Exoplanet Host and K Giant Star Project Status

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The Gist

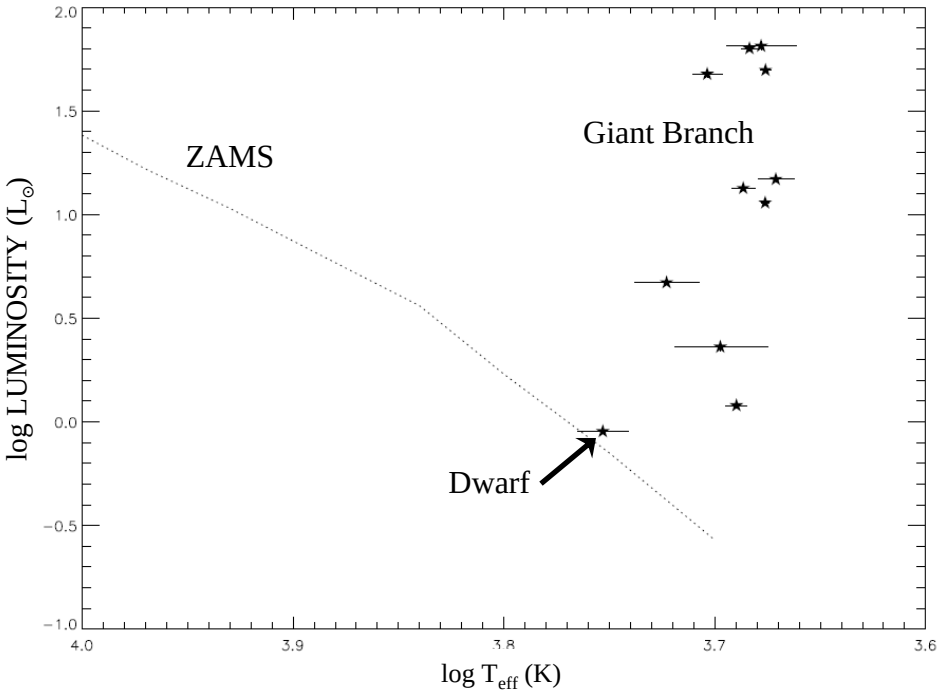
- Observe exoplanet host stars
- Measure angular diameters
- Calculate radii, $T_{\rm eff}$
- Check for stellar companions

Baines et al. 2009, ApJ, 701, 154

Recent Work

- Eleven exoplanet host stars
  - 1 dwarf, 4 subgiants, 6 giants

- Estimated mass, age using stellar model (inputs = [Fe/H], $T_{\rm eff}$, V mag)



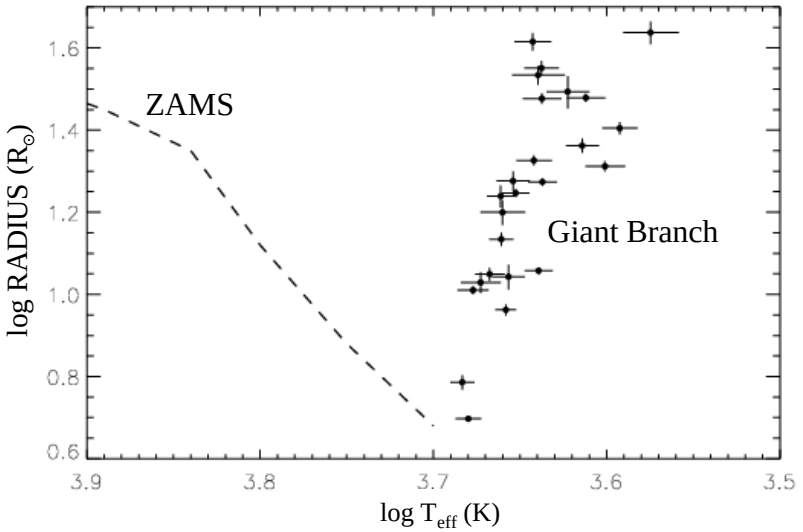
HD	Spectral Type	θ_{LD} (mas)	σ_{LD} (%)	R_L ($R_\odot$)	σ_R (%)	T_{eff} (K)	σ_{Teff} %
16141	G5 IV	0.490±0.049	10	2.05±0.21	10	4982 ± 254	5
17092	K0 II	0.601±0.041	7	11.8±1.4	12	4765 ± 182	4
45410	K0 III-IV	0.970±0.035	4	5.82±0.26	4	4689 ± 92	2
154345	G8 V	0.502±0.026	5	1.00±0.05	5	5664 ± 158	3
185269	G0 IV	0.480±0.033	7	2.59±0.19	7	5283 ± 186	4
188310	G9 III	1.726±0.008	0.4	10.45±0.18	2	4742 ± 26	1
199665	G6 III	1.111±0.028	3	9.00±0.31	3	5054 ± 81	2
210702	K1 III	0.875±0.018	2	5.17±0.15	3	4859 ± 62	1
217107	G8 IV	0.704±0.013	2	1.50±0.03	2	4895 ± 57	1
221345	G8 III	1.336±0.009	1	11.38±0.26	2	4826 ± 40	1
222404	K1 IV	3.302±0.029	1	5.01±0.05	1	4744 ± 21	0.4

Target HD	V mag	Average [Fe/H]	R_{model} ($R_\odot$)	Mass ($M_\odot$)	Age (Gyr)
16141	6.83	0.11 ± 0.07	2.3 ± 0.1	1.1 ± 0.0	7.2 ± 1.1
17092	7.82	0.00 ± 0.05	7.8 ± 0.4	1.5 ± 0.2	2.6 ± 0.9
45410	5.87	0.17 ± 0.05	6.1 ± 0.3	1.3 ± 0.1	4.0 ± 1.3
185269	6.70	0.11 ± 0.05	2.6 ± 0.1	1.4 ± 0.0	3.4 ± 0.2
188310	4.70	−0.27 ± 0.10	10.0 ± 0.4	1.0 ± 0.2	7.1 ± 3.6
199665	5.48	−0.10 ± 0.12	8.0 ± 0.3	2.0 ± 0.1	1.1 ± 0.1
210702	5.95	0.00 ± 0.05	5.2 ± 0.2	1.4 ± 0.1	3.5 ± 1.1
221345	5.22	−0.32 ± 0.05	10.3 ± 0.3	1.1 ± 0.2	4.5 ± 1.9
222404	3.21	0.08 ± 0.11	5.0 ± 0.2	1.2 ± 0.1	5.4 ± 2.1

Baines et al. 2010, ApJ, 710, 1365

K III Stars

- Measured 25 stars
  - 6 host exoplanets
- Estimated mass using stellar model
- Asteroseismology will measure mass directly



Target HD	θ_{LD} (mas)	σ_{LD} (%)	R_{linear} ($R_\odot$)	T_{eff} (K)	σ_{Teff} %
32518	0.851 ± 0.022	3	11.04 ± 0.77	4536 ± 99	2
60294	1.044 ± 0.010	1	9.17 ± 0.29	4552 ± 63	1
73108	2.225 ± 0.020	1	18.79 ± 0.38	4336 ± 83	2
102328	1.606 ± 0.006	0.4	11.42 ± 0.23	4358 ± 81	2
103605	1.098 ± 0.010	1	11.20 ± 0.41	4651 ± 92	2
106574	1.498 ± 0.028	2	23.02 ± 0.92	4113 ± 90	2
113049	0.971 ± 0.022	2	17.35 ± 1.07	4583 ± 85	2
118904	1.871 ± 0.032	2	25.38 ± 0.88	3913 ± 92	2
136726	2.293 ± 0.020	1	30.12 ± 0.70	4093 ± 106	3
137443	1.690 ± 0.031	2	20.51 ± 0.62	3990 ± 106	3
138265	2.062 ± 0.038	2	43.40 ± 2.75	3758 ± 139	4
139357	1.073 ± 0.013	1	13.63 ± 0.51	4580 ± 74	2
150010	1.024 ± 0.029	3	15.84 ± 1.08	4572 ± 137	3
152812	1.440 ± 0.004	0.3	31.16 ± 2.82	4193 ± 120	3
157681	1.664 ± 0.010	1	34.22 ± 1.78	4361 ± 154	4
160290	1.515 ± 0.010	1	17.65 ± 0.42	4493 ± 82	2
167042	0.922 ± 0.018	2	4.98 ± 0.07	4785 ± 82	2
170693	2.041 ± 0.043	2	21.19 ± 0.60	4386 ± 104	2
175823	0.988 ± 0.023	2	18.88 ± 1.04	4509 ± 99	2
176408	1.125 ± 0.023	2	10.24 ± 0.23	4755 ± 98	2
186815	0.731 ± 0.020	3	6.11 ± 0.25	4823 ± 77	2
192781	1.859 ± 0.003	0.2	35.57 ± 1.46	4342 ± 99	2
195820	0.863 ± 0.041	5	10.69 ± 0.62	4707 ± 126	3
200205	2.032 ± 0.045	2	41.23 ± 2.08	4392 ± 108	2
214868	2.731 ± 0.024	1	29.98 ± 0.84	4339 ± 111	3

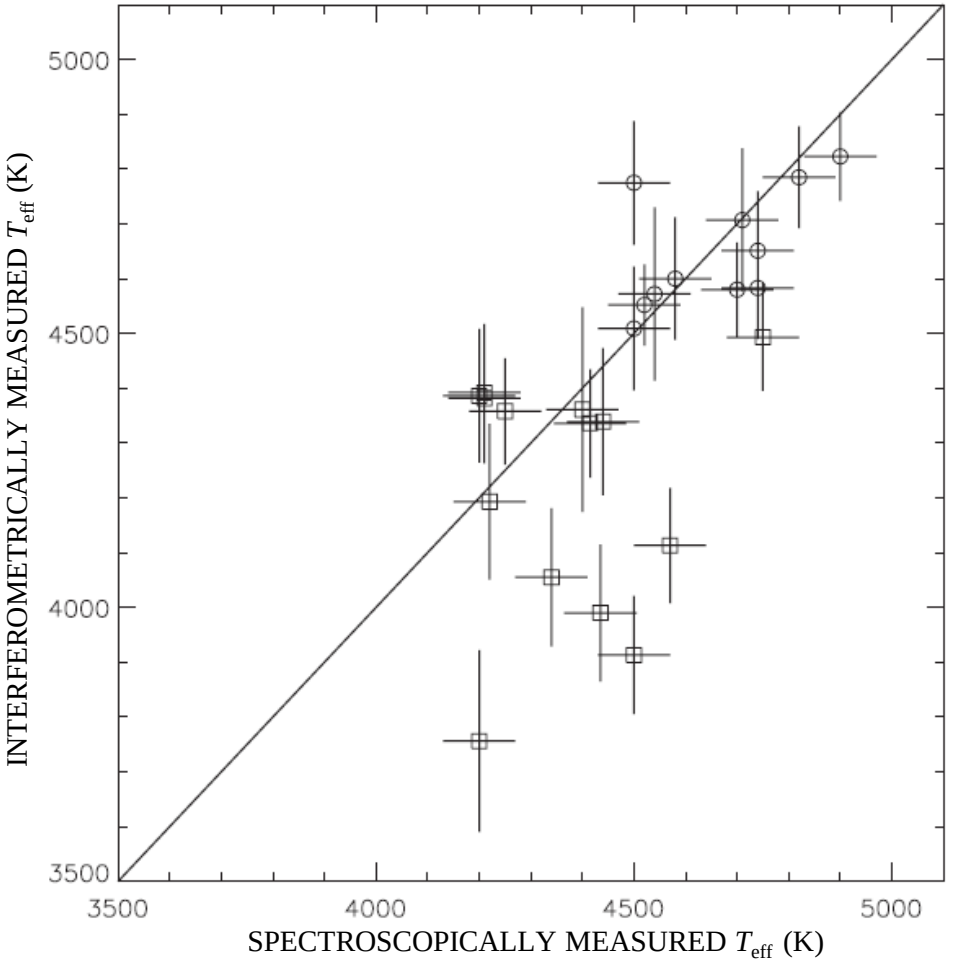
Collaborating with:

- M. Döllinger (ESO)
- F. Cusano, E. Guenther, & A. Hatzes (TLS, Germany)

$T_{\rm eff}$ Issue

- Döllinger et al. measured $T_{\rm eff}$ spectroscopically using Fe I and Fe II lines

- We calculated it using our measured θ_{LD}



$T_{\rm eff}$ Issue

- $T_{\rm eff}$ errors didn't show trends with:
  - log g
  - Diameter/radius
  - (V-K) color
  - Distance
  - Spectral type
  - Metallicity
  - Bolometric correction

$T_{\rm eff}$ Issue

- May be due to:
  - Spectroscopic measure $T_{\rm eff}$ in that part of the atmosphere where the Fe lines are present
  - Our measurements consider the entire face of the star
  - Atmospheric models may be missing source of extinction, which would affect $T_{\rm eff}$

Stellar Companions

- Use residuals to diameter fits to eliminate certain spectral types for each exoplanet host star

- Did this for 22 stars in 2008

All About Inclination

- *i* is assumed to be nearly edge-on
  - Therefore the companion mass $m \sin^3 i$ is assumed to be a planet
- A low-mass star in a nearly face-on orbit could mimic a planet
- Interferometric measurements help to rule out certain spectral types

G5 V, K0 V, K5 V, M0 V, M5 V

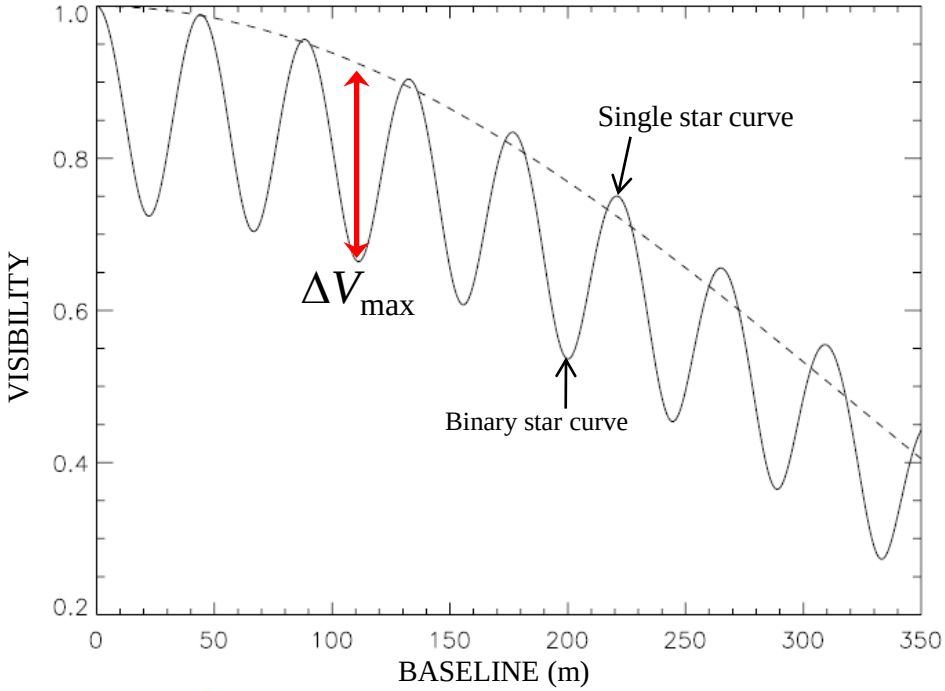
- Magnitude difference (ΔK) and separation (α) were calculated for each exoplanet host star

- The angular diameter (θ) for each secondary was calculated using π and standard R values

G5 V, K0 V, K5 V, M0 V, M5 V

- ΔK, α, θ were used to calculate the visibility curve for a binary system composed of the known host star and each possible secondary

- Used position angles 0, 30, 60˚



Calculated Visibility Residuals

			ΔV_{max}, PA=0°					ΔV_{max}, PA=30°					ΔV_{max}, PA=60°				
HD	Obs Date	σ_{res}	G5V	K0V	K5V	M0V	M5V	G5V	K0V	K5V	M0V	M5V	G5V	K0V	K5V	M0V	M5V
10697	2005/10/23	0.092	0.224	0.164	0.100	0.058	0.023	0.220	0.161	0.099	0.059	0.023	0.232	0.167	0.100	0.058	0.023
	2007/09/14	0.053	0.224	0.164	0.100	0.058	0.023	0.220	0.161	0.099	0.059	0.023	0.232	0.167	0.100	0.058	0.023
13189	2005/12/12	0.033	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
	2006/08/14	0.019	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
32518	2007/11/14	0.036	0.010	0.007	0.004	0.002	0.001	0.010	0.007	0.004	0.002	0.001	0.009	0.006	0.003	0.002	0.001
45410	2008/09/11	0.052	0.018	0.012	0.007	0.004	0.001	0.018	0.012	0.007	0.004	0.001	0.018	0.012	0.007	0.004	0.001
50554	2005/12/12	0.047	0.495	0.369	0.232	0.133	0.063	0.497	0.372	0.233	0.131	0.063	0.484	0.373	0.242	0.140	0.063
73108	2008/05/09	0.018	0.205	0.204	0.204	0.203	0.203	0.199	0.200	0.201	0.202	0.203	0.201	0.201	0.202	0.203	0.203
136726	2008/05/09	0.018	0.194	0.195	0.196	0.196	0.196	0.195	0.195	0.195	0.195	0.195	0.193	0.194	0.195	0.195	0.196
139357	2007/09/14	0.019	0.007	0.005	0.003	0.002	0.001	0.007	0.005	0.003	0.002	0.001	0.007	0.005	0.003	0.002	0.001
145675	2006/08/12	0.056	0.622	0.491	0.326	0.187	0.089	0.623	0.497	0.326	0.185	0.089	0.640	0.500	0.328	0.186	0.084
154345	2008/09/10	0.039	0.579	0.561	0.378	0.225	0.099	0.575	0.578	0.380	0.223	0.096	0.568	0.578	0.387	0.226	0.096
164922	2008/08/11	0.161	0.611	0.475	0.311	0.178	0.081	0.608	0.466	0.309	0.180	0.080	0.631	0.482	0.311	0.177	0.078
167042	2007/09/15	0.040	0.042	0.030	0.017	0.010	0.004	0.043	0.030	0.017	0.010	0.004	0.040	0.028	0.016	0.009	0.004
170693	2007/09/03	0.037	0.220	0.221	0.222	0.221	0.221	0.219	0.219	0.220	0.220	0.221	0.218	0.219	0.221	0.221	0.221
185269	2008/07/18	0.078	0.070	0.054	0.034	0.019	0.008	0.051	0.040	0.025	0.014	0.006	0.008	0.006	0.004	0.003	0.001
	2008/07/20	0.079	0.070	0.054	0.034	0.019	0.008	0.051	0.040	0.025	0.014	0.006	0.008	0.006	0.004	0.003	0.001
188310	2008/09/08	0.012	0.134	0.138	0.144	0.145	0.147	0.146	0.147	0.148	0.148	0.148	0.133	0.138	0.142	0.145	0.147
199665	2008/09/08	0.054	0.018	0.013	0.007	0.004	0.002	0.018	0.013	0.007	0.004	0.002	0.018	0.012	0.007	0.004	0.002
210702	2008/09/08	0.025	0.058	0.040	0.023	0.012	0.005	0.055	0.038	0.022	0.012	0.005	0.051	0.036	0.021	0.011	0.005
217107	2008/09/08	0.017	0.072	0.069	0.055	0.039	0.004	0.043	0.043	0.036	0.026	0.000	0.017	0.012	0.008	0.005	0.007
221345	2008/09/11	0.013	0.006	0.004	0.002	0.001	0.001	0.006	0.004	0.002	0.001	0.001	0.005	0.003	0.002	0.001	0.000
222404	2008/09/11	0.006	0.193	0.196	0.198	0.201	0.201	0.210	0.204	0.198	0.192	0.192	0.148	0.162	0.177	0.190	0.198

σ_{res} = observed scatter

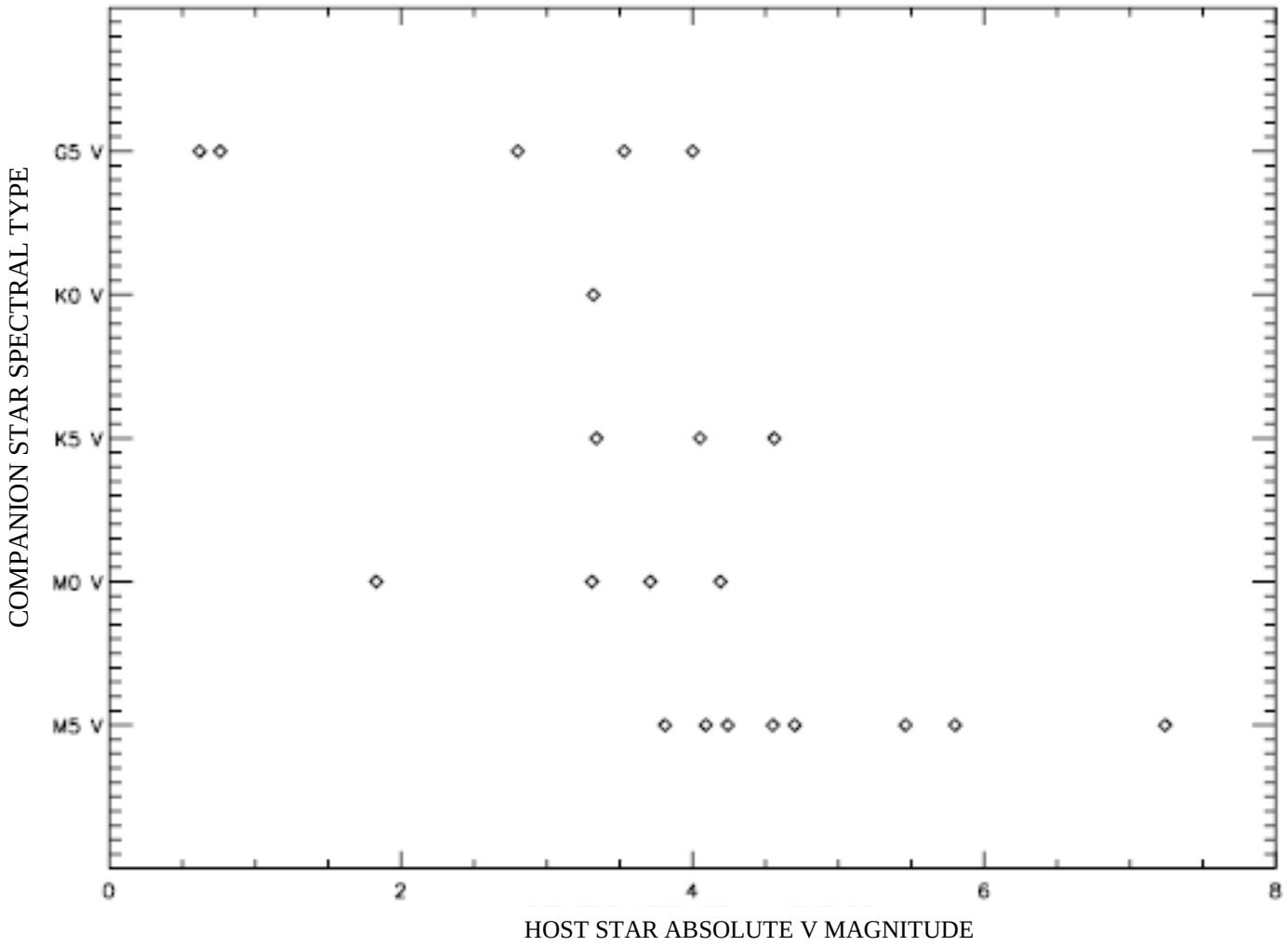
ΔV_{max} = theoretical binary curve

Criteria

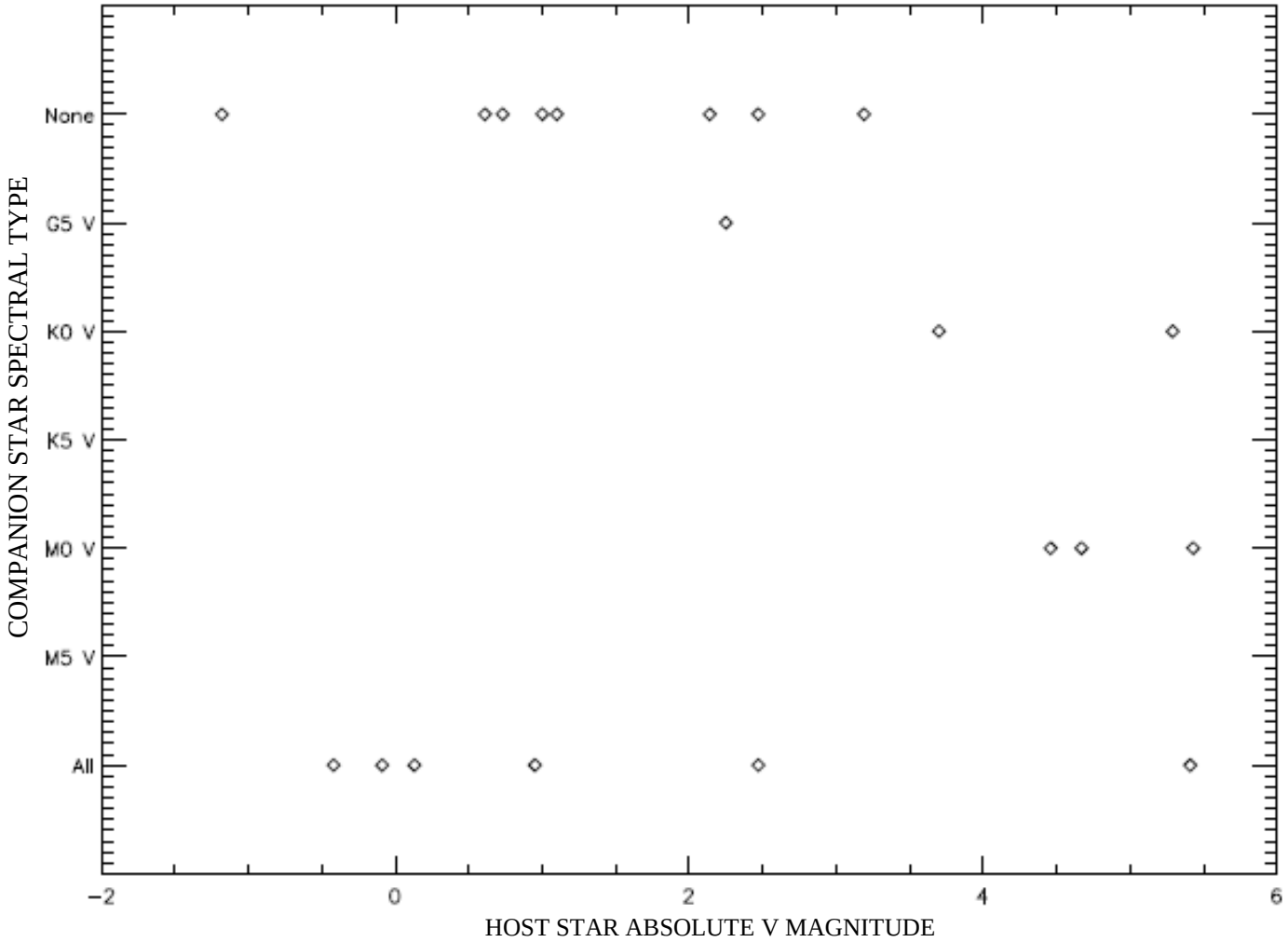
- If $\Delta V_{max} \geq 2\sigma_{res}$ for a given secondary component, that spectral type could be ruled out

- If $\Delta V_{max} < 2\sigma_{res}$, it can't be guaranteed the effects of the secondary star would be seen in the visibility curve

Absolute Magnitude vs. Spectral Type



20 More Stars

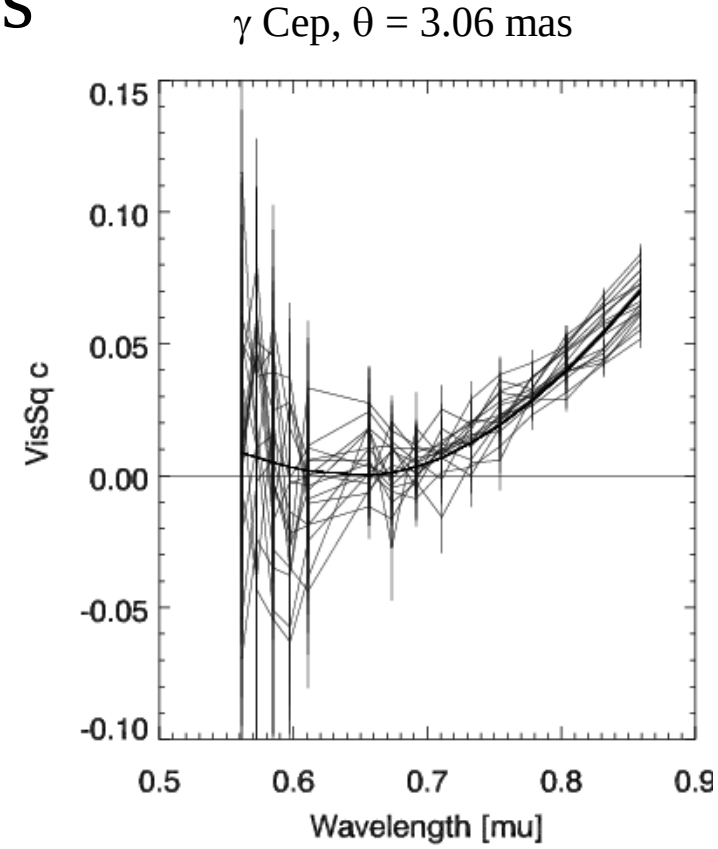


Totals So Far

- 60 angular diameters have been measured
  - Physical radii for all
  - $T_{\rm eff}$ for 36
- Companion checks for 42 stars

NPOI Work

- Observe exoplanet host stars
- 16 observed to date
- 9 have diameter measurements
- 2 zero-crossing stars



NPOI + PTI Archival Data

- 77 stars were observed using both instruments
- Diameter measurements from both for 29 stars
- Will tell us about limb-darkening
- When do diameter fits to both data sets, should reduce the errors

Future Work

- Put an end to fires and mud slides
- Use PAVO to observe smaller exoplanet hosts
- Continue with K III measurements using Classic/CLIMB
- More measurements from the NPOI