Photometric Ultracool dwarf catalogue in Euclid's Q1 data release

arXiv:2503.22497

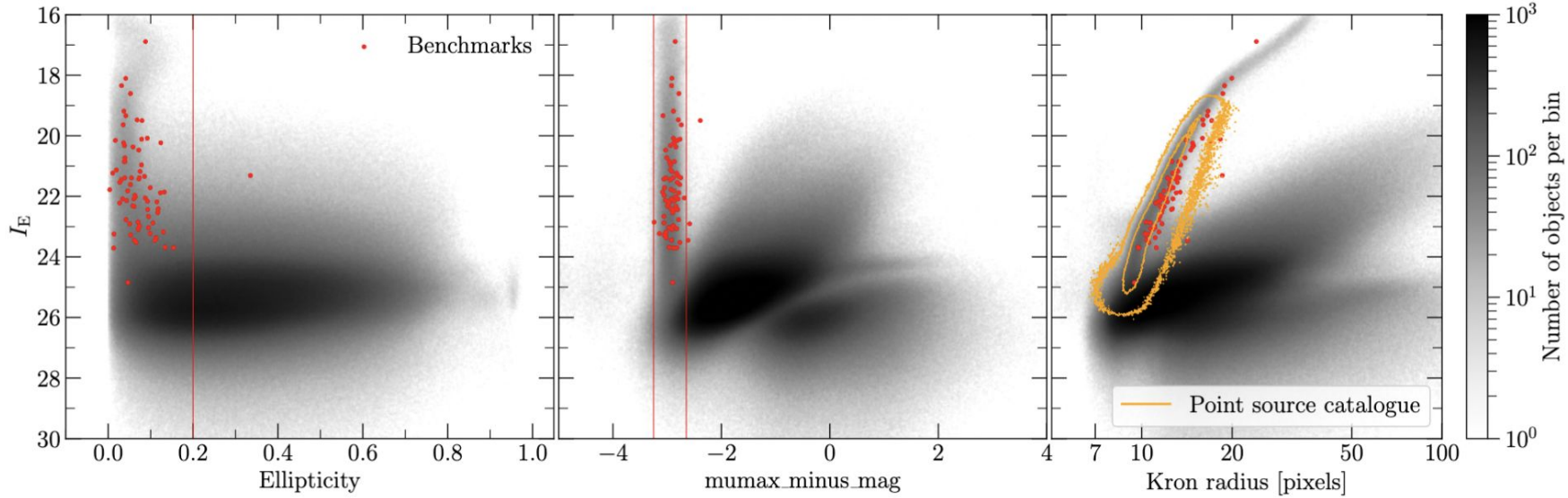
Maruša Žerjal
Carlos Domínguez-Tagle
Eduardo Martín
Nafise Sedighi
Nikola Vitas
And others

BD30, 1-5 September 2025, La Gomera

A point-source catalogue

Morphology

- Ellipticity
- Mumax_minus_mag (extended/point source separation)



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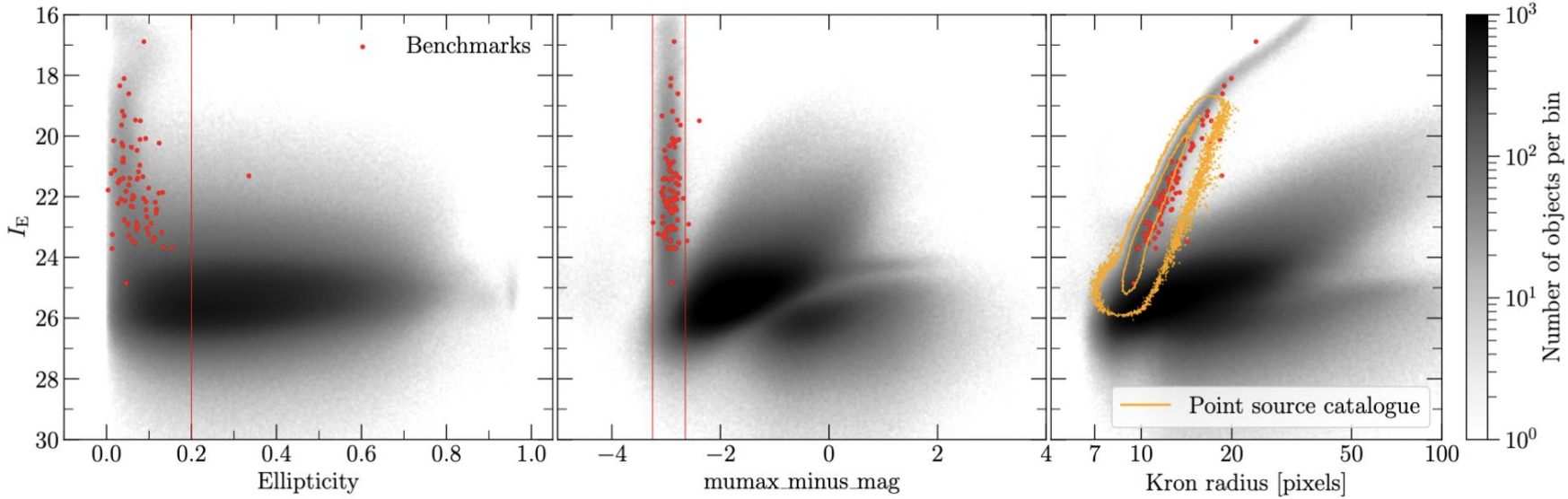
Quality
- Det_quality_flag < 3
- S/N > 4



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A point-source catalogue

Morphology
- Ellipticity
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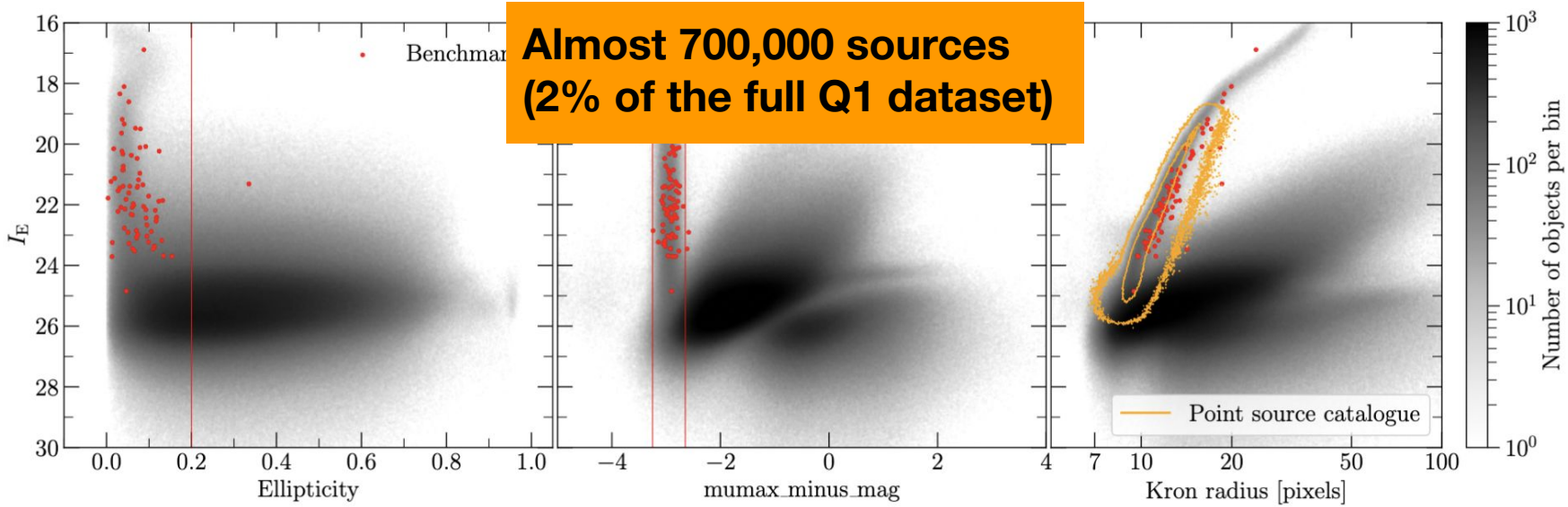
Almost 700,000 sources (2% of the full Q1 dataset)



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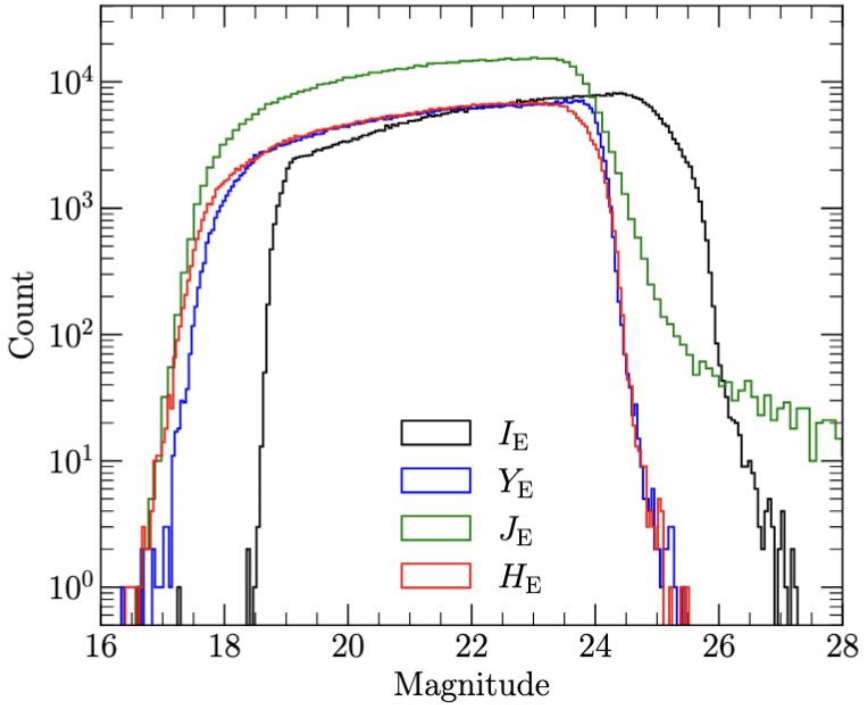
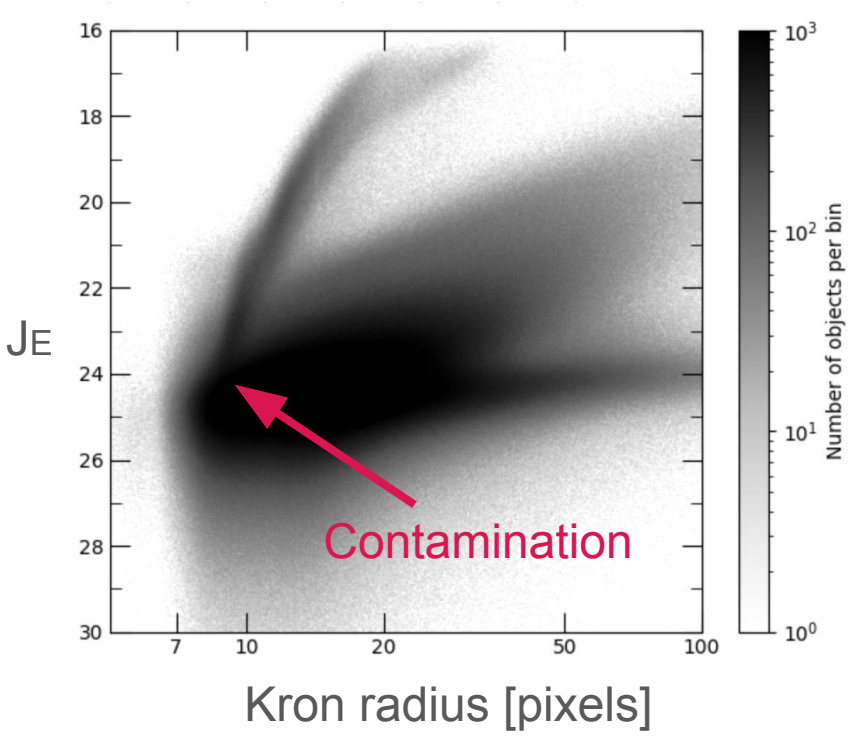
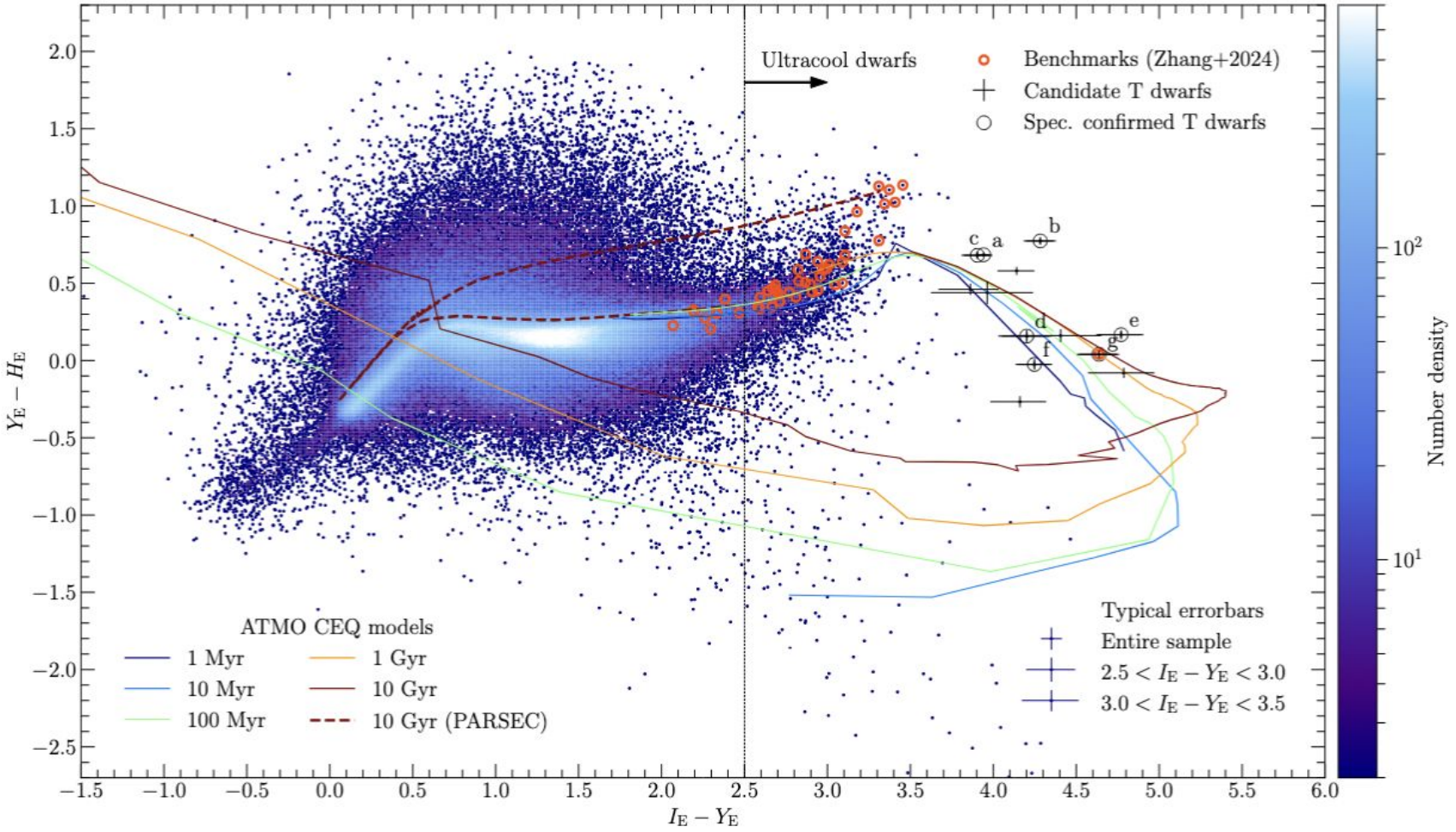
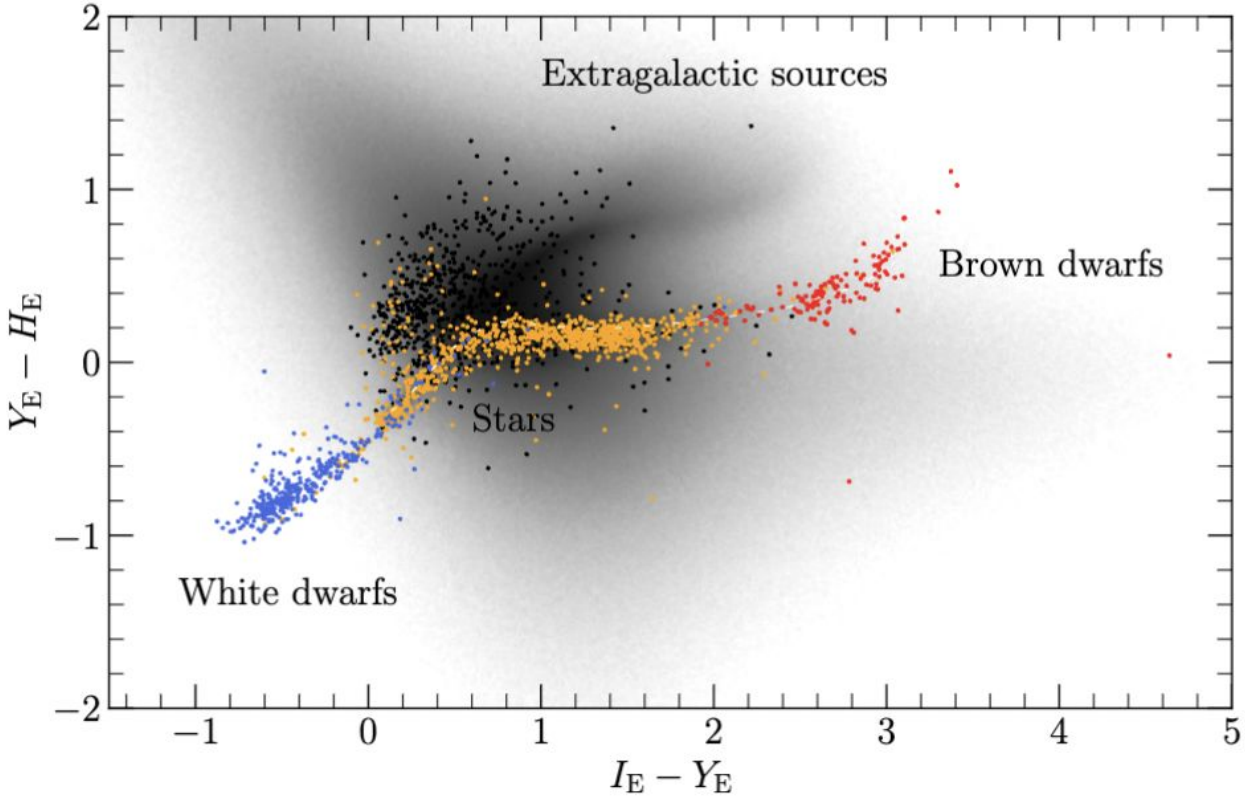
A point-source catalogue: VIS detection required






Ultracool dwarfs
Benchmarks (Zhang+2024)
Candidate T dwarfs
Spec. confirmed T dwarfs
a
b
c
d
e
f
g
ATMO CEQ models
1 Myr
10 Myr
100 Myr
1 Gyr
10 Gyr
10 Gyr (PARSEC)
Typical errorbars
Entire sample
$2.5 < I_E - Y_E < 3.0$
$3.0 < I_E - Y_E < 3.5$
Number density
10^2
10^1
$Y_E - H_E$
$I_E - Y_E$



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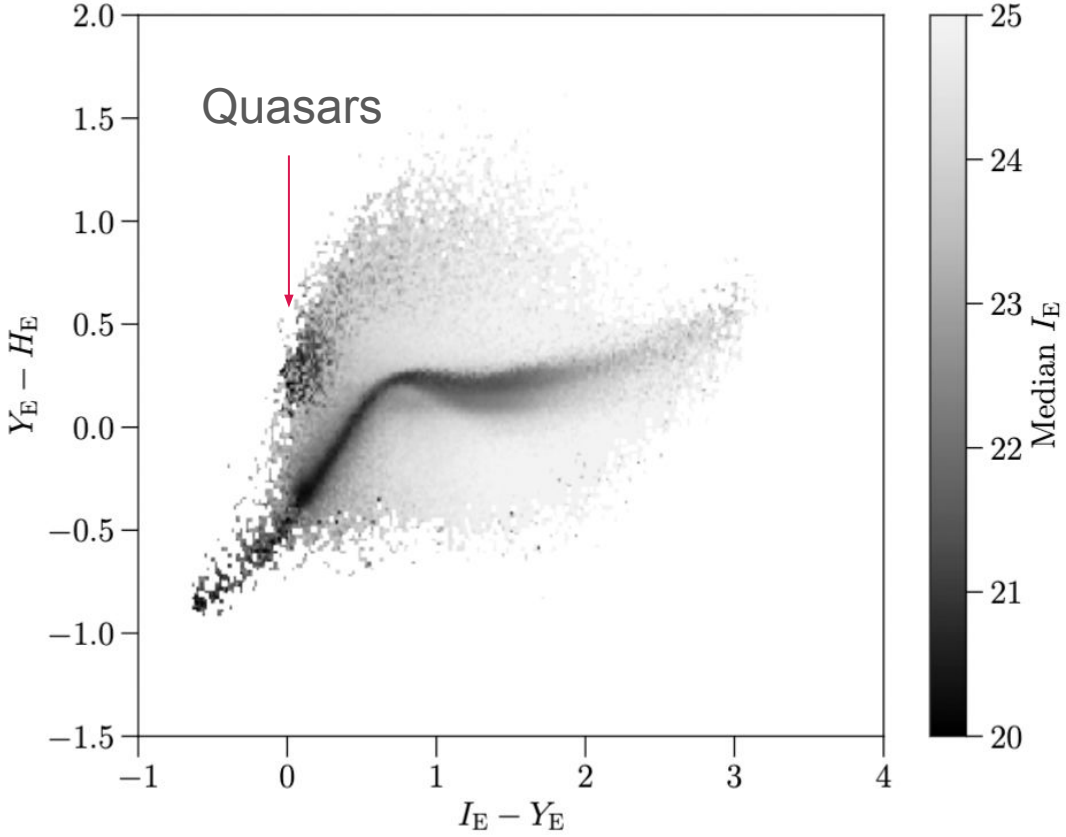

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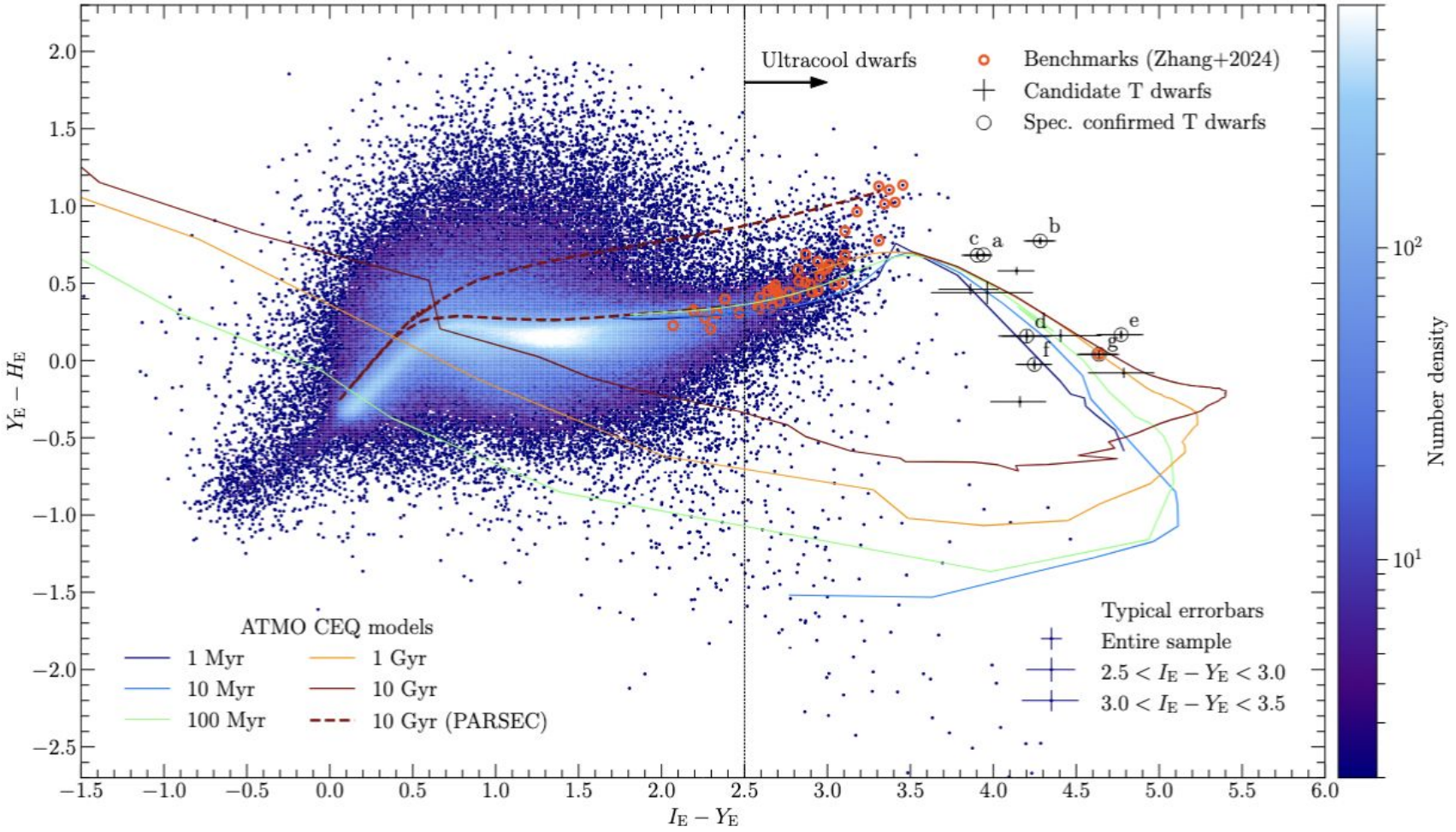
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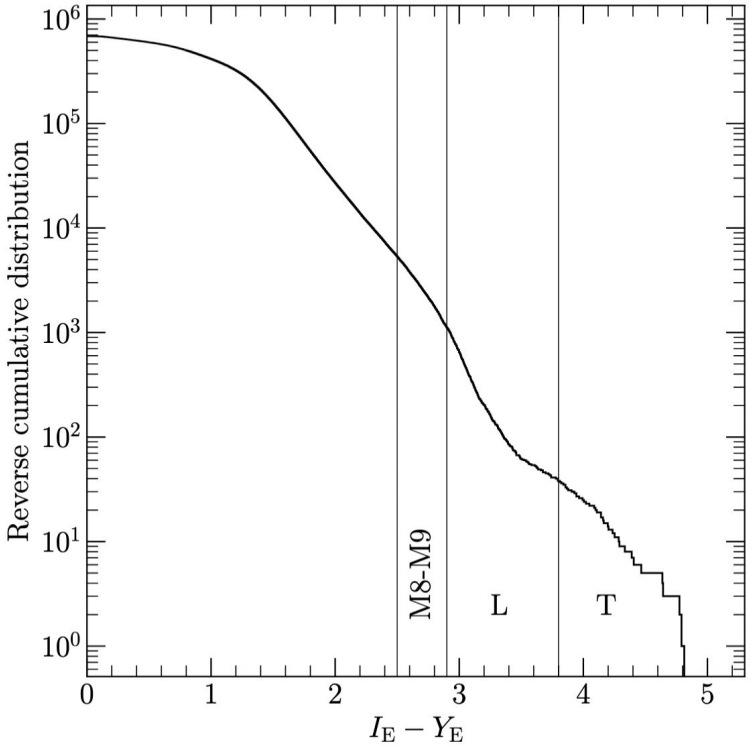
Number of detections



5306 UCD candidates in Euclid, 1200 L and T dwarfs (26 T dwarfs spec. confirmed)
Surface density: 100 UCDs per deg2; this is lower limit
Future: more than 1.5 million UCDs, and more than 300,000 L and T dwarfs in the Wide Field Survey

For comparison:

- Dark Energy Survey: 20 000 candidates (dal Ponte et al. 2023), surface density 4 UCDs per deg2

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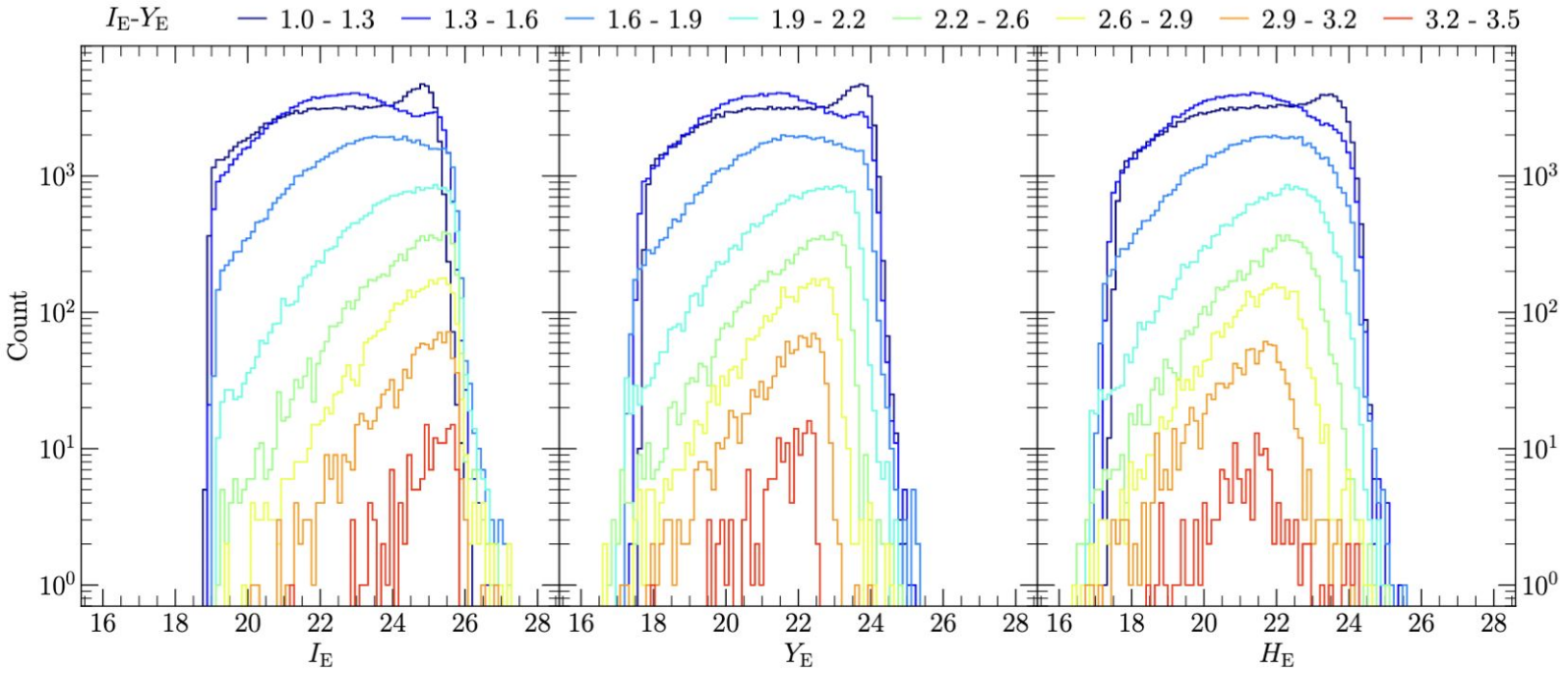

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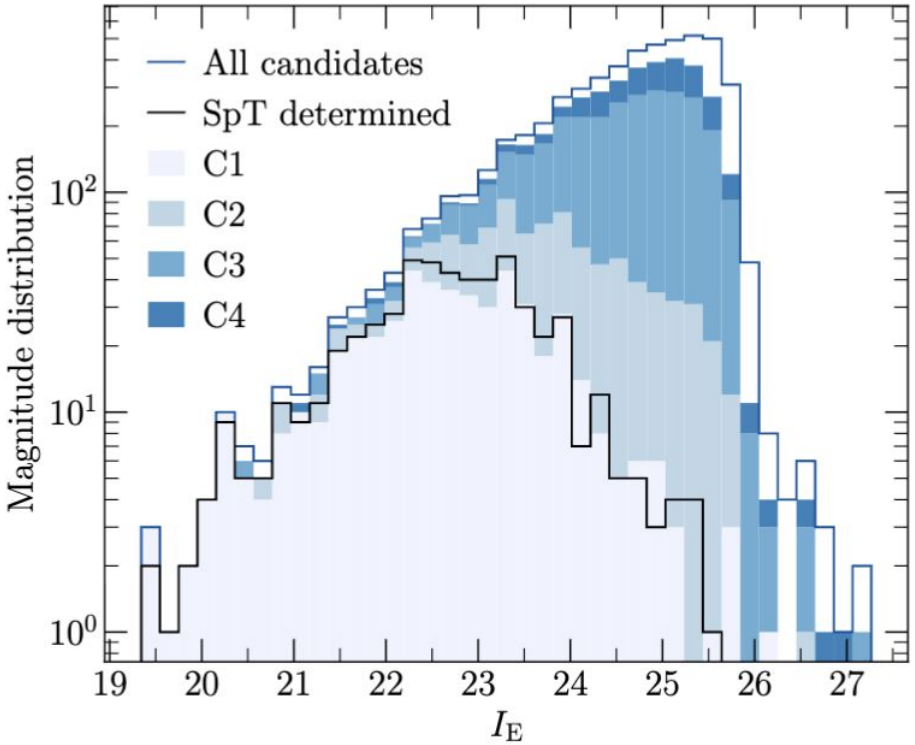
Spectroscopic confirmation

- Spectra for ~90% of candidates
- 1111 more with UCD features (Vitas et al., in prep)
- 546 objects with SpT (Dominguez-Tagle et al. 2025)

→ If we detect more than 1 million UCD candidates photometrically, we can expect >10% **(>100 000)** to be confirmed by Euclid's spectra

Stacked histogram



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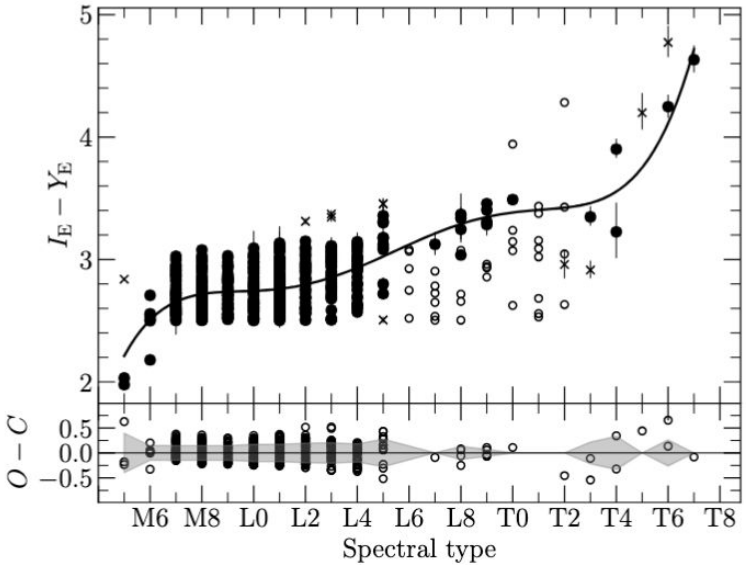
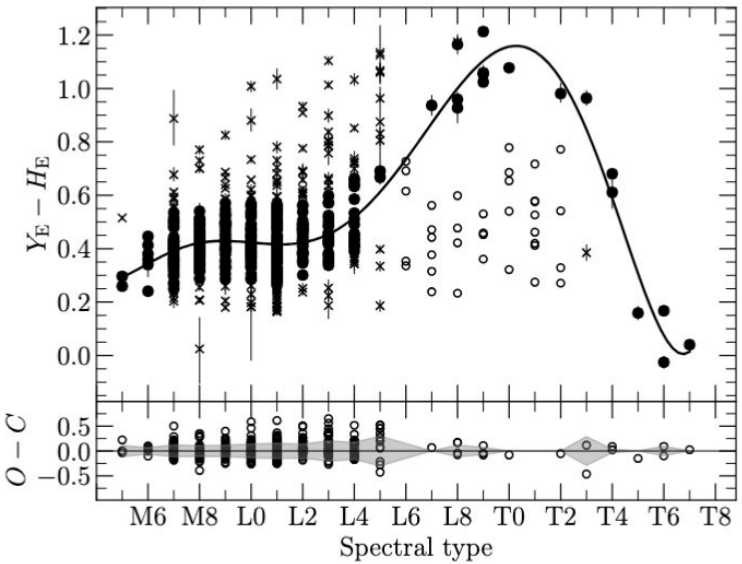
SpT - colour relations





Empty circles: variable objects? L/T transition

SpT - colour relations

SpT	$I_E - Y_E$	$I_E - J_E$	$I_E - H_E$	$Y_E - J_E$	$Y_E - H_E$	$J_E - H_E$
M7	2.65	2.97	3.09	0.29	0.39	0.11
M8	2.72	2.97	3.08	0.30	0.42	0.12
M9	2.74	2.99	3.09	0.30	0.43	0.13
L0	2.74	3.02	3.12	0.29	0.42	0.12
L1	2.76	3.07	3.18	0.30	0.42	0.12
L2	2.80	3.13	3.25	0.30	0.42	0.12
L3	2.85	3.20	3.36	0.32	0.45	0.14
L4	2.93	3.29	3.48	0.35	0.52	0.18
L5	3.02	3.38	3.62	0.38	0.61	0.24
L6	3.12	3.49	3.78	0.43	0.73	0.32
L7	3.21	3.60	3.95	0.49	0.87	0.41
L8	3.29	3.73	4.13	0.55	1.00	0.48
L9	3.35	3.86	4.30	0.61	1.10	0.54
T0	3.38	3.99	4.47	0.67	1.16	0.56
T1	3.40	4.12	4.61	0.72	1.14	0.52
T2	3.42	4.26	4.72	0.75	1.04	0.41
T3	3.46	4.39	4.78	0.76	0.85	0.25
T4	3.55	4.51	4.79	0.74	0.59	0.03
T5	3.75	4.63	4.72	0.68	0.31	−0.20
T6	4.11	4.74	4.57	0.56	0.08	−0.38
T7	4.72	4.83	4.31	0.38	0.01	−0.41

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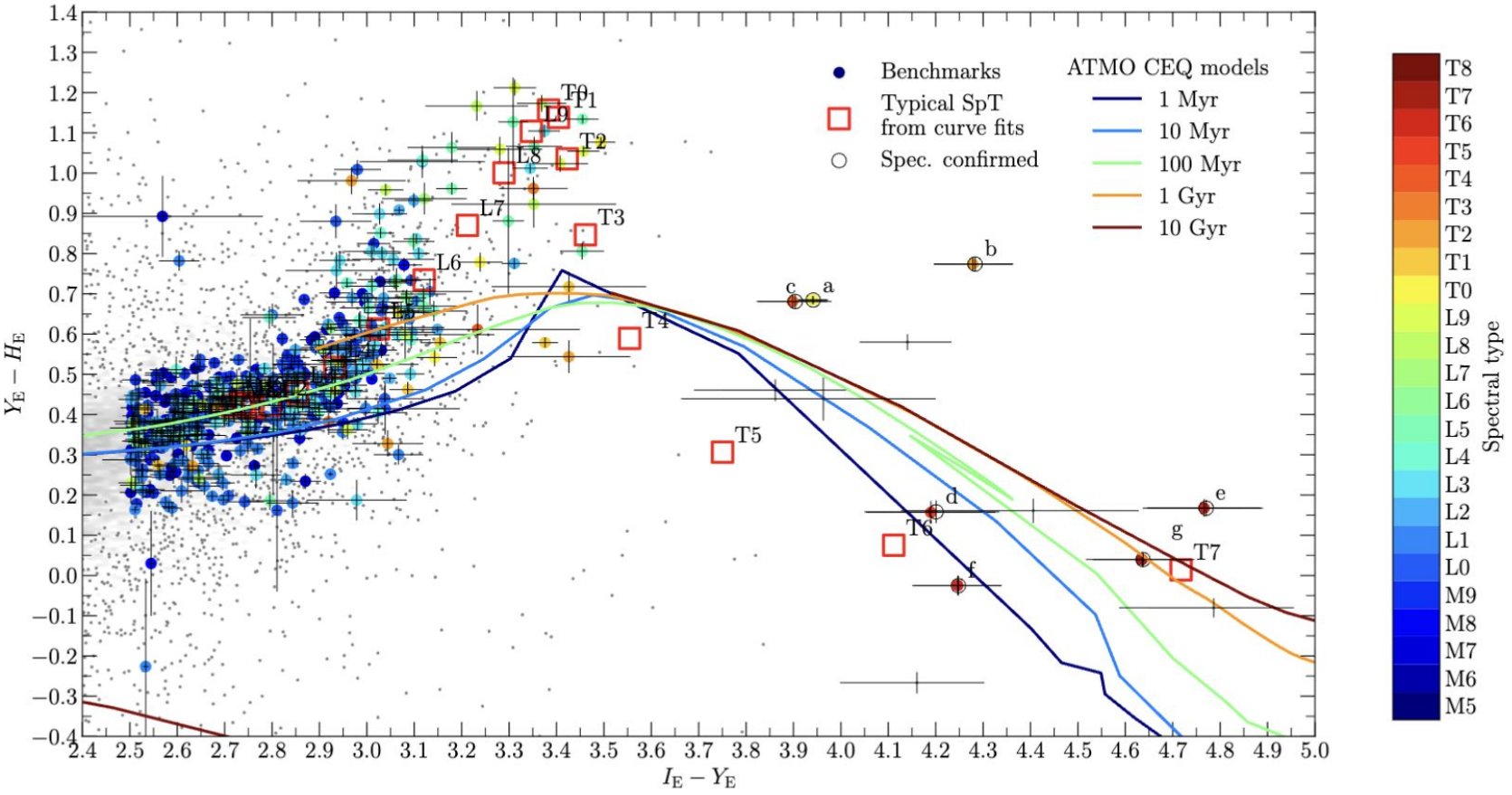

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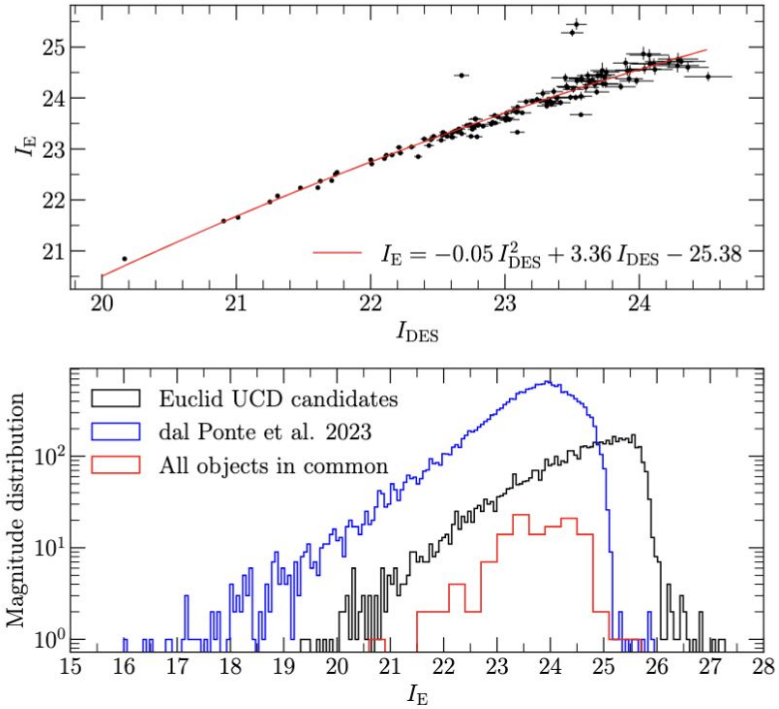
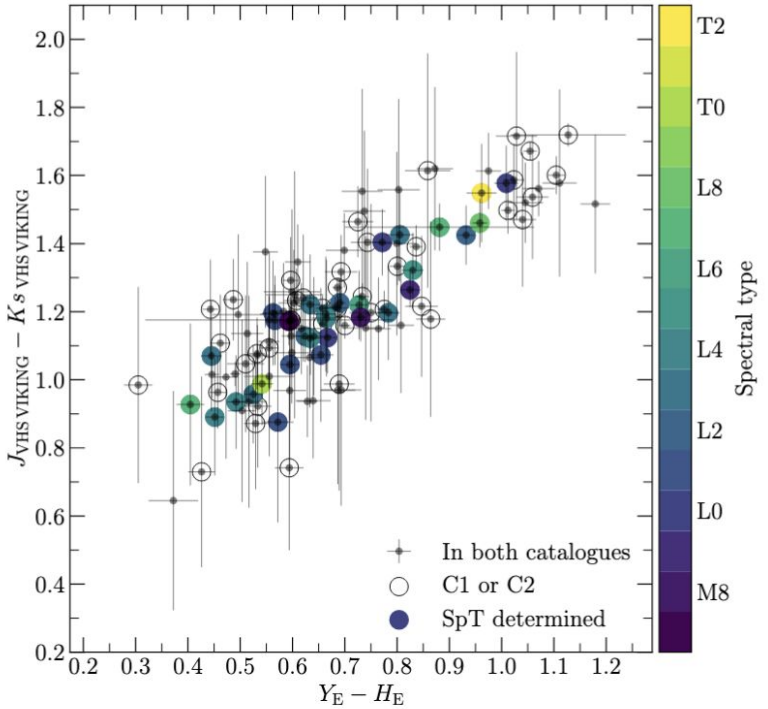
Cross-match with DES (dal Ponte et al. 2023)





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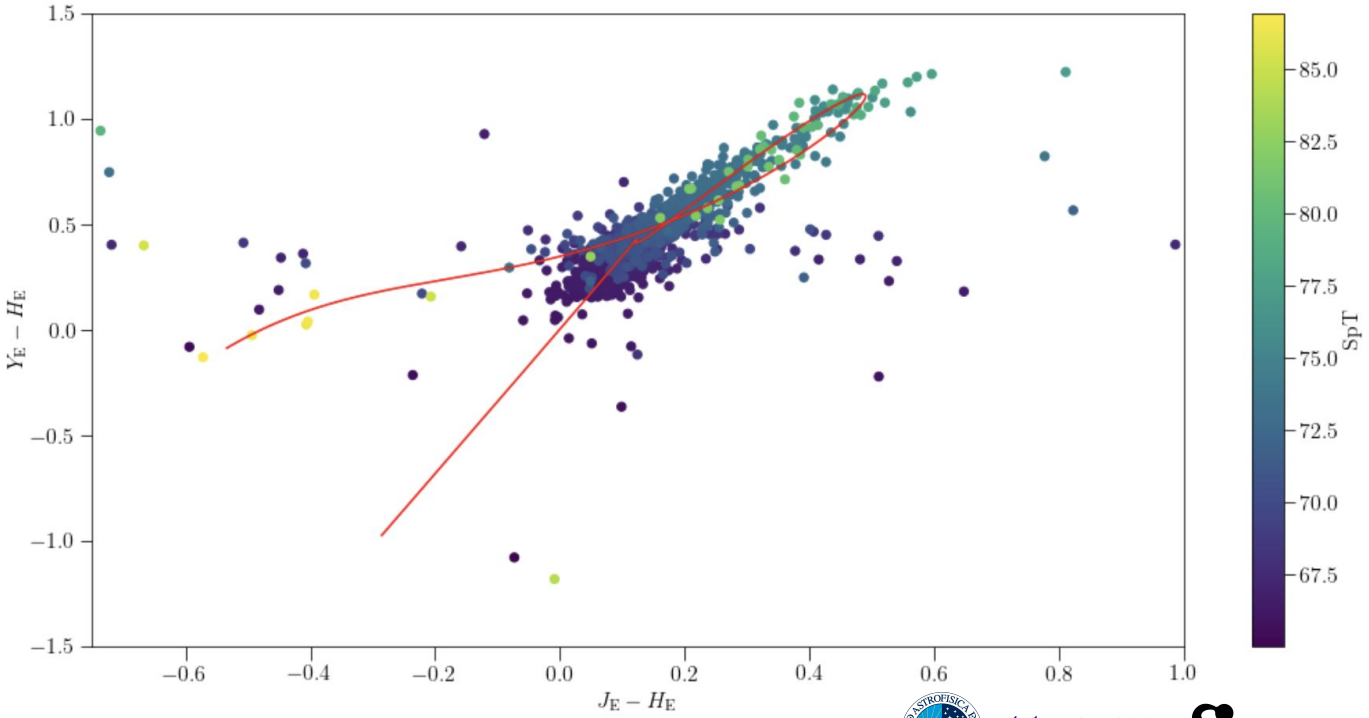
Spectrophotometric distances: preliminary results

Photometric spectral type



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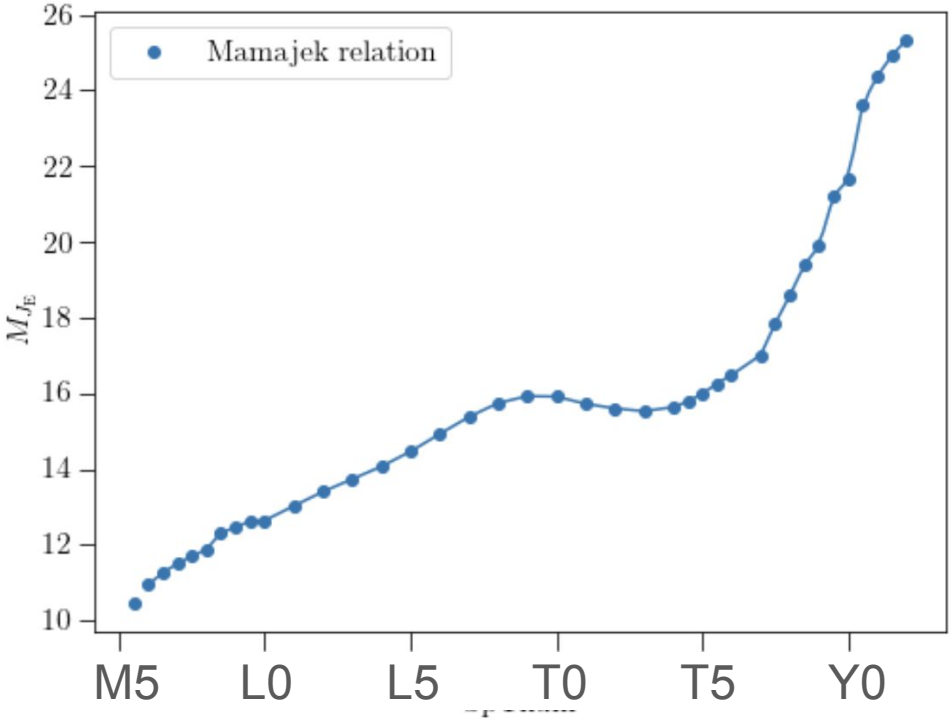
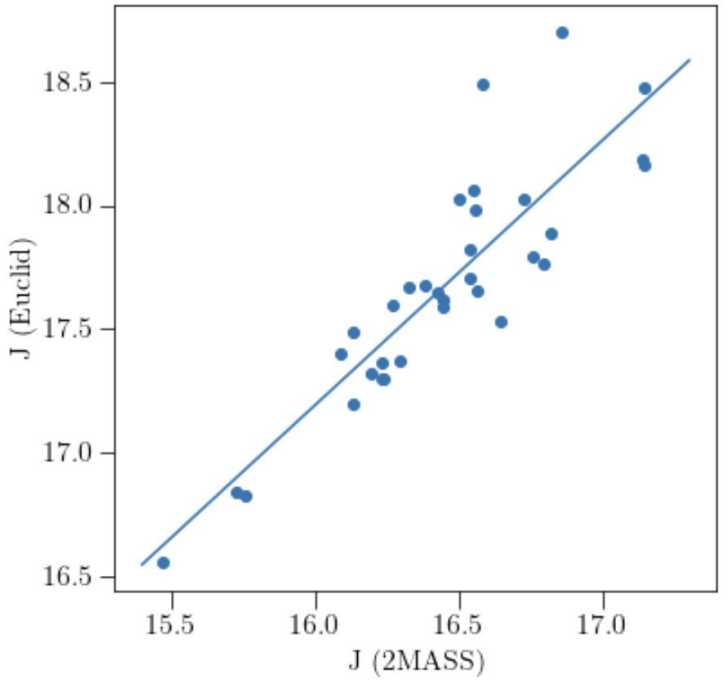
Empirical absolute magnitude vs SpT relation





Empirical relation: https://www.pas.rochester.edu/~emamajek/EEM_dwarf_UBVIJHK_colors_Teff.txt

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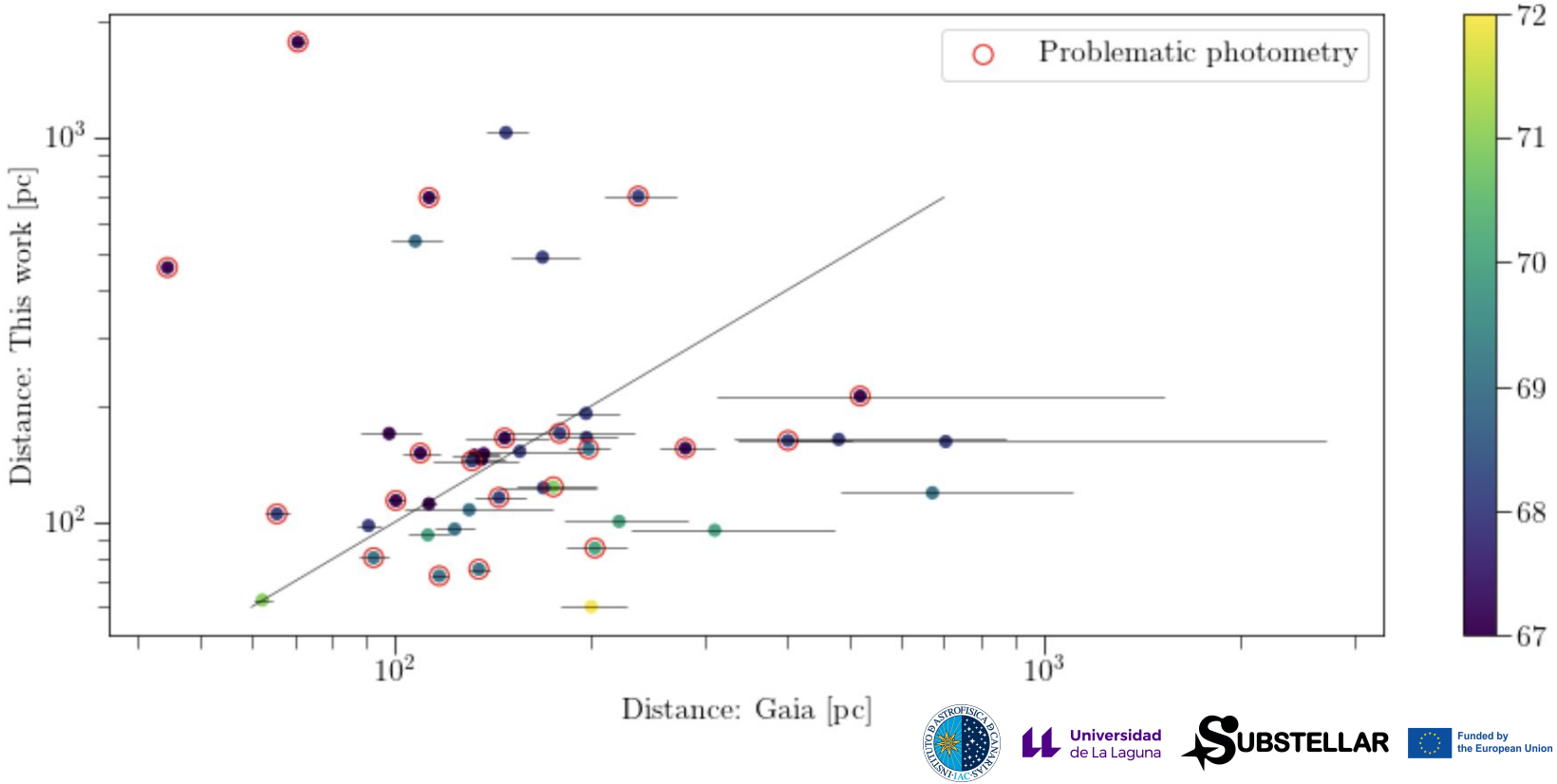
Cross-check with Gaia



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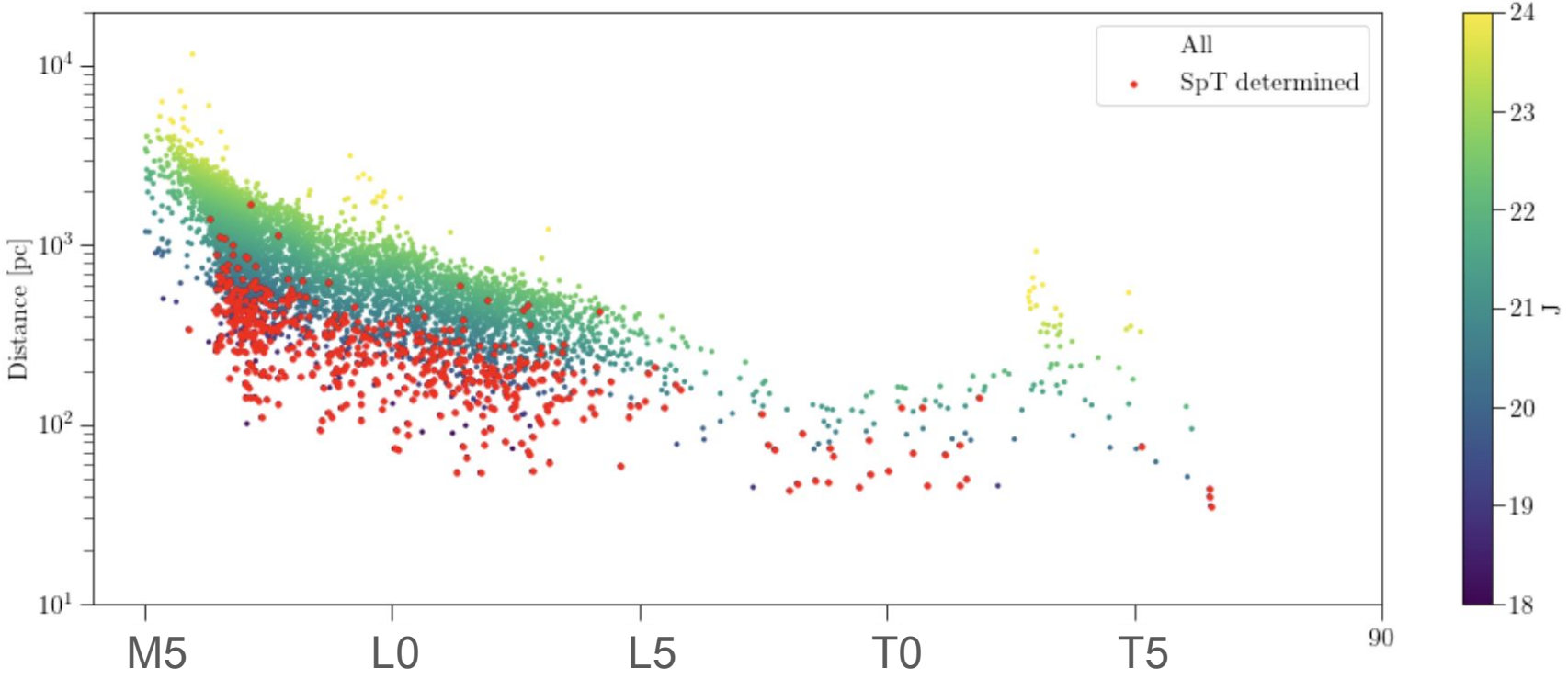
Distance distribution



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Key takeaways

- Euclid passbands useful for UCD candidate search
- Higher-purity sample of 5306 candidates to trace the parameter space
- Candidate UCD sky density: 100 UCDs per square degree
- SpTs can be determined for about 10% of the candidates (brightest); UCD features in 25% of candidate spectra

TODO:

- Expand the search to the completeness limit, and NISP only
- Cross-match with other surveys: proper motions, reduced contamination

DR1 expectation:

+ >160,000 UCD candidates
+ >16,000 spectroscopically confirmed
+ 40,000 spectra with UCD features
+ Deep Fields: Repeated observations → deeper; variability
+ Will enable field IMF study
+ Halo brown dwarfs?
+ Y dwarfs?

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Thank you for your attention!

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Additional slides