OBSERVING REQUEST
University of Arizona Observatories

Year: 2015 **Term:** Jan–Jul **Proposal type:** short-term⋆

Companions to Nearby M-dwarfs: A Large-Scale Survey of Multiplicity Across the Stellar/Substellar Boundary

P.I.: Kimberly Ward-Duong⋆ (Arizona State University; *kwardduo@asu.edu*; 928-202-8562)

CoI(s): Jenny Patience (Arizona State University), Don McCarthy (SO), Craig Kulesa (SO), Robert De Rosa (Arizona State University), Joanna Bulger (Arizona State University), Abhijith Rajan⋆ (Arizona State University)

Abstract of Scientific Justification

We propose to obtain MMT ARIES imaging to complete a large-scale survey of the 245 M-dwarfs within 15 pc as defined from *Hipparcos* parallaxes. All of the stars from our volume-limited survey have archival widefield imaging covering companion separations from $\sim$300 to 10^4 AU, but 30 systems lack the multi-epoch AO imaging necessary to cover the $\sim$1 to 300 AU range, and continuous separation coverage is essential to determine higher-order stellar and substellar multiplicity. Of these systems, 10 systems require second epoch confirmation imaging of candidate substellar companions, while the remaining 20 systems have no previous AO observations and constitute a first epoch search for new candidates. With the proposed first and second-epoch observations of the remaining systems from our sample, we will characterize the frequency of stellar and substellar companions to M-dwarfs down to $\sim$30-40 Jupiter masses. The requested AO observations combined with existing widefield imaging will allow us to determine M-dwarf companion frequencies over an unprecedented separation range of $\sim$1 to 10^4 AU, thereby providing the most comprehensive companion statistics to-date across the stellar/substellar boundary for low-mass stars. Given the intrinsic low luminosities and masses of M-dwarfs, the abundant nearby M-dwarf population is also of particular interest for upcoming exoplanet surveys and missions, such as *TESS*, which aim to discover Exo-Earths. The proposed ARIES observations, which will enable a census of local M-dwarf stellar and substellar systems, will provide important constraints upon our nearest, lowest-mass neighboring stellar systems.

Summary of observing runs requested for this project

Run	Telescope	Cage	Instrument	PI	AO	Nights	Moon	Scheduling Optimal	Scheduling Acceptable	Sharing Poss.	Sharing Adv.
1	MMT	f/15	ARIES	*	*	2	bright	Mar–Jun	Jan–Jun	yes	yes

Scheduling constraints and unusable dates *(up to 4 lines)*: As the proposed targets span a range of RA values, these targets may be scheduled any time during the 2015A semester, although the month of April would be optimal. These observations may also be combined with an associated MMT ARIES proposal ("Testing the origins of brown dwarf companions with measurements of C/O ratios") by A. Rajan (ASU) to optimize scheduling.

no text past this line

A ⋆ appended to the proposal type indicates a continuation proposal; a ⋆ appended to the name of a proposer indicates the proposer is a (graduate) student; a proposer whose name is underlined is certified on the proposed telescope/instrument combination; if a * appears within the PI or AO box in the observations summary table, the instrument is a PI instrument and/or Adaptive Optics are requested – signatures are required on the next page.

Target list (attach list if longer than 26 objects)

#	Object	RA	Dec	mag / color / type / redshift / comment / etc.
1	Example: HIP52600	10:45:21.49	+38:30:42.35	V=9.27, K=5.55, Stellar Target
2	(Please refer to the end of the proposal for the complete target list)			

Approval for Instrument Use from PI: Please see attached approval e-mail from Don McCarthy.

Graduate students *(provide the following information for **each** student named as PI or CoI on the cover page. Have the advisor's signature(s) appear on **all** submitted copies)*

Student's Name	Advisor's Name	Advisor's Signature	2nd-yr	Thesis
Kimberly Ward-Duong	Jenny Patience		no	yes
Abhijith Rajan	Jenny Patience		no	no

Scientific Justification

Scientific Context: M-dwarfs comprise the large majority of the nearest stars (e.g. Reid & Gizis 1997), and low mass stars also dominate the nearest star-forming regions, with $\sim$50% of Taurus members having spectral types later than M3 (Luhman et al. 2010). The abundance of these stars highlights the importance of constructing a comprehensive view of the full diversity of M-dwarf stellar and substellar systems. Due to their low masses and luminosities, M-dwarfs also represent a particularly attractive population of stars around which to search for exoplanets and brown dwarfs. The study of their substellar companions therefore represents an important link between characterizing stellar multiplicity for M-star primaries (e.g. Fischer & Marcy 1992) and efforts to investigate their exoplanet systems (e.g. Montet et al. 2014). Despite the observed "brown dwarf desert" in companion frequency at close ($\sim$1 AU) separations (Marcy & Butler 2000), studies have indicated that wide orbit substellar companions may be more common (Gizis et al. 2001). Detections of M-dwarf planets (Dressing & Charbonneau 2013) indicate important distinctions between the exoplanet and brown dwarf populations, however, no comprehensive survey exists to definitively constrain the frequency, separations, and mass ratios of both substellar and stellar companions to M-dwarfs over a wide range of separations.

The M-dwarfs in Multiples (MinMs) Survey: Our sample consists of M-dwarfs with parallax measurements placing them within 15 pc, such that AO data cover separations from $\sim$1 to 300 AU. We derived this sample from the SIMBAD database by selecting on parallax measurements obtained with the *Hipparcos* satellite (Van Leeuwen 2007). The catalog was filtered to obtain only those stars with a parallax $\pi > 66$ mas and color criteria corresponding to spectral types within the M-dwarf range M0-M9. This selection process produced a sample containing 245 M-dwarfs, and for 196 of these targets, we analyzed archival high-resolution and adaptive optics imaging from the VLT, HST, Subaru, and CFHT archives, as well as new AO observations from the MMT. The AO companion data produced a number of interesting substellar candidate companions, including a previously detected brown dwarf companion (Gliese 229B; Nakajima et al. 1995), as shown in Figure 1. We have also searched archival digitized photographic plates for the full 245-star sample to detect common proper motion companions at separations from $\sim$300-10^4 AU to determine the most comprehensive population statistics on binary fraction, mass ratio distribution, and binary separation distribution for companions to M-stars; the stellar separation distribution is shown in Figure 2 (Ward-Duong et al. 2014, *submitted*). In order to determine the brown dwarf frequency from the 196-star AO observed sample, we require 1) confirmation AO imaging of the remaining candidate systems in our volume-limited sample, and 2) new observations of the sample targets which lack any previous AO observations to detect any additional unknown companions. **With well-defined distance measurements, the combination of wide and close searches for brown dwarf companions will provide an unprecedented census of M-dwarf companions over the widest range of separations.** With MMT/ARIES, we propose to continue a deep imaging search for stellar and substellar companions to 30 M-dwarf systems, including 10 second-epoch observations required to test the physical association of new substellar companion candidates to M-dwarf stars. The targets shown in Figure 1 represent some of the substellar candidate companions detected within our volume-limited survey of 245 field M-dwarfs, and have estimated masses within the $\sim$35-75 Jupiter mass range, if associated.

Previous Work: We are pursuing a set of coordinated observational and theoretical programs to measure, compare, and interpret the stellar and substellar binary properties of star-forming regions and the field. In the first two papers (King et al. 2012a, 2012b), we applied uniform mass ratio and separation cuts to construct comparable binary statistics for five star-forming regions (Taurus, Chameleon I, Ophiuchus, IC 348, and the Orion Nebula Cluster) and used N-body simulations to search for a set of initial conditions that could reproduce the density, morphology, and binary fractions of all five clusters. The results show that, if star-formation is universal, then the initial conditions must be clumpy with a high ($\sim$70%) binary fraction (King et al. 2012a), and simulations also predict a large percentage of triple and higher-order systems. Since most of the star-forming regions consisted of M-stars, one implication is a high initial binary fraction for the youngest M-stars, underscoring the need for a well-characterized M-star field sample for comparison. While large-scale stellar population statistics have been studied for G-dwarf binaries (Duquennoy & Mayor 1991, Raghavan et al. 2010) and A-type stars (the Volume-limited A-STar survey, De Rosa et al. 2011, 2012, 2014), existing M-star binary surveys with comprehensive separation coverage have been far more limited in their statistics. The Fischer & Marcy (1992) study involved a limited sample with few stars observed over the full range of separations and mass ratios; the Bergfors et al. (2010) study included a mixed collection of distances (often based on photometry) and an activity-based selection criterion; and the Jansen et al. (2012) AstraLux survey, while covering a larger sample of 700 K and M stars, did not probe the most widely-separated systems and therefore could not fully characterize higher-order multiplicity of the lowest-mass stars. Similarly, benchmark studies have been made for substellar companions to solar-type stars (e.g. Metchev et al. 2007), but existing M-star planet searches have detected only a limited number of brown dwarfs (e.g. the PALMS survey; Bowler et al. 2012a, 2012b). By contrasting a sample of field stars with star forming regions, it is possible to compare primordial binary populations with the population of field binaries, and **our proposed measurements to complete the census of stellar and substellar companions to a well-defined field M-dwarf sample provide this much-needed, directly comparable field study.**

Proposed Targets: From our archival search, we found that of the 48 targets lacking archival AO observations, a large number of previously unobserved M-dwarf systems are visible in the North (37 targets). These stars form the search sample of our proposed observations, of which 20 targets are observable during the 2015A semester. Existing archival imaging also produced 30 new stellar and substellar candidates, and with an approved VLT/NACO program (PI: De Rosa), we obtained confirmation imaging of nine new Southern stellar candidates – two of which were confirmed to share common proper motion – and four of the Southern substellar candidates detected in our sample, which we are currently incorporating into our population analysis. For the remaining Northern substellar candidates, we have searched all public archives with high angular resolution data (VLT, Keck, HST, Gemini, Subaru, and CFHT), and found that the remaining 19 substellar candidates lack any available second-epoch data needed to confirm physical association, and that 10 of these 19 targets are visible from the MMT in the January-July term of 2015. These stars form the confirmation sample of our proposed observations. Imaging of these systems will uncover any previously unknown close stellar and substellar companions, and will provide important measurements of host binarity for upcoming M-dwarf planet searches. By identifying new candidates in the remainder of our sample and confirming or rejecting identified candidates, we will measure the frequency of substellar companions, providing the most complete study of low-mass multiplicity across the stellar/substellar boundary. **The results of the proposed observations will provide definitive constraints upon the hierarchical nature of M-dwarf systems and how their architectures relate to star, brown dwarf, and planet formation.**

References

Bergfors et al. 2010, A&A, 520, 54
Bowler et al. 2012a, ApJ, 753, 142
Bowler et al. 2012b, ApJ, 756, 69
De Rosa et al. 2011, MNRAS, 415, 854
De Rosa et al. 2012, MNRAS, 422, 2765
De Rosa et al. 2014, MNRAS, 437, 1216
Duquennoy & Mayor 1991, A&A, 248, 485
Fischer & Marcy 1992, ApJ, 396, 178
Gizis et al. 2001, ApJ, 551, 165
King et al. 2012a, MNRAS, 421, 2025
King et al. 2012b, MNRAS, 427, 2636
Luhman et al. 2010, ApJ, 720, 178
Marcy & Butler 2000, PASP, 112, 137
Metchev et al. 2007, ApJS, 181, 62
Montet et al. 2014, ApJ, 781, 28
Patience et al. 2002, ApJ, 581, 654
Raghavan et al. 2010, ApJS, 190, 1
Reid & Gizis 1997, AJ, 114, 1992
Van Leeuwen 2007, A&A, 474, 653.

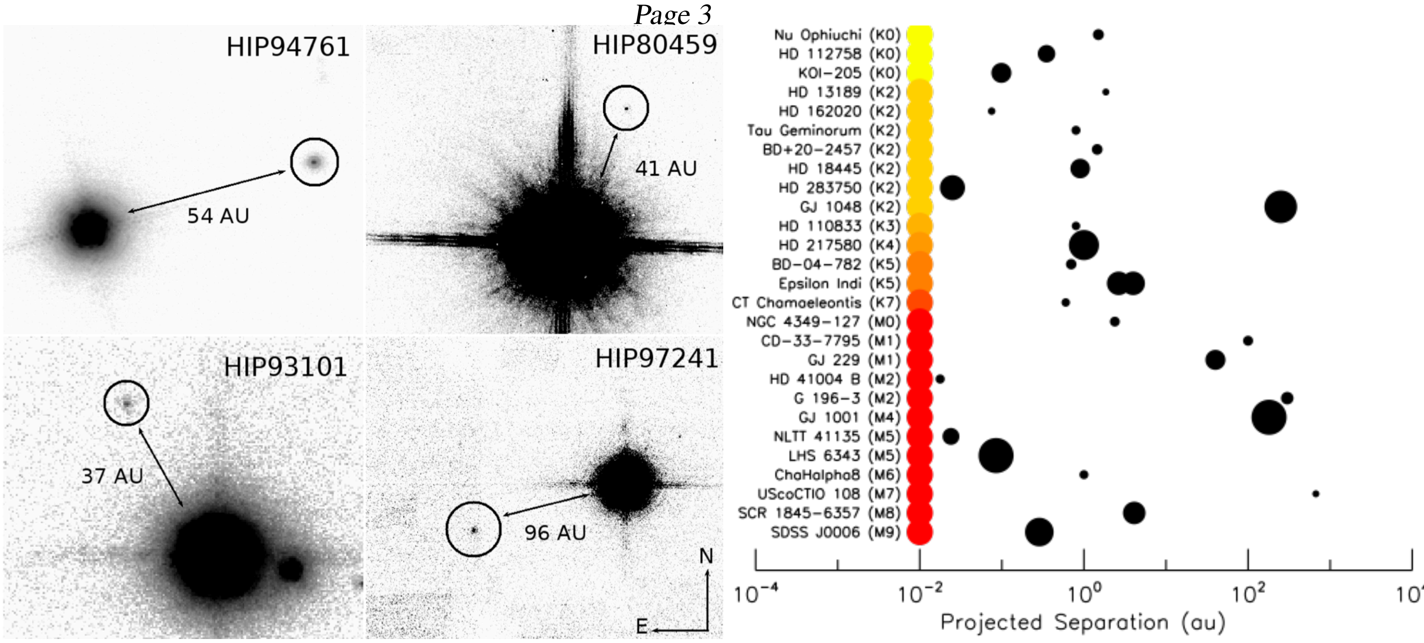

Figure 1 (Left): Example substellar candidates identified in our 245-star M-dwarf multiplicity survey. If associated, each companion has an absolute K-band magnitude of $M_K>10$, corresponding to substellar masses below the bottom of the Main Sequence. Given the large proper motions of the primary hosts, the proposed MMT/ARIES observations will allow us to confirm or reject the physical association of detected substellar candidates. **(Right:)** Known brown dwarf companions to low-mass stars, with symbol size corresponding to brown dwarf mass. The largest circle corresponds to ~70 Jupiter masses. Given the yield from our archival AO imaging search, we anticipate detection of ~4 new substellar candidates from our 2015A M-dwarf search with ARIES.

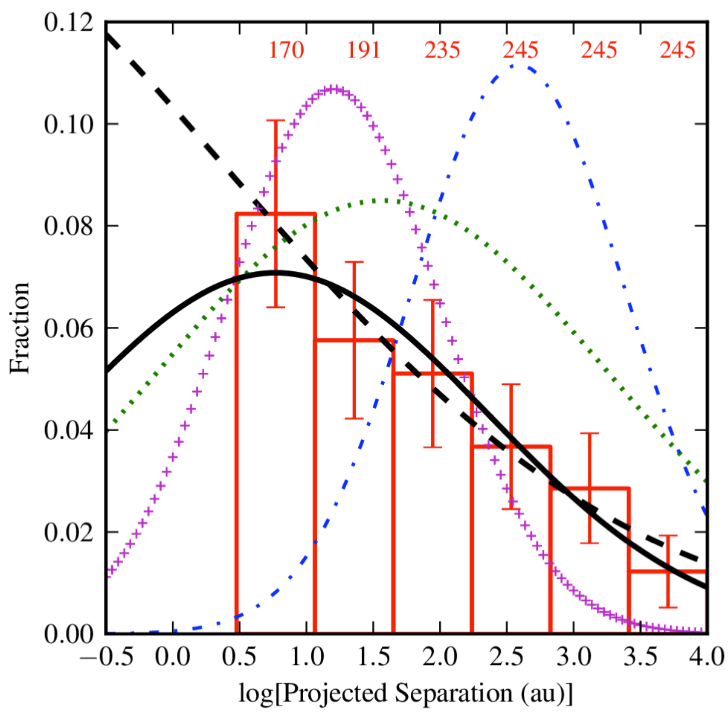

Figure 2: The stellar separation distribution from our survey of 245 M-dwarfs covering separations of ~1 to 10,000 AU (Ward-Duong et al. 2014, *submitted*). The overplotted curves represent the separation distributions for A-type stars (blue dot-dashed line; De Rosa et al. 2014); solar-type (green dotted line; Raghavan et al. 2010); a comparison M-dwarf study (Bergfors et al. 2010); and free (dashed) and restricted (solid) fits to the M-dwarfs within our study. With the proposed observations, we will generate similar distributions and other robust statistics for substellar companions to M-dwarfs, which in turn inform models of low-mass star formation and dynamical evolution.

Experimental Design & Technical Description *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification? If you've requested long-term status, justify why this is necessary for successful completion of the science. (**up to one page**)*

We propose to use the ARIES instrument in conjunction with the MMT AO system to conduct a search for new companions and confirmation imaging of companion candidates to nearby M-dwarfs. We will obtain diffraction-limited imaging of 30 nearby M-dwarf systems – 10 second-epoch systems with candidate brown dwarf companions, and 20 first-epoch systems without previous AO imaging – to complete our large, volume-limited survey of nearby low-mass stars. From the 245-star survey sample, 10 systems within the 196-star sample with previous AO observations have candidate substellar companions. These require second epoch observations, which will allow us to confirm or reject common proper motion and therefore physical association. With the proposed second-epoch observations, it will be possible to eliminate contamination from chance superpositions of unassociated pairs within the final statistics. Due to the extremely high proper motion of the sample targets ($0\farcs5$/year for a typical target, i.e. $1''$-$5''$ between the discovery epochs and proposed observations), second epoch MMT/ARIES observations will ensure unambiguous confirmation of resolved companion candidates. Measurements of separations and magnitude differences will allow us to accurately constrain orbital characteristics and mass ratios of these systems. The 10 brown dwarf candidates span a range of angular separations (between $\sim1''$ and $8''$) and (if associated) absolute K-band magnitudes between $M_K = 10.2$ and $M_K = 17.4$, corresponding to companions with substellar masses.

For the 20-target search component of this proposal, we anticipate detection of $\sim$4 new substellar candidates given the yield from our previous search, and we will perform similar follow-up common proper motion imaging to confirm any detected candidates. At a median distance of 7 pc, the field of view of the ARIES instrument with the f/15 camera ($40''$) corresponds to a companion search space of $\sim$1 to $\sim$300 AU. Given the span in K-band magnitudes of the targets within the sample, the time required on each target will be tailored to ensure that substellar companions beyond the bottom of the Main Sequence are detectable. For the faintest field late-type M-dwarfs, only very short exposures will be required to reach beyond the Main Sequence, with a total integration time of only $\sim$2 minutes. For the brightest targets, a greater level of contrast is required to ensure sensitivity to the faintest substellar companions, increasing the time required on each target to approximately 15 minutes. Given the limiting K-band magnitude of ARIES of 22 mag in 60 minutes ($M_K \sim 19$ in 15 minutes), this corresponds to a 10σ detection of a 5 Gyr, 30 Jupiter mass brown dwarf at approximately 1-$2''$ separation in 15 minutes, based on contrast curves compiled from previous deep MMT/ARIES imaging. Including the instrument and telescope overheads for acquiring each target and obtaining a series of images (including two wavelengths for high probability associated companions), an average of 3 targets per hour will be observed.

Each target will be dithered across the detector to remove cosmetic defects, and to increase the area around the target searched for companions. This dither pattern will be selected to ensure that the proposed observations will overlap with existing *2MASS* observations, allowing for a complete characterization of the frequency of substellar companions to nearby M-dwarfs over the full range of companion separations. For the brightest targets, it becomes necessary to saturate the detector to ensure sensitivity to fainter companions below the bottom of the Main Sequence, and so a series of unsaturated exposures will be taken first to calibrate photometry of the saturated image. As the targets all have well-measured and high proper motions, it will be possible to confirm or reject any wide ($>5''$-$10''$, depending on target brightness) companion candidates based on comparison with archival *2MASS* images. For any companions that show common proper motion over the time baseline of *2MASS* and MMT images, we will obtain colors to further characterize the spectral type of the companion. For targets with close companions only clearly resolved with AO, the probability of being a background object will be estimated from *2MASS* source counts in the same part of the sky so that the single epoch measurements can be published, although follow-up measurements will be required to confirm candidate substellar companions. In addition to science imaging, we will obtain unsaturated exposures of several calibration binaries (e.g. Trapezium) to determine any distortion of the plate-scale across the detector, and the angle of North. Overall, given previous observations at the MMT and with other AO systems, we request 2 nights of observing time with ARIES, allowing for acquisition, instrument overheads, and observations of calibration targets.

Summary of Time Requested and Awarded *The TAC needs to understand the scope of this project — (1) tell us how many UAO nights you've already had for this project, how many you request this time, and (a good guess of) how many you need to complete the project; (2) if a substantial amount of observing for this project comes from non-UAO telescopes, tell us about that observing, and how the UAO part fits in; (3) if you are collaborating with people who have telescopes, especially if you are part of a large collaboration, tell us who is leading the project, and how UAO time and your participation fit in. (**up to one page**)*

1 – UAO Telescope Time

We previously requested time for this project from the UAO TAC for the 2014B semester (August-Dec), and the program was awarded 3.5 nights (UAO-S39). The previously requested observations will be conducted this coming week (October 3rd-8th) with MMT ARIES, and the proposed observations for the 2015A semester represent the time required to complete this project by observing remaining targets inaccessible this semester.

2 – non-UAO Telescope Time

A related program targeting brown dwarf companions to Southern M-dwarfs was submitted to ESO in the recent call for proposals. We were previously allocated $\sim$15 hours of NACO time in Period 91 for follow-up observations of substellar and stellar candidate companions to nearby Southern M-dwarfs.

3 – Collaborations

Patience and her group are involved in several large survey programs – the **MinMs** (M-dwarfs in Multiple Systems) snapshot survey, the **VAST** (Volume-limited A-STar) survey, the **TBOSS** ("Taurus Boundary of Stellar/Substellar") collaboration, the **BAM** (Brown dwarf Atmosphere Monitoring) Project, and the **IDPS** (International Deep Planet Search) current AO system survey. Patience is the PI of the VAST survey which combined AO telescope access across a partnership of $\sim$10 collaborators to observe $\sim$250 A-stars. Patience is a co-I of the IDPS survey, which targets $\sim$250 young M-B stars, with primary responsibilities related to the B/A-star sample. Patience is a co-I of the BAM program that was extended to observe fainter brown dwarfs at the MMT. Publications and papers in progress from these surveys are listed below. Patience, De Rosa, Rajan, and Ward-Duong are Co-Is of the recently initiated **LEECH** LBT survey. Patience and De Rosa are also Co-Is of the upcoming **GPIES** Gemini survey for imaged planets in the North and South, and the Patience group has contributed to defining the target sets for both programs and some early observations with both LBT instruments and GPI.

The MinMs and VAST publications thus far are student/postdoc-led: Ward-Duong et al. 2014, MNRAS, submitted [**Stellar companions to M-dwarfs**], De Rosa et al. 2011 [**X-ray A-stars**], De Rosa et al. 2012 [**A-star orbits**], De Rosa et al. 2014, [**A-star binary statistics**], De Rosa et al. 2014 [**A-star brown dwarf detection**], Patience et al. 2014, in prep [**A-star debris disk binaries**], Schneider et al. 2014, in prep [**A-star binary age estimates**]. The TBOSS publications thus far are student-led: Bulger et al. 2014 [**Herschel Disk Study**], A&A, accepted. The BAM publications thus far are student-led: Rajan et al. 2014, received referee report [**TY pilot study**], Wilson, Rajan, & Patience 2014 [**LT large scale survey**], 2014, A&A, 566, 111. The IDPS A-star subset has been published by a postdoc working with Patience: Vigan et al. 2012 [**IDPS A-star initial results**].

Previous Use of Steward Facilities *List **all** allocations of telescope time for the present project and allocations for other projects on facilities available through UAO during the past 2 years, together with the current status of the data (cite publications where appropriate). Mark those allocations related to the present proposal (i.e, precede text with* `\related` *command). **(up to one page)***

Companion Search - Allocations and Papers:

⋆ **Magellan: 2013B - FourStar search for companions to GPI targets** - *PI: Patience (2 nights)* - not useful

⋆ **MMT: 2013A-UAO-S2 - ARIES A-star companion follow-up** - *PI: De Rosa (4 half-nights)* - 50% useful, **2013B-UAO-S2 - ARIES A-star companion follow-up** - *PI: De Rosa (1 night)* - 75% useful, **2013C-UAO-S10 - ARIES A-star companion follow-up** - *PI: De Rosa (2 nights)* - 75% useful

⋆ **Patience et al. 2014**, *The TBOSS (Taurus Boundary of Stellar/Substellar) Survey of Disk Properties*, 2014 IAUS, 299, 224 - Sample for follow-up projects, including LBT proposal

⋆ **Bulger et al. 2014**, *The Taurus Boundary of Stellar/Substellar (TBOSS) Survey I: far-IR disk emission measured with Herschel*, A&A accepted - Sample for follow-up projects, including LBT proposal

⋆ **Ward-Duong et al. 2014**, *A Direct Imaging Study to Search for and to Characterize Planetary Mass Companions*, 2014 IAUS, 299, 74 - Includes MMT data

⋆ **Ward-Duong et al. 2014**, *The M-dwarfs in Multiples (MinMs) survey - I. Stellar multiplicity among low-mass stars within 15 pc*, MNRAS, submitted - Includes MMT data

⋆ **Skemer et al. 2014** *LEECH: A 100 Night Exoplanet Imaging Survey at the LBT*, 2014 IAUS, 299, 70

Companion Characterization - Allocations and Papers:

LBT: 2013A - Thermal-IR measurements of substellar companions: - *PI: Patience (1 night)* - 50% useful

MMT: 2013C-UAO-S11 - ARIES Substellar spectroscopic characterization - *PI: Ward-Duong (2 nights)* - 0% useful, **2014A-UAO-S1 - ARIES Substellar spectroscopic characterization** - *PI: De Rosa (4 nights)* - 25% useful

• **De Rosa et al. 2014**, *Debris Disks and Multiplicity within the 75pc Volume-limited A-Star (VAST) Survey*, 2014 *IAUS*, 299, 334 - Includes MMT data

• **De Rosa et al. 2014**, *The VAST survey - IV. A wide brown dwarf companion to the A3V star ζ Delphini, MNRAS*, accepted - Characterization most similar to MMT proposal; includes MMT data

• **De Rosa et al. 2014**, *The VAST survey - V. Confirmation observations of low-mass companions to nearby A-type stars, MNRAS* - Analysis of MMT data complete, paper in progress

• **Maire et al. 2014**, *The LEECH Exoplanet Imaging Survey. Further constraints on the planet architecture HR 8799 system, A&A*, in prep

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Brown dwarf Atmosphere Monitoring - Allocations and Papers:

MMT: 2012A-UAO-S3 - SWIRC Brown dwarf variability monitoring - *PI: Patience (2 nights)* - 75% useful, **2013A-UAO-S99 - SWIRC Brown dwarf variability monitoring** - *PI: Rajan (2 nights)* - 0% useful

• **Rajan et al. 2014**, *Searching for Photometric Variability across the L, T & Y Dwarf Sequence*, 2014 IAUS, 299, 301 - Includes MMT data

• **Wilson, Rajan & Patience 2014**, *The Brown-dwarf Atmosphere Monitoring (BAM) Project I: Multi-epoch monitoring of extremely cool brown dwarfs*, A&A, 566, 111 - The paper established the code and observing practices for all current and future BAM projects, including the MMT proposal

• **Rajan et al. 2014**, *The Brown-dwarf Atmosphere Monitoring (BAM) Project II: Multi-epoch monitoring of extremely cool brown dwarfs*, MNRAS, submitted - Includes MMT data

• **Burgasser et al. 2014**, *Splinter Session on Cool Cloudy Atmospheres: Theory and Observations*, Cool Stars 18, submitted - Includes MMT data

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Index	Name	RA	Dec	V Mag	K Mag	Note
1	HIP47103	09 36 01.63592	-21 39 38.8679	10.906	6.475	Substellar Candidate
2	HIP47650	09 42 51.73312	+70 02 21.8980	11.36	6.469	Stellar Target
3	HIP48336	09 51 09.64114	-12 19 47.4939	10.016	6.15	Stellar Target
4	HIP49986	10 12 17.66904	-03 44 44.3966	9.264	5.015	Substellar Candidate
5	HIP50341	10 16 45.94710	-11 57 42.3878	10.998	6.452	Stellar Target
6	HIP52600	10 45 21.48828	+38 30 42.3470	9.27	5.55	Stellar Target
7	HIP56157	11 30 41.82360	-08 05 42.9317	12.01	7.152	Stellar Target
8	HIP60444	12 23 33.18441	+67 11 17.9164	11.54	6.807	Stellar Target
9	HIP61706	12 38 52.44015	+11 41 46.1767	11.502	6.691	Stellar Target
10	HIP65714	13 28 21.07950	-02 21 37.0186	11.23	6.613	Stellar Target
11	HIP66077	13 32 44.60871	+16 48 39.0197	11.401	6.826	Stellar Target
12	HIP70475	14 24 55.98373	+08 53 15.4283	12.257	7.59	Stellar Target
13	HIP70865	14 29 29.69845	+15 31 57.5015	10.676	6.393	Stellar Target
14	HIP72509	14 49 31.76303	-26 06 42.6229	12.066	7.907	Stellar Target
15	HIP72511	14 49 32.62621	-26 06 20.1915	11.656	7.619	Stellar Target
16	HIP74190	15 09 35.59099	+03 10 00.5776	11.473	6.858	Stellar Target
17	HIP74995	15 19 27.509	-07 43 19.44	10.61	5.837	Substellar Candidate
18	HIP78353	15 59 53.38296	-08 15 11.5236	10.487	6.343	Stellar Target
19	HIP79431	16 12 41.77667	-18 52 31.7905	11.372	6.589	Stellar Target
20	HIP80459	16 25 24.62333	+54 18 14.7733	10.17	5.833	Substellar Candidate
21	HIP83043	16 58 08.85039	+25 44 38.9888	9.655	5.624	Substellar Candidate
22	HIP83599	17 05 13.77807	-05 05 39.2239	10.071	5.975	Substellar Candidate
23	HIP84521	17 16 40.98082	+08 03 30.2292	11.529	7.106	Stellar Target
24	HIP84794	17 19 54.20401	+26 30 03.1084	11.29	6.422	Stellar Target
25	HIP85665	17 30 22.727	+05 32 54.71	9.32	5.422	Substellar Candidate
26	HIP86162	17 36 25.89973	+68 20 20.9108	9.15	4.548	Substellar Candidate
27	HIP86776	17 43 55.96263	+43 22 42.9977	10.51	5.964	Substellar Candidate
28	HIP91430	18 38 44.74773	-14 29 26.0319	11.224	6.849	Stellar Target
29	HIP91699	18 41 59.03435	+31 49 49.7642	11.3	6.722	Substellar Candidate
30	HIP100923	20 27 41.66086	-27 44 51.7148	11.433	6.864	Stellar Target

From: Don McCarthy <dwmccarthy@gmail.com>
Subject: **Re: proposals**
Date: 28 September 2014 21:47:44 MST
To: Jennifer Patience <Jennifer.Patience@asu.edu>
Cc: Craig Kulesa <ckulesa@as.arizona.edu>

OK, Jenny!

FYI, the new detector in ARIES is still undergoing some tests and is not yet ready for prime time. So, we continue to swap the same detector between ARIES and PISCES. Thus, the two instruments cannot be scheduled close in time.

Don

On Sun, Sep 28, 2014 at 9:18 PM, Jennifer Patience <Jennifer.Patience@asu.edu> wrote:

> Hi, Don. My students and I are working on proposals for the upcoming deadline. Will PISCES be available at the MMT? If possible, we would like to submit an MMT/PISCES proposal for brown dwarf monitoring as part of one of my students (Abhi Rajan) thesis projects. We would also like to submit AO ARIES proposals for companion search and characterization observations continuing our ongoing projects (part of the thesis for Kim Ward-Duong). As always, we are happy to include you and Craig in all the results.
>
> -- Jenny