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A Search for Close-in Companions and Circum-stellar Dust around Nearby Stars

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Abstract. We present results from an on-going search for stellar and sub-stellar companions with the Palomar 200" adaptive optics system. We have observed 12 sources with a coronagraph and present detection limits for faint companions. From non-coronagraphic imaging, we find that 8 of 20 observed stars are probable binaries. The objects are taken from the Meyer et al. (2001) SIRTF Legacy Science Team sample. $JHK_{\rm s}$ and 10 μm photometry is used to set upper limits on the presence of dust disks.

1. Observations and Detection Limits. Observations in $JHK_{\rm s}$ were conducted with the Palomar Adaptive Optics (PALAO; Troy et al. 2000) system, using the Palomar High Angular Resolution Observer (PHARO; Hayward et al. 2001) camera at the 200" Hale telescope. Strehl ratios of 25% in $K_{\rm s}$ were routinely achieved. 10 μm photometry was obtained with SpectroCam-10 (Miles, Hayward, & Houck 1993).

With PHARO, 2 to 10 sec unsaturated exposures were taken of each object in non-coronagraphic mode, using a five-point dithering technique, to perform absolute $JHK_{\rm s}$ photometry and to check for close ($< 1''$) bright companions. Six 60 sec exposures were then taken with the coronagraph ($0.97''$) in place, at each of four orthogonal Cassegrain ring orientations, to minimize systematic non-radial artifacts in the PSF.

The observed sample is plotted on an age vs. distance diagram. Superimposed (dotted lines) are detection limits for 1, 3, 5 and 10 $M_{\rm Jup}$ planets, based on the PHARO K-band dynamic range sensitivity results of Oppenheimer et al. (2000), and brown dwarf cooling curves by Burrows et al. (1997). At the mean age (0.1 Gyr) and distance (40 pc) of our sample, we are sensitive to companions $\gtrsim 5M_{\rm Jup}$ at $\theta \geq 2''$.

2. Results. Eight of the 20 imaged stars have companions at separations $< 3''$ visible in the short exposures, 7 of which are new detections (*top*). Given the angular separations, all of these systems are candidate physical binaries. Color and spectroscopic information will be used to further constrain this likelihood. Four much fainter objects ($\Delta K_{\rm s} > 6.5$) are present in the long coronagraphic exposures (*bottom*), only one of which is also detectable in the short (non-coronagraphic) exposures. Given the large angular separations ($> 7'' \sim 300$ AU for the mean distance of our sample), these are unlikely to be physically associated with the observed targets.

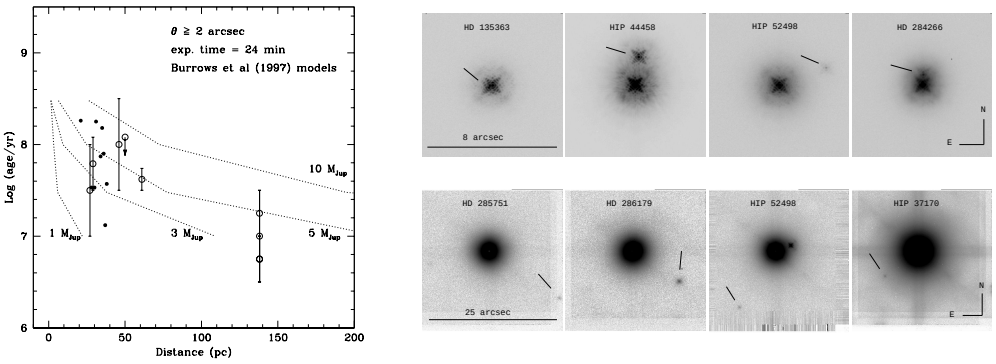

Figure 1. *Left:* PHARO detection limits in K. *Right, top:* some binary candidates; *right, bottom:* faint field objects.

The table lists photometry: $JHK_{\rm s}$ differences and apparent $K_{\rm s}$ magnitude for the fainter object; errors are 0.1 mag. The last column combines 2MASS data with our 10 μm photometry. Only HIP 50180 shows a $(K_{\rm s} - N)$ excess unusual for its spectral type (G5), while the rest do not show evidence of obviously strong dust disks.

The case of HIP 37170 (37 pc, 38 Myr; Soderblom et al. 2002, in prep.) is particularly interesting. If the faint object is physically associated with the star (at projected separation of 290 AU), current evolutionary models (Burrows et al. 1997, Chabrier et al. 2000) place it just below the deuterium-burning limit.

Object	ΔJ [mag]	ΔH [mag]	$\Delta K_{\rm s}$ [mag]	$K_{\rm s}$ secondary [mag]	separation [arcsec]	distance [pc]	$(K_{\rm s} - N)$ primary [mag (err)]
candidate binaries							
HD 284266A,B	1.5	1.8	1.7	10.3	0.60	...	...
HIP 44458A,B	2.6	2.1	2.0	7.5	1.65	30	0.07 (0.07)
HD 284135A,B	...	...	0.13	8.5	0.36	138	...
HD 135363A,B	0.6	0.6	0.7	7.1	0.25	29	...
HD 285281A,B	1.3	1.2	1.2	8.9	0.75	138	...
HIP 52498A,B	4.5	4.5	4.3	10.2	2.93	35	...
HIP 63008A,B	2.1	2.1	2.2	7.7	1.51	34	..
faint object in the field of							
HD 285751	...	...	8.8	17.6	15.33	138	...
HD 286179	...	...	6.8	15.2	10.40	138	...
HIP 37170	...	...	8.5	14.7	7.63	37	−0.14 (0.08)
HIP 52498	9.0	...	8.9	14.8	12.15	35	...
HD 105601†	7.6	7.3	7.0	13.7	9.55	120	...
apparent single stars							
HD 70573	n.a.	n.a.	n.a.	n.a.	n.a.	46	0.0 (0.2)
HIP 41184	n.a.	n.a.	n.a.	n.a.	n.a.	36	0.10 (0.08)
HIP 50180	n.a.	n.a.	n.a.	n.a.	n.a.	37	0.46 (0.08)
HIP 60074	n.a.	n.a.	n.a.	n.a.	n.a.	28	0.14 (0.08)

†Elias photometric standard.

References

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