

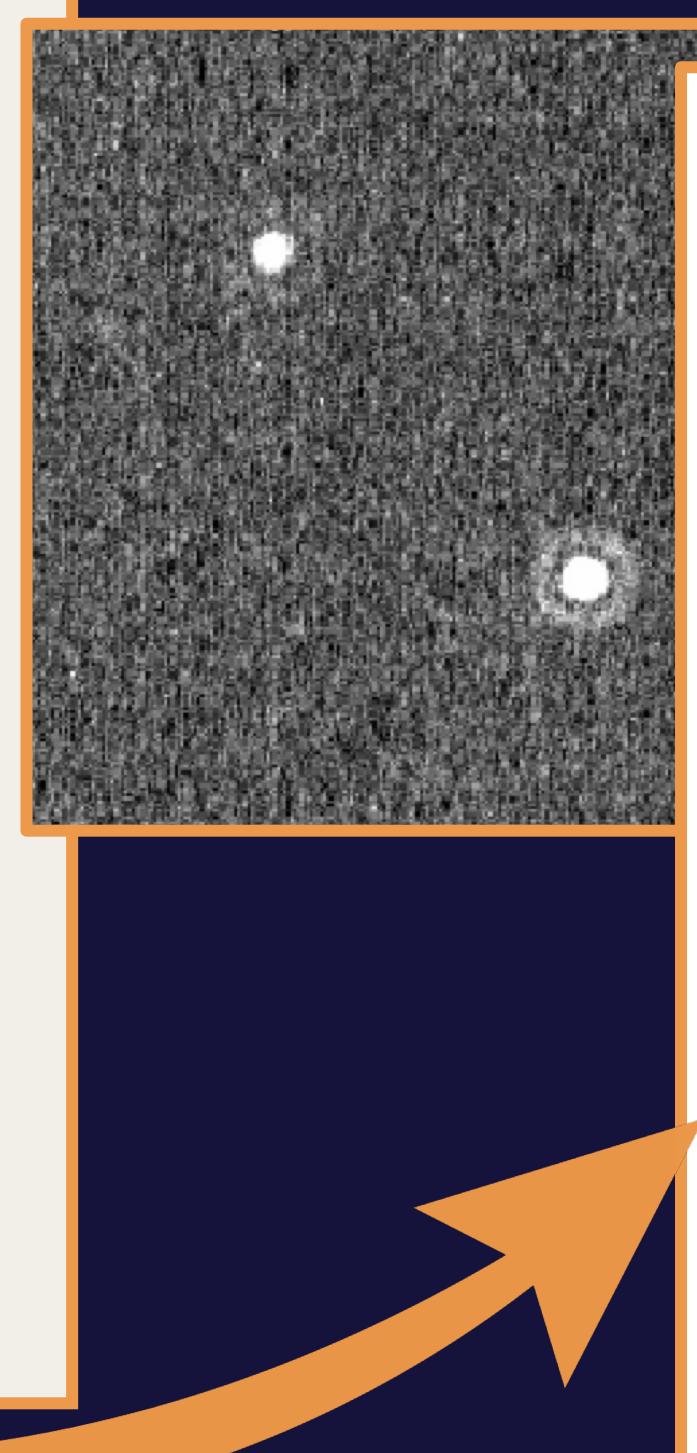
A New Stellar Companion from Binary Differential Imaging with MagAO/CLIO and MagAO-X

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Binary Differential Imaging (BDI):

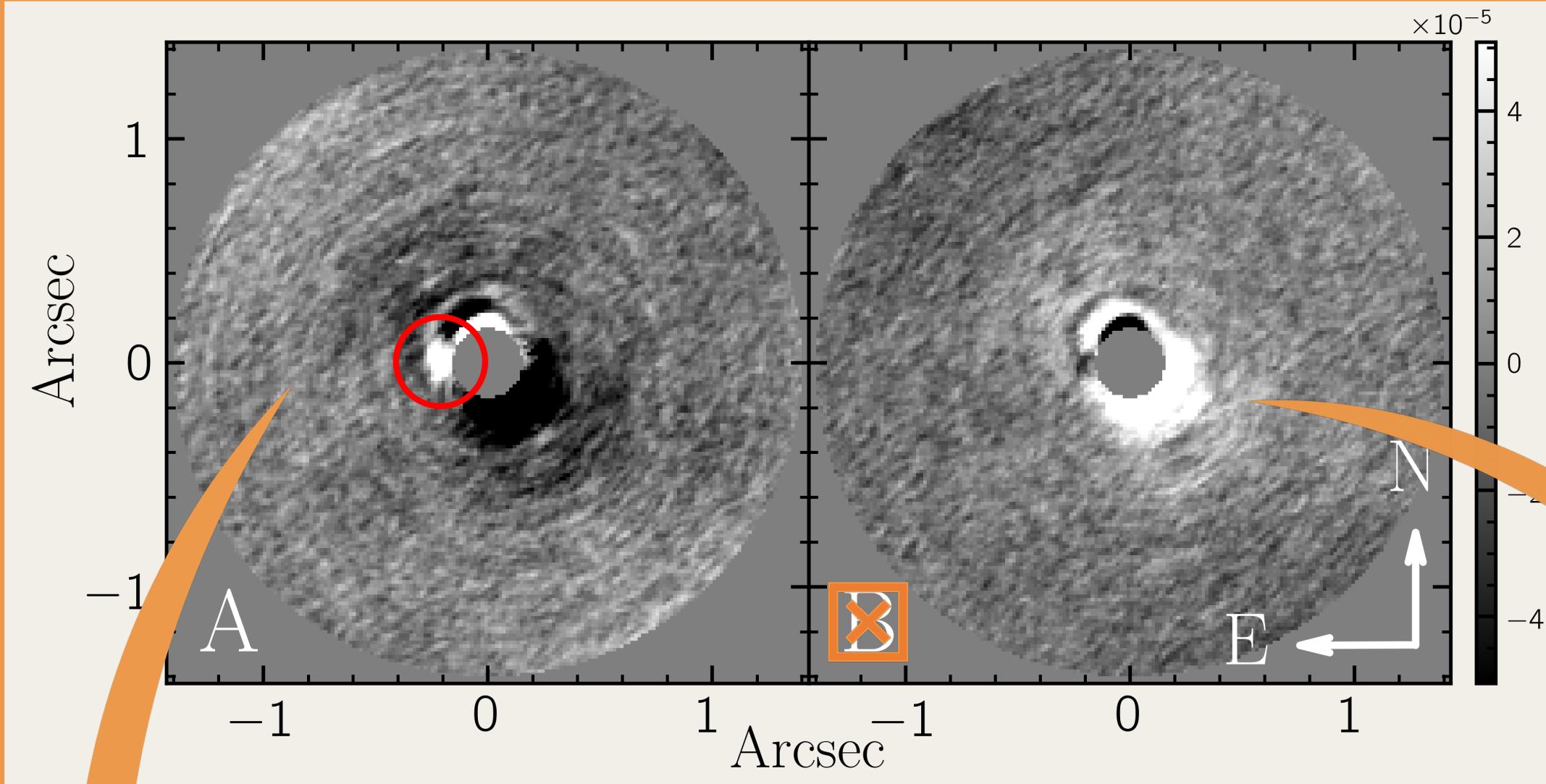
- Simultaneously image science target and PSF reference star in same filter
- Combine binary imaging with Karhounen-Loeve Image Processing¹ (KLIP) and angular differential imaging (ADI)
- Image at L' to take advantage of large isoplanatic patch (~30") -> PSFs should be nearly identical²



Key Result:

One candidate companion!

- Rotated with the sky
- Significant acceleration btwn Hipparcos and Gaia⁵
- Poor Gaia astrometric solution



Followed up with MagAO-X⁶:

- April 18th, 2022
- z', i', r', g'
- Easily detected!

Confirmed!

HD Name	Alt Name	Separation ^{a,*} (arcsec)	Distance ^a (pc)	Age (Myr)	SpT	Group Membership **
HD 36705	AB Dor	8.8609 ± 50	14.93 ± 0.02	100 ^b	K0V + MS-6 ^c	AB Dor
HD 37551	WX Col	4.00175 ± 1	80.45 ± 0.07	15±4 ^d	G7V + K1V ^c	AB Dor ^e
HD 47787	HIP 31821	2.15685 ± 2	47.83 ± 0.04	16.5 ± 6.5 ^f	K1IV + K1IV ^c	Field ^d
HD 76534	OU Vel	2.06874 ± 2	869 ± 14	0.27 ^h	B2Vn ⁱ	Field ^d
HD 82984	HIP 46914	2.0041 ± 30	274 ± 7	53.4 ± 15.1 ^f	B4IV ^f	Field ^d
HD 104231	HIP 58528	4.45718 ± 5	102.7 ± 0.5	21 ^k	F5V ^l	LCC ^m
HD 118072	HIP 66273	2.27647 ± 7	79.5 ± 0.4	40-50 ⁿ	G3V ^c	90% ARG ^j
HD 118991	Q Cen	5.56444 ± 6	88.3 ± 0.3	130-140 ^p	B8.5 + A2.5 ^q	Sco-Cen ^j
HD 137727	HIP 75769	2.20358 ± 3	111.7 ± 0.3	8.2 ± 0.6 ^f	G9III + G6IV ^c	Field ^d
HD 147553	HIP 80324	6.23216 ± 7	138.2 ± 1.3	11 ± 2 ^{k,r}	B9.5V + A1V ^s	UCL ^j
HD 151771	HIP 82453	6.8957 ± 3	270 ± 2	200-300 ^q	B8III + B9.5 ^u	Field ^d
HD 164249	HIP 88399	6.49406 ± 2	49.30 ± 0.06	25 ± 3 ^v	F6V + M2V ^c	Beta Pic ^{w,x}
HD 201247	HIP 104526	4.17040 ± 3	33.20 ± 0.04	200-300 ^y	G5V + G7V ^z	Field ^d
HD 222259	DS Tuc	5.36461 ± 3	44.12 ± 0.07	45 ± 2 ^a	G6V + K3V ^c	Tuc-Hor ^g
-	HIP 67506	9.38117 ± 9	89.5 ± 30 ^t	210 ± 5 ^t	G5 ^s	Field ^d
-	TWA 13	5.06925 ± 3	59.9 ± 0.1	10-20 ^t	M1Ve + M1Ve ^c	TW Hydra ^f
-	2MASS J01535076-	2.8543 ± 10	33.85 ± 0.09	25 ± 3 ^t	M3 ^c	Beta Pic ^w
		1459503				

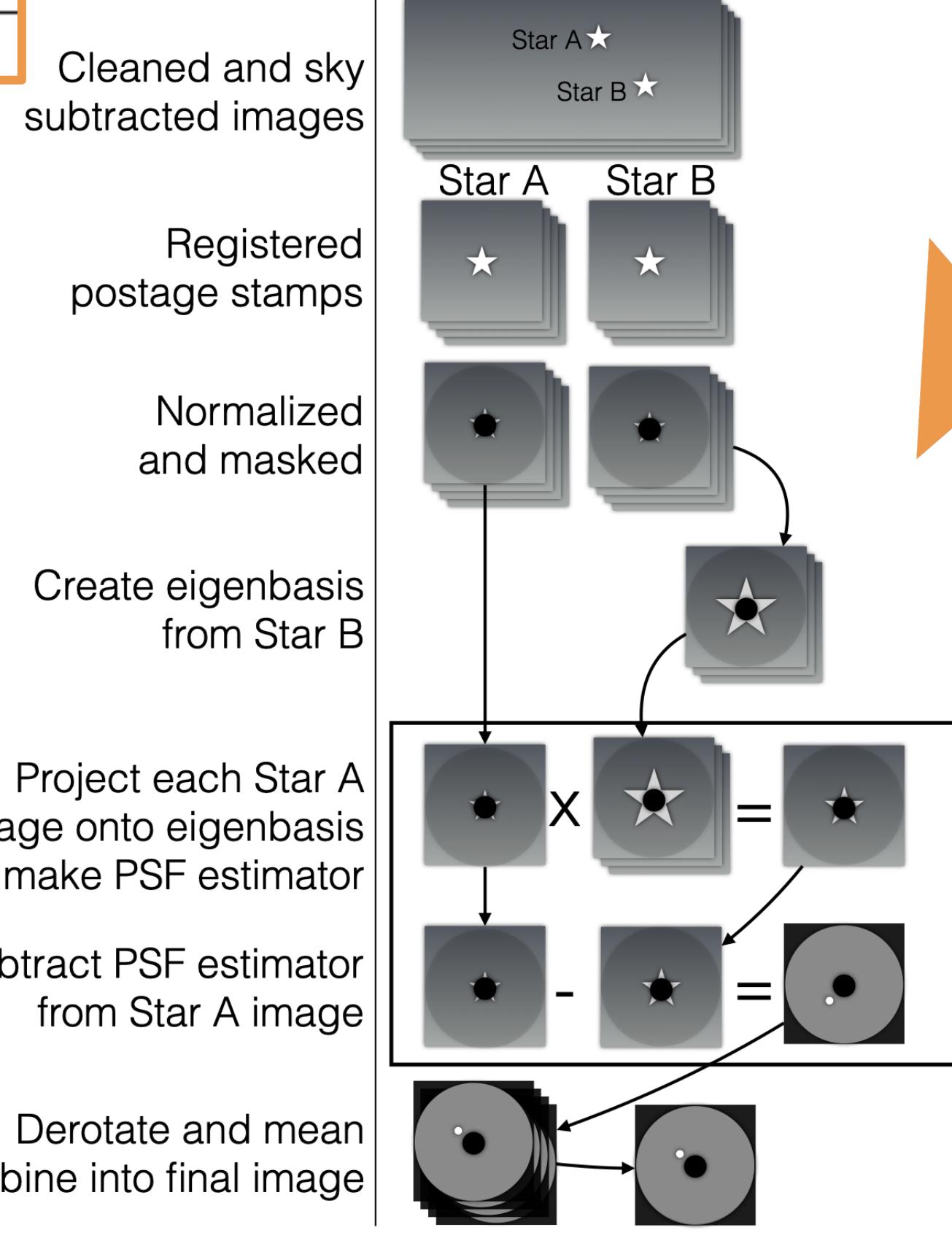
*Uncertainties in units of 10^{-5} arcsec

The MagAO/CLIO survey:

17 visual binary systems²:

- Nearby (<~200 pc)
- Young (<~200 Myr)
- Separation 2-10"
- L' mag within ~2 mag

Imaged 2015 – 2017
With MagAO + CLIO³
camera on Magellan Clay telescope in L'

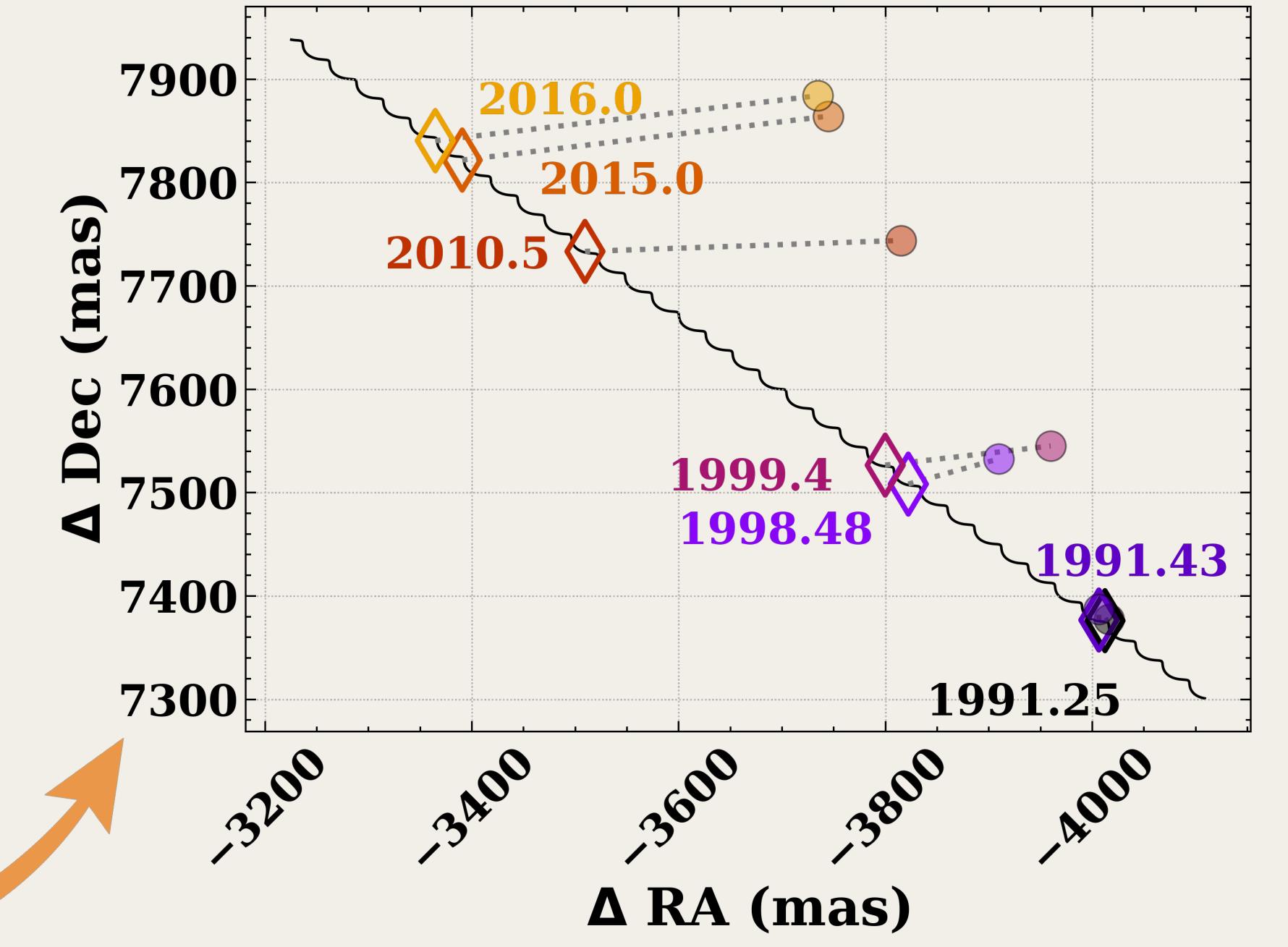


Processed with KLIP:

- Principle component analysis (PCA) applied to image data.
- Each star is used to form the basis set for the other⁴

Aside: TYC 7797-34-2 is NOT HIP 67506 B

- HIP 67506 was identified as a wide binary in the Hipparcos and Tycho Doubles and Multiples Catalog with another star (TYC 7797-34-2) with separation 9"
- Dubbed HIP 67506 A and B
- We conducted a common proper motion analysis with WDS and Gaia astrometry
- TYC 7797-34-2 is not gravitationally bound and is ~10x further distant than HIP 67506 A!

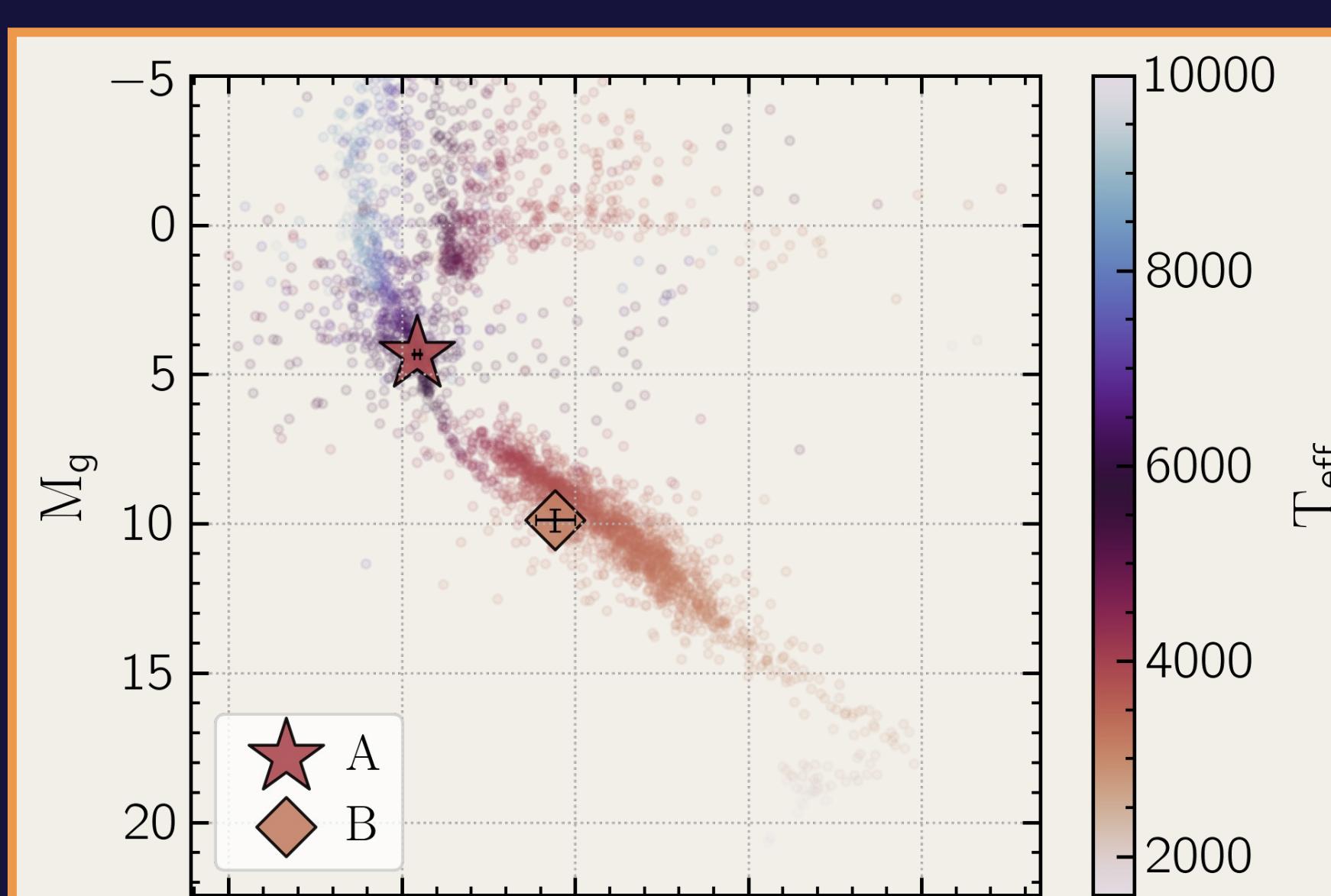


HIP 67506 B:

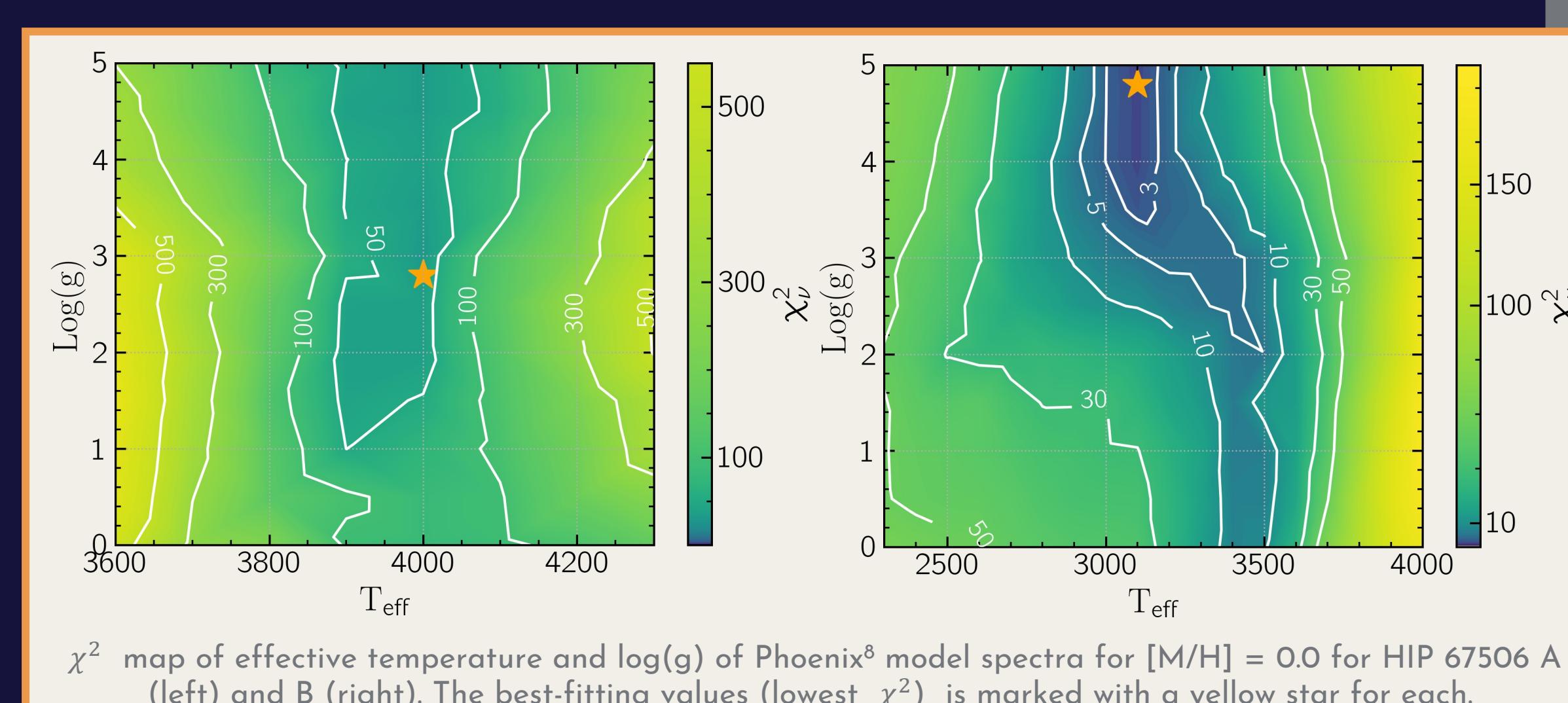
- Best fit models give SpT = M4V, Teff = 3100K, log(g) = 5.0

HIP 67506 A:

- Best fit models give SpT = K7V-M0V, Teff = 4000K, log(g) = 3.0
- Formerly classified as G5V



Color-Magnitude diagram of stars in the CARMENES⁷ sample of M, L, and T dwarfs and selected Hipparcos stars (earlier SpTs) in Sloan r'-i' color vs g' abs magnitude, colored by spectral type, with our MagAO-X photometry (converted to Sloan system) of HIP 67506 A (maroon) and B (orange). B is consistent with mid-M and A is consistent with late-K to early-M colors.



April 18th, 2022

About the Author:
Logan is a graduate student at the University of Arizona Steward Observatory studying how planetary systems form and evolve with Dr. Jared Males. She was a US Navy Nuclear Power Officer from 2003-2008, and a middle school science teacher from 2009-2015, and calls Austin TX home.

References:

1. Soummer, R. et al. 2012, ApJL, 755, L28; 2. Rodigas, T. et al. 2015, ApJ, 811, 157; 3. Morzinski, K. et al. 2015, ApJ, 815, 108; 4. Pearce, L. et al. (Submitted to MNRAS); 5. Kervella, P. et al. 2022, A&A, 657, A7; 6. Males, J. et al. 2020, Proceedings of SPIE, id. 114484L; 7. Cifuentes et al. 2020, A&A, 642, A115; 8. Allard, F. et al. 2012, RSPTA, 370, 1968; 9. Pickles, A. et al. 1998, PASP, 110, 749