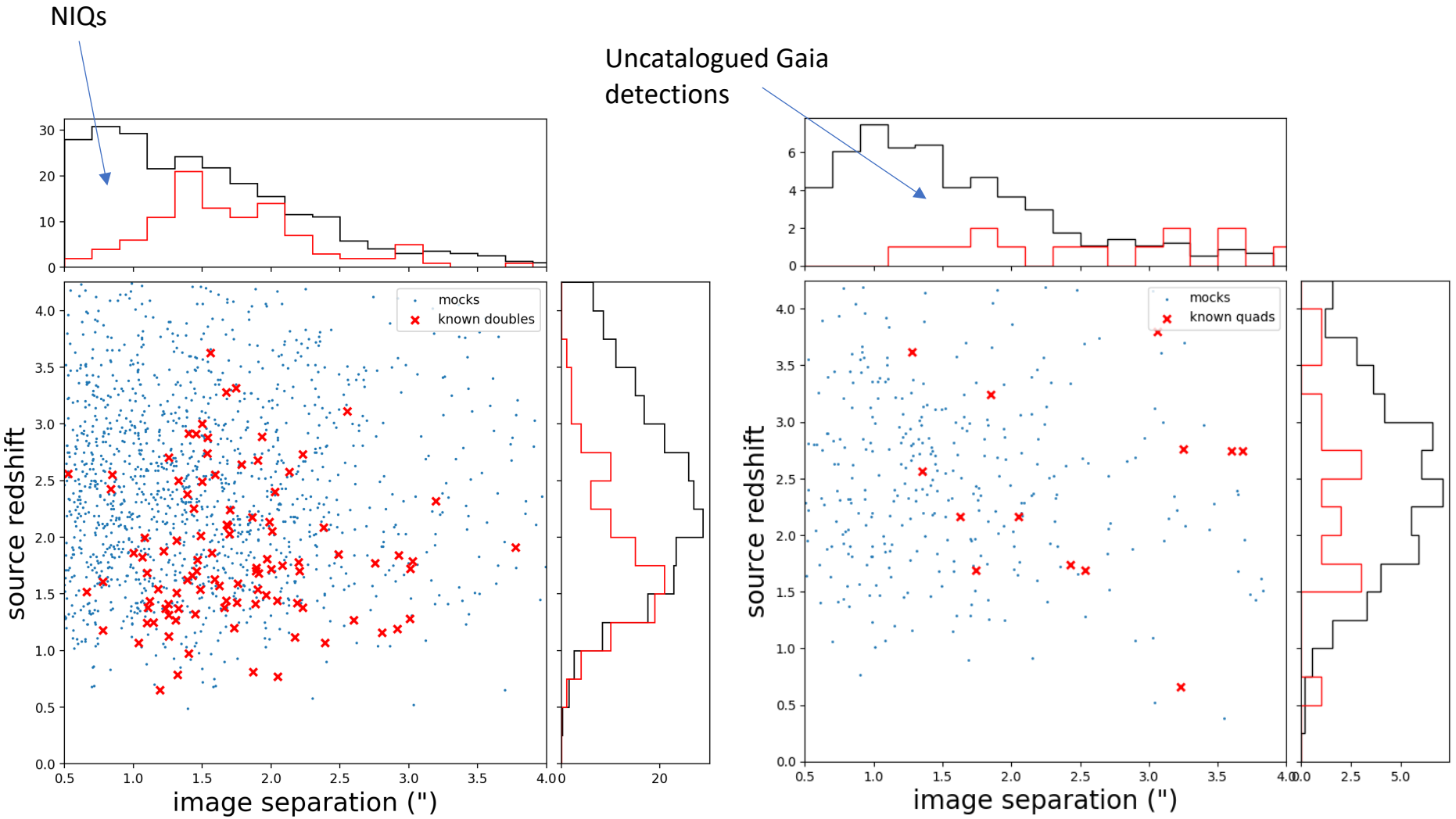




>200 new lensed quasars + NIQs



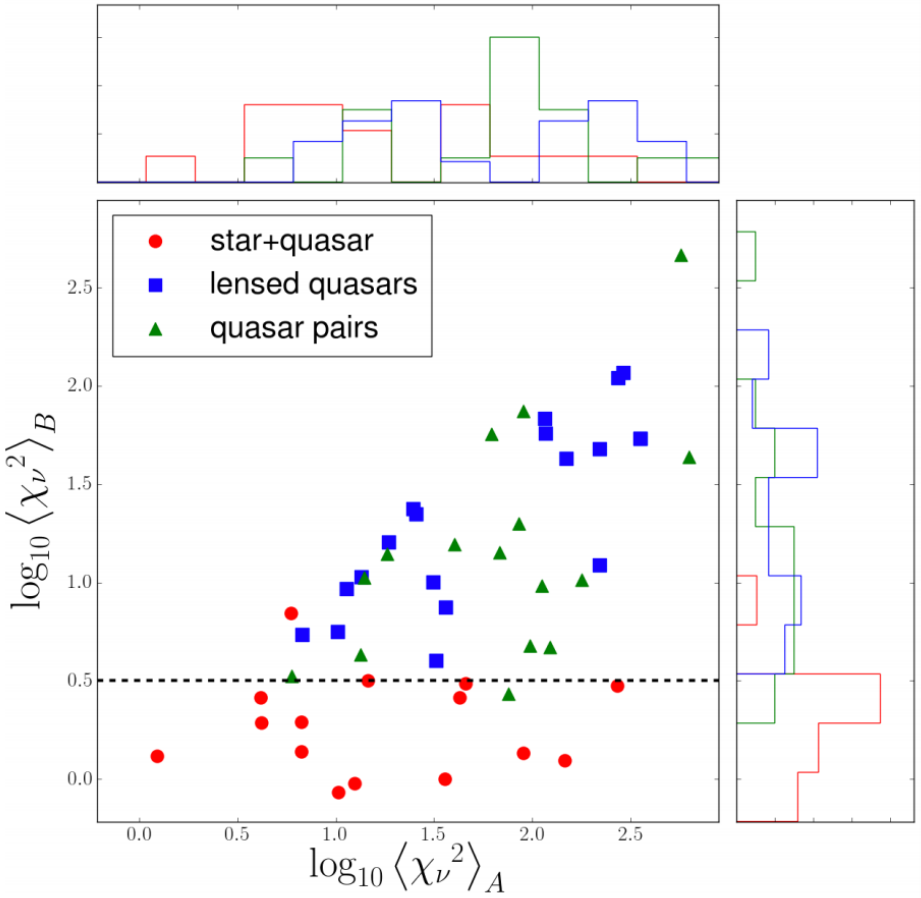
Where are the missing lenses?

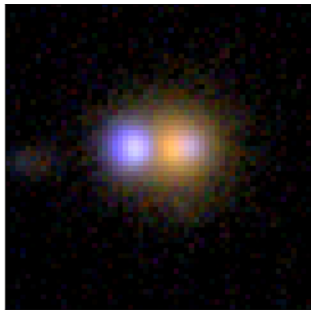


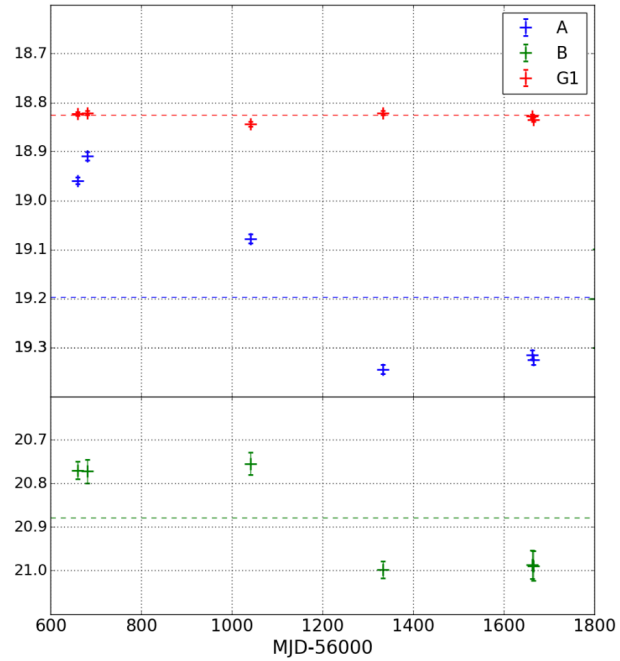
- compare to mock catalogue of Oguri & Marshall 2010
- use known quasars to synthesise G mags based on G-i at similar redshift
- require 2 detections at G<20.7, within Pan-STARRS, |b|>20

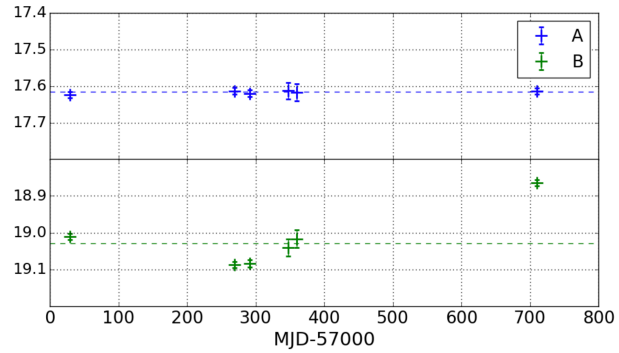
Testing variability selection with DES

- model as 2/4 PSFs (+galaxy) and extract single epoch flux
- lenses clearly separated from star+QSO systems
- which mocks pass the multiple variability condition? → **quad bias due to magnification bias**
- fainter intrinsic QSOs are more variable
- ~8% higher quad fraction in DES; see Lemon et al. 2020





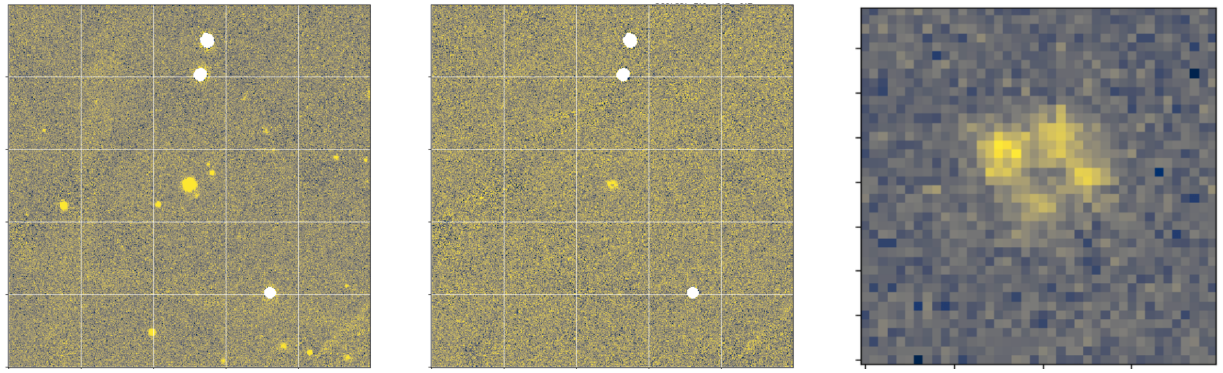




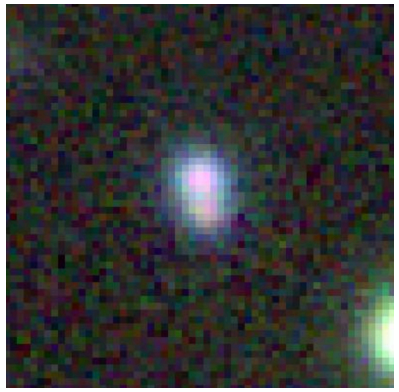
Extended variables in Pan-STARRS

- Pan-STARRS has 10-20 epochs in r of sky above dec.=-30
- create best seeing reference frame and perform difference imaging
- stack weighted absolute residuals and look for multiple detections/extended objects
- starting to follow-up best candidates, e.g:

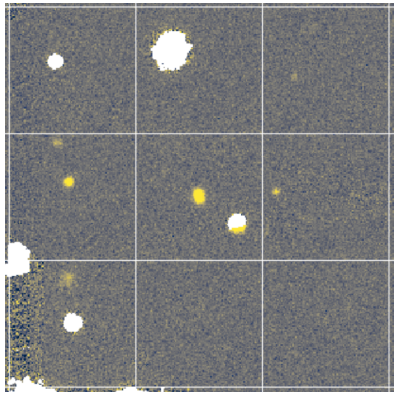
HE0435-1223



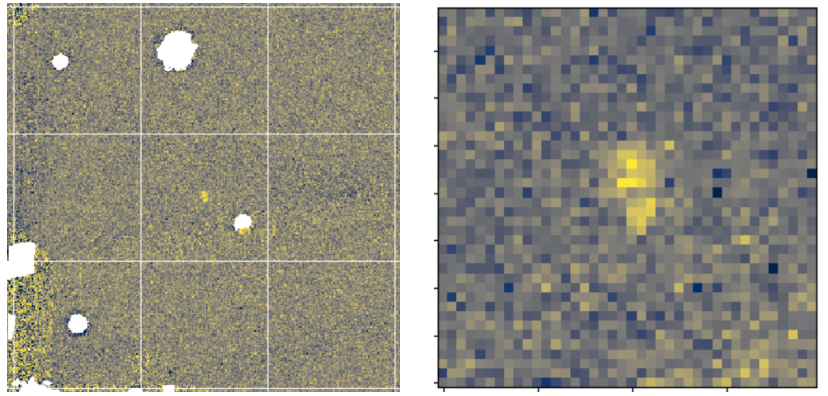
gri image



r-band reference



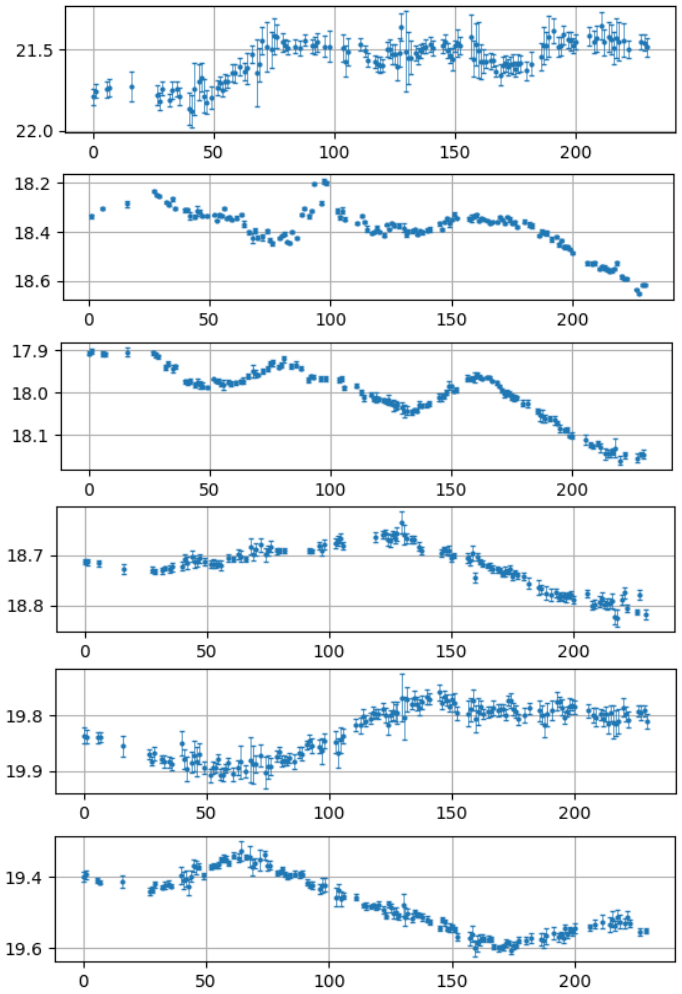
variability map



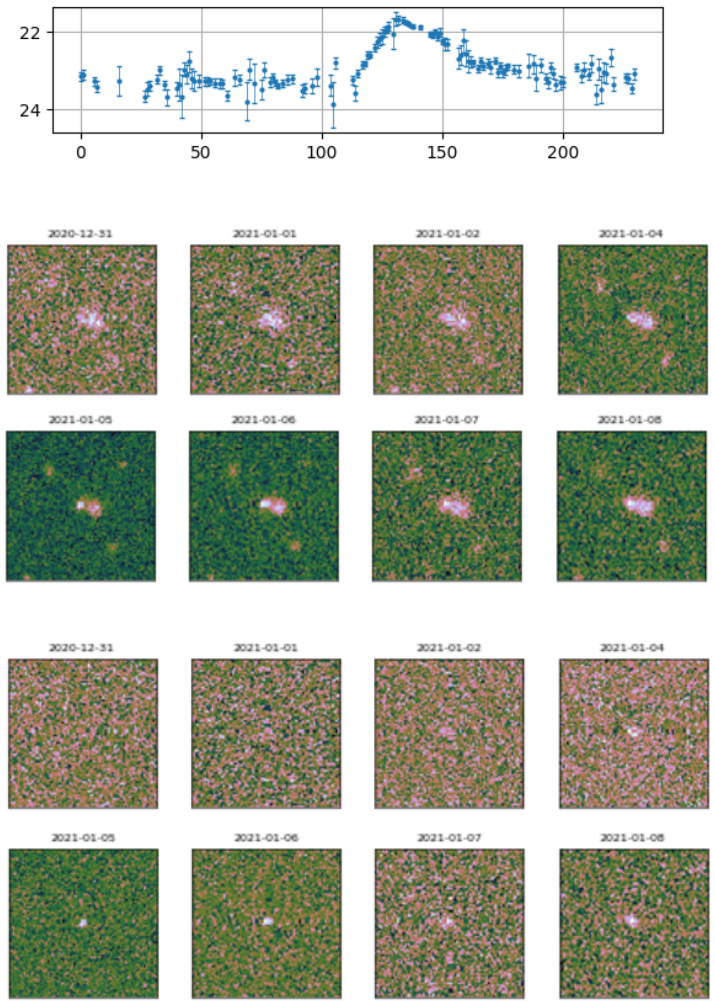
- currently analysing milliquas
- recently confirmed z=2.32 NIQ

Variables in the VST lens monitoring fields

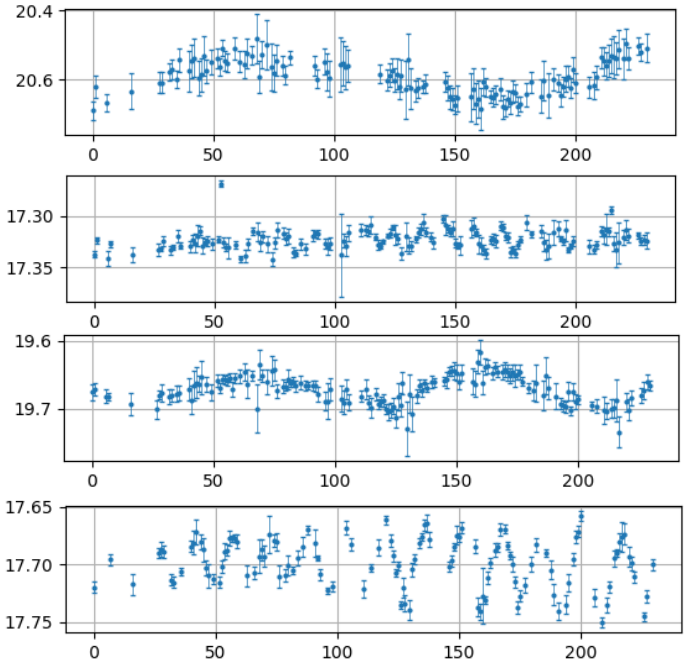
QUASARS



SUPERNOVAE



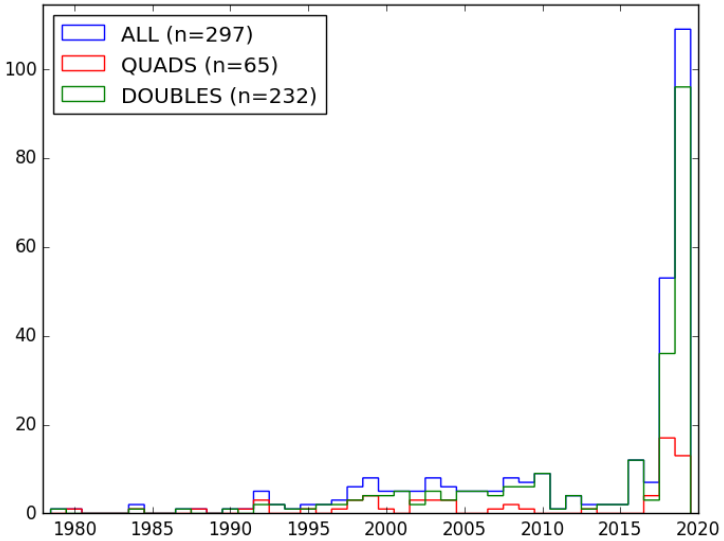
VARIABLE STARS



- current supernova watch of 5 fields (~20 supernovae per month)
- detecting down to r~24.5
- 50-100 quasars per field

Conclusions

- >200 new lensed quasars since the Gaia mission began
- complete (or nearly?) at wider separations for doubles, when Gaia is deblending for quads; need to target NIQs to find missing doubles; wait for further Gaia detections for quads
- variability removes star+qso pairs effectively based on DES



- significant quad bias if using variability selection compared to magnitude limited sample
- currently watching supernovae in the VST lensed quasar monitoring fields for lensed supernova candidates