EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

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APPLICATION FOR OBSERVING TIME LARGE PROGRAMME PERIOD: **86A**

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title Category: **C–7**

NPARSEC: NTT PARallaxes of Southern Extremely Cool objects

2. Abstract / Total Time Requested

Total Amount of Time: Total Number of Semesters:

The discovery and subsequent detailed study of T dwarfs have provided many surprises and pushed the physics of atmospheric modeling in unpredicted directions. A critical physical quantity required to understand these objects is their distance. However, to date only 31 have published parallaxes. Here we propose the determination of T dwarf parallaxes across the full range of T sub-types, tripling the number of T dwarfs with robust distances and so providing fundamental calibrators of properties in the low-temperature substellar regime. This program will compliment the ESO2.2/WFI PARSEC program to determine parallaxes of a sample of 118 L and 22 bright T dwarfs. The areas of research directly impacted by this sample will be wide spread. On an individual object basis distances are key for assignments of binarity, metallicity and gravity and more generally the sample will provide key input for the substellar luminosity and mass functions, the connection to exo-planetary models as well as complex atmospheric processes such as non-equilibrium chemistry and turbulent mixing. Eventually these objects will provide new insights into the history of our galaxy, the kinematics of the solar neighborhood and our understanding of differing formation scenarios from stars to brown dwarfs to giant planets. In this program we will quickly exploit new T dwarfs being detected by surveys on UKIRT and VISTA – surveys which have placed European astronomers at the forefront of the study of brown dwarfs.

3. Run	Period	Instrument	Time	Month	Moon	Seeing	Sky	Mode	Type
A	86	SOFI	4n=2+2	oct	n	n	THN	v	
B	86	SOFI	4n=2+2	nov	n	n	THN	v	
C	86	SOFI	4n=2+2	jan	n	n	THN	v	
D	86	SOFI	4n=2+2	feb	n	n	THN	v	
E	87	SOFI	4n=2+2	apr	n	n	THN	v	
F	87	SOFI	4n=2+2	may	n	n	THN	v	
G	87	SOFI	4n=2+2	jul	n	n	THN	v	
H	87	SOFI	4n=2+2	aug	n	n	THN	v	
I	88	SOFI	4n=2+2	oct	n	n	THN	v	
J	88	SOFI	4n=2+2	dec	n	n	THN	v	

Following runs moved to box 3a, last page...

4. Principal Investigator: RSMART

4a. Co-investigators:

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B.	Burningham	1668
H. R. A.	Jones	1668
S. K.	Leggett	1035
D.	Pinfield	1668

Following CoIs moved to the end of the document ...

5. Description of the proposed programme

A) Scientific Rationale:

Executive Summary

We propose a program to measure the parallaxes of 60 T dwarfs. The program will consist of 2 parts: a selected sample of 40 objects across the T spectral range to ensure there are at least 10 objects per subclass; and 20 of the most interesting new discoveries from the ongoing UKIDSS/VISTA surveys. This will more than triple the number of these objects with known parallaxes and will allow us to have statistically significant samples in all T subclasses. As parallaxes underlie much of the scientific return from T-dwarf studies, we advocate a survey-type parallax program as opposed to mere follow-up based on discovery, while still having the potential to rapidly follow-up on exciting new astrophysically interesting targets. This proposal team is responsible for almost 50% of measured T dwarf parallaxes including the first T dwarf survey [1] and the latest cool objects [2,3]. This team is also leading the current slew of UKIDSS T dwarf discoveries [4,5,6,7,8,9]. Finally, the experience of this team with the instrument proposed, SOFI/NTT, is sufficient to guarantee a positive result.

Historical Context

The prototype T dwarf was discovered in 1995 as a companion to the nearby M dwarf star Gl229 [10]. This was rapidly followed by many discoveries in the large infrared sky surveys 2MASS/DENIS, and in the deep optical survey SDSS. Significant efforts were quickly undertaken to determine the distances to these new objects [1,11,12] for mapping out the lower end of the Hertzsprung-Russell diagram and constraining model atmospheres. The majority of T dwarfs with measured parallaxes are the result of the the USNO Flagstaff program and a NTT-SOFI program in periods 65-69. The USNO program was limited to bright targets and in 2004 the camera was damaged and the program halted. The NTT-SOFI concentrated on a small number of intrinsically faint targets due to the scarcity of objects then known. To date, then, T dwarf parallax programs to date have been operating in a ”discovery” mode in which they respond to new and exciting discoveries at cooler and cooler temperatures, with the result that today we have more parallaxes of low luminosity objects than we do of bright ones. The UKIDSS survey has now significant increased the number of known T dwarfs, as well as extending the range of know T dwarfs to T9 and beyond. Now is therefore the time to move out of ”discovery” mode and into a mode that puts the parallax observations of the coolest dwarfs on a robust and systematic footing.

Distance is a fundamental quantity in Astronomy. Distance, combined with an object’s apparent magnitude, determines that object’s intrinsic absolute luminosity and hence its energetic output. Distances are also required to convert observed motions into absolute velocities which in turn provide important age and origin indications. Distances are required for most mass determinations and are often required to prove (or disprove) an object’s binarity. Distances are often the only way to unravel the degeneracy between effective temperature, chemical composition and surface gravity in spectral observations. The only precise, model-independent means to determine distance is trigonometric parallax.

In addition a sample with parallaxes allows the calibration of spectroscopic and photometric distance relations that are critical for almost all studies of T dwarfs. Unfortunately, the current calibration for T dwarfs is based on **just 31 objects** – sometimes with as few as 2 per spectral bin. Nine of these derive from the NTT+SOFI program of Tinney et al [1], which first identified an unexpected “bump” in the absolute magnitude vs spectral type relation. The existence of this “bump” highlights the importance of parallax distances – without them this pronounced feature of T dwarf photospheric evolution would never have been found or understood. Fig. 1 plots all 31 objects with parallaxes, along with the median J magnitude, in spectral bins. This is a graphical representation of the state-of-the-art spectroscopic parallax calibration for T dwarfs. The spread per bin is nearly a magnitude with an rms of 0.4 magnitudes[3]. Moreover the small samples per bin make it impossible to understand the statistics of the distribution functions of these absolute magnitudes about their medians.

To rectify this serious problem it is critical that the number of T dwarfs with high quality parallaxes be increased. In Fig. 2 we plot the current distribution of T dwarfs with parallaxes in black, and the T dwarfs with parallax observations currently underway in red. Overplotted in blue is the initial sample of 40 objects with which we will start this program. It will deliver more than 10 objects per spectral bin to allow both the identification of outliers and to provide a robust median at each spectral type, which in turn will reduce the photometric parallax uncertainty from a poorly understood 0.4 magnitudes to a well-constrained 0.2 magnitudes [13].

T dwarf science drivers

Our parallax observations will have a major impact in a range of science areas across brown dwarf and exoplanetary science, which we now consider.

Modeling substellar atmospheres: Studies of the coolest substellar atmospheres are providing essential tests for the latest generation of model atmospheres [14] which are central to interpreting observations of warm exo-planets. The UKIDSS follow-up program run by our group has already successfully identified more that 70 T dwarfs within the UKIDSS Large Area Survey (LAS) [4,5,6,7,8,9], and of these 11 have spectral types T7.5 or later (only 8 T dwarfs in this regime have been found by other surveys such as 2MASS, SDSS, DENIS) whilst five are later in type than the latest T dwarfs known prior to the advent of UKIDSS. The new extremely late-type T dwarfs have necessitated the extension of the T spectral class beyond T8 to the class T9 and maybe T10, and have now been shown to have temperatures below 600K, and in the case of ULAS J1335+1130 as cool as 500K [15]. As a natural result of our search strategy, we are able to calculate proper motions for all T dwarfs, and identify common proper motion companions which can provide fiducial constraints on brown dwarf properties such as age. Such systems are important probes of atmospheric physics, and this process has already identified a T8.5+M4 binary system which is now highlighting specific shortcomings in the current generation of model atmospheres[5]. One of the difficulties in modeling of brown dwarfs can be seen in Fig. 3 reproduced from Kirkpatrick et al. [16] where the spectra of three objects with optical/J-band spectral types of L7 are overplotted. While the spectral profiles are similar in the optical/near IR, hence the identical spectral classification, the longer wavelength spectra shows strong variations.

Role of parallaxes: Parallaxes are fundamental for any direct comparison to luminosity predictions from models. The luminosity requires the bolometric flux and distance. The bolometric flux we are obtaining through large programs on 8m class telescopes and Spitzer to measure the NIR and MIR spectra, what is missing is the distance hence this proposal. A comparison of the absolute magnitudes of later T objects in Marocco et al (2010) and reproduced in Fig. 4 shows that models [14,17] differ at the 0.5-0.7 magnitude level. In J-H space model tracks for high metallicity are bluer than the low metallicity ones, while in J-K they are redder. The use of only photometric distances with errors of 0.4 magnitudes would mask this effect. Also, the parallax is an atmosphere independent parameter that helps to resolve apparent individual object inconsistencies and models.

Exoplanets: T dwarfs overlap in both mass and effective temperature with the largest exoplanets, but with the critical difference that without a host star getting in the way they are *far more readily observable.* Models, binary fractions, and other physical properties arising from our parallaxes work will therefore provide critical and well determined "boundary conditions" for exoplanet models. In turn exoplanets provide important and unique data applicable to T dwarfs: radii (from exoplanet transits), masses (from orbital solutions) and elemental abundances (from transmission spectroscopy). As the two environments and their formation processes – isolated vs companion – are very different, the observational data that out parallax work will contribute will be critical to understanding these physical, evolutionary and environmental differences.

Role of parallaxes: As we find colder objects the overlap with exoplanets will increase. Precise distances will be required to provide boundary condition constraints for exoplanet models at high masses and temperatures.

Peculiar T dwarfs: A number of cool T dwarfs have anomalous features and their interpretation will rely heavily on accurate parallax determinations. For example, the T8.5 dwarf ULAS J1238+0953, has IRAC colours that suggest extremely low-metalicity or high gravity. The T8p dwarf, ULAS J1017+0118, has a T8 classification, but appears T6-like in H and K band spectra. Likewise, some earlier-type objects show anomalous blue near-infrared colours, and weak or absent KI absorption which is suggestive of low-metalicity, high-gravity or both.

Role of parallaxes: It is only with a robust determination of the $T_{\rm eff}$ from well determined parallaxes, can these anomalies be placed in the correct context. Following the maxim "the exception proves the rule" these peculiar objects aid our understanding of the general population.

The $T_{\rm eff}$ distribution of the coolest T dwarfs: The picture of the local population of cool brown dwarfs that our spectroscopic program is revealing is perplexing. In the 980 sq degs of UKIDSS DR4 LAS sky for which we have completed follow-up, we have found a factor of four fewer T6 and later dwarfs (Teff $\sim$ 1050K) than would be expected given the substellar IMF that has been measured in young clusters, and reasonable assumptions regarding the star formation history.

There are a number of plausible explanations for this puzzling result. The most straightforward is that the underlying IMF of the field is indeed different to that seen in the nearby young clusters that have been studied to-date. Such a situation might arise if the bulk of the field population were formed in very high mass clusters (such as Westerlund 1), rather than the OB associations and low-mass star forming regions that dominate the sample of substellar IMF determinations. Alternatively, the difference may arise due to the shortcomings in the evolutionary models that are used to predict the properties of the observed population. For example, if the evolutionary models have over-estimated the cooling times for substellar objects, we would expect to observe a dearth of warmer (e.g. T6-T8 objects) objects, and a glut of the coolest objects (T8+) in our sample.

Fig. 5 shows the spectral type distribution of our sample in terms of space densities compared to the predictions of Deacon & Hambly [18] for different underlying underlying IMFs (assuming power-law parameterisations with a likely range of indices). Although the total number of T6-T9 dwarfs is significantly less than would be expected from the IMF seen in young clusters, the form of the spectral type distribution is not well constrained at present. By measuring the form of the spectral type distribution we plan to distinguish between alternative scenarios that can explain the uncomfortable discrepancy that is currently observed. At present the uncertainties in the space densities are dominated by Poisson noise, the uncertain M_J-spectral type relation for late type objects and the $T_{\rm eff}$ scale for cool T dwarfs which is based on as few as 2 objects per spectral type bin. The first of these sources of uncertainty will be addressed as we increase our spectroscopic sample size and the Poisson uncertainties fall below 20% in each spectral type bin. The latter two sources, however, require the determination of the reliable parallaxes for a representative subset of our full sample.

5. Description of the proposed programme (continued)

Role of parallaxes: The pivotal role of distances is especially critical for this science case, where the measured quantity is the density of the tracer sample which is a function of the distance *cubed*. The distances in this case are provided by photometric parallaxes because the samples are too large to contemplate deriving trigonometric parallaxes for the all tracers. Hence the derived IMF is only as good as the photometric parallax calibration. Any errors in the calibration will systematically distort the IMF being derived and dramatically limits any the added value we could obtain by increasing sky coverage and tracer sample size.

Galactic Chronometers: T dwarfs form particularly long lived, stable, chronometers. Eventually they will be a key tool in understanding the evolution of Galaxy as some will have comparable ages. In this respect the identification of binary systems is particularly important for T dwarfs both to provide age and composition benchmarks, possible systems for a mass determination and the binary fraction. Once we have a statistically significant sample of T dwarfs with a reliable age calibration their role in the study of the Galaxy will begin.
Role of parallaxes: The UKIDSS program is actively looking for visual binary systems, and parallaxes of those systems are needed to precisely find ages. In addition, parallaxes can identify unresolved binary systems by their over-luminosity.

Results found to date

The UKIDSS parallax follow up program on UKIRT has been operating since April 2007 and has produced cutting edge results. In Smart et al [2] we report the parallax of ULAS J0034-0052 one of the coolest brown dwarf yet discovered. The system SDSS J1416+13AB, a sdL7+T7.5p binary reported in Burningham et al [19], was confirmed using proper motions from the UKIRT program. Currently one publication from the UKIRT program is submitted with 11 new T dwarf distances and another with a preliminary distance to an extremely close faint candidate T10 dwarf [3,20]. This telescope is however due to close in 2012 and we will not begin any new programs. Hence this NTT program will become the focus of the parallax follow up for future UKIDSS/VISTA brown dwarf discoveries.
The UKIDSS program has enabled European Astronomers to be at the forefront of research in this field. In Pinfield et al [7] by considering the number of detected T dwarfs later than T4 we found a negative values of α in the substellar mass function, though it is very weakly constrained. In Leggett et al [15] we find cool T dwarf physical relations by considering four T8/T9 dwarfs and the most recent atmospheric models, reasonable constraints on the metalicity and size of these objects. In Burningham et al [5] we report the discovery of Wolf 940B a benchmark binary system. In Burningham et al [21] recently published the largest list of T dwarfs todate. Finally in Lucas et al [20] we report the exciting discovery of a very close, later than T9, object. This parallax follow up is needed to maintain this leadership.

Relation to other programs

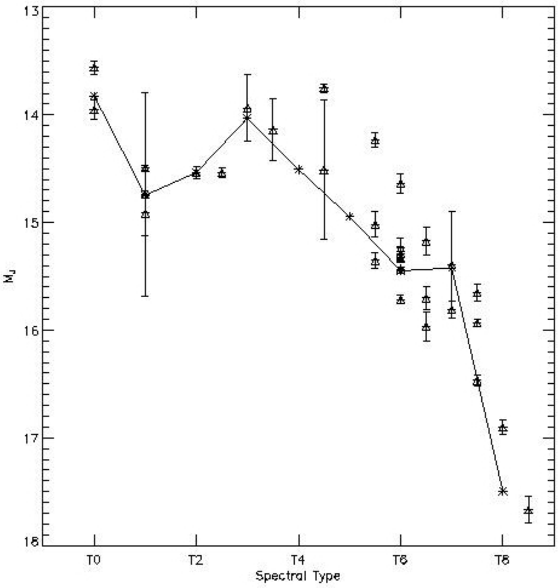
As these objects will be predominantly new discoveries in UKIDSS/VISTA they will not be included in any active programs and in particular it represents our best possibility to fill the T8+ bins. Due to their colors and magnitudes none of these objects will be observed by Gaia or SIM, and, they are not the focus of any other ground based program. There is a hope that the next generation of sky surveys (e.g. PANSTARRS, LSST, SkySurvey) will find parallaxes for these objects but for a number of reasons we believe the required 1-2mas precision can only be achieved by a dedicated focused program such as this one: 1) No absolute astrometric system has demonstrated the precision and accuracy of differential experiments targeted at specific science goals; 2) For parallax determination intelligent scheduling is needed to maximize the weight of each observations which is only possible in a program that considers each object individually; 3) Budget constraints force survey operations to focus on increasing size or depth rather than repetition and astrometric performance as required for parallax determination. 4) The coolest objects will only be visible in the infrared where we are working.

B) Immediate Objective: The determination of parallaxes is a long term investment, however, we expect to have preliminary results (distance limits - companions within 2" - refined proper motions) in the first 2 years. While there is no guarantee, in our similar program that is finishing on the UKIRT observations of interesting objects contributed to 4 publications [9,15,19,20] within the first 18 months.

C) Telescope Justification: The determination of parallaxes requires a stable instrument and high astrometric precision. SOFI has excellent image quality, a simple straight through optical train, a sealed optical system and a gravity invariant mechanical design that makes it almost the ideal instrument for this work. It has a proven track record in parallax determination and provided the first significant sample of T dwarf parallaxes [1]. There are other T dwarf parallax programs but none of them will have this target list or are focused on filling the gaps highlighted in Fig. 2.
This proposal is asking for a total of 96 nights over 4 years, e.g. one 4 night observing block every 6 weeks. Long term status is requested. The determination of robust parallaxes can not be done in less than 3 years, and so it makes little sense to begin such a program if its completion is not guaranteed.

D) Observing Mode Justification (visitor or service): Only offered in visitor mode.

5. Attachments (Figures)



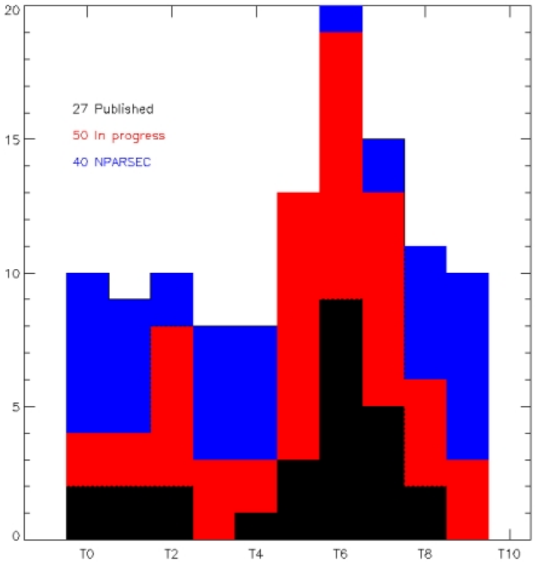


Fig. 1 Left Panel: A plot of absolute J magnitude for all T dwarfs with known parallaxes, including the T9 ULAS0034 submitted for publication. The solid line represents the variation of the median absolute J magnitude for each spectral bin.

Fig. 2 Right Panel: The distribution of all T dwarf measured parallaxes with relative errors better than 10% (27 of the published 31) vs spectral type in black. In red (light grey) the contribution expected from ongoing programs, in blue (dark grey) we plot the contribution from the 40 selected targets, the other 20 objects will be in the cool T10/Y0 bins or unusual objects where a parallax is required as a photometric distance is no longer reliable.

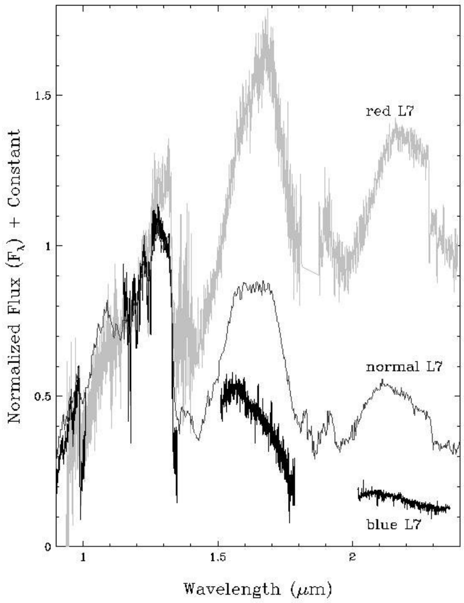


Fig. 3: Reproduced from Kirkpatrick et al. 2008 an over-plot of three objects typed as L7 in J-band. Shown are an unusually red L7 (top, light grey), a normal L7 (middle, dark grey), and a blue L7 (bottom, black). All spectra have been normalised at 1.2 mum.

5. Attachments (Figures)

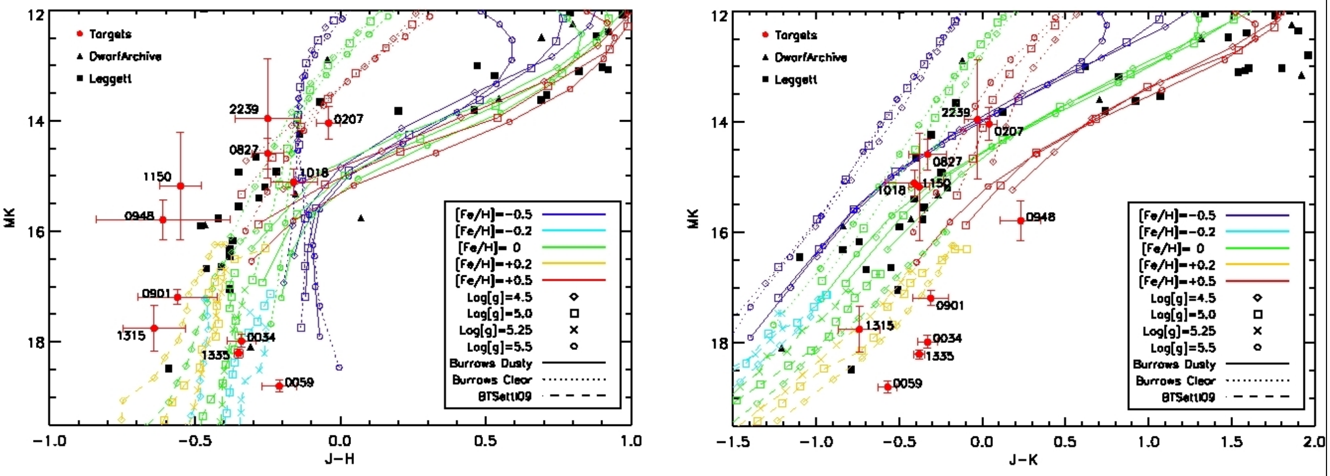


Fig. 4: Color-magnitude diagrams for a sample of T dwarfs from Marocco et al 2010. The colored (grey) lines are theoretical tracks from different models in the temperature range of 500 - 2000 K, for different gravities and metallicities. Overplotted are all T dwarfs with published parallaxes, plain symbols, and first results from the UKIRT program, symbols with error bars. In the J-H space tracks for high metallicity are bluer than the low metallicity ones, while in J-K they are redder. The UKIDSS results for the faintest objects are not consistent with the models.

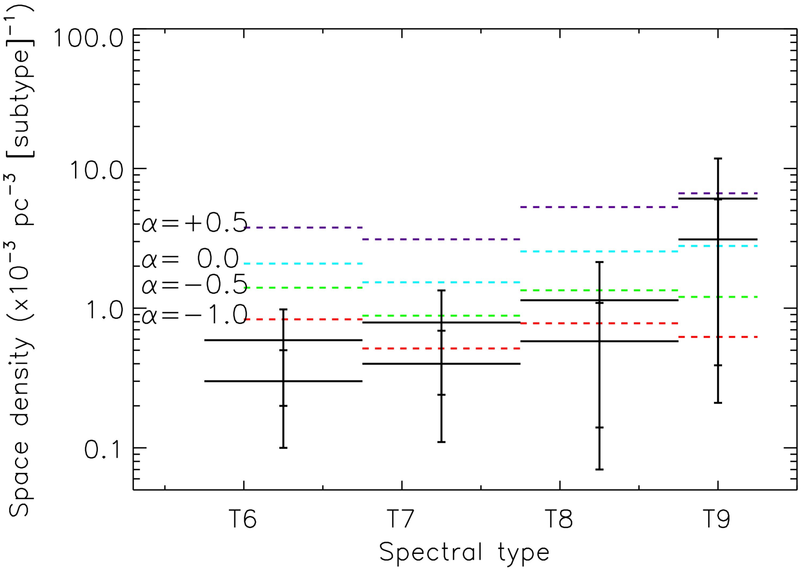


Fig. 5: The spectral type distribution of our DR4 bias corrected sample of T6-T9 dwarfs, in terms of space densities. The solid lines represent the maximum and minimum densities based on different assumptions about the binary fraction (see Burningham et al 2010b), whilst error bars indicate uncertainties arising from Poisson noise and distance uncertainties.

References: [1] C. G. Tinney et al. AJ, 126:975, 2003. [2] R. L. Smart et al. AA, 511:A30+, 2010. [3] F. Marocco et al. sub. to A&A, 2010. [4] B. Burningham et al. ArXiv 0902.1812B, 2009. [5] B. Burningham et al. MNRAS, 395:1237, 2009. [6] B. Burningham et al. MNRAS, 391:320, 2008. [7] D. J. Pinfield et al. MNRAS, 390:304, 2008. [8] N. Lodieu et al. MNRAS, 379:1423, 2007. [9] S. J. Warren et al. MNRAS, 381:1400, 2007. [10] T. Nakajima et al. Nature,378:463, 1995. [11] F. J. Vrba et al. AJ, 127:2948, 2004. [12] C. C. Dahn et al. AJ, 124:1170, 2002. [13] R. L. Smart. MSAIt, 80:674, 2009. [14] N. F. Allard et al. *AA*, 506:993, 2009. [15] S. K. Leggett et al. ApJ, 695:1517, 2009. [16] J. D. Kirkpatrick 384 ASPC 2008. [17] A. Burrows et al. *ApJ*, 640:1063, 2006. [18] N. Deacon et al. MNRAS, 371, 1722, 2006. [19] B. Burningham et al. ArXiv 1001.4393B,2010. [20] P. W. Lucas et al. Sub. to Nature, 2010. [21] B. Burningham et al. Sub. to MNRAS, 2010.

6. Experience of the applicants with telescopes, instruments and data reduction

Many of the collaborators in this program have substantial experience observing with the NTT. We can therefore immediately setup an observing procedure that will maximize the use of NTT and the precision of the observations being made. We will have an experienced observer at every run and sometimes a companion observer in training as a future observer.

We have included a number of Chile and Brazil based collaborators and expect them to provide a significant fraction of the observational support. As describe in section 7 we have a large staff exchange program that will result in 4-6 researchers from the Osservatorio Astronomico di Torino (OATo) and the Center for Astrophysical Research at the University of Hertfordshire (CAR-UH) to exchange with staff at the Brazil National Observatory in Rio, these trips will be combined with some of the observing runs.

For the data reduction this group has extensive experience with data from the NTT and similar telescopes and have a track record to prove this. Part of the staff exchange programs discussed in section 7 will be to build a www accessible database for all collaboration members and this data will form a significant part of the foundation for that database.

7. Resources available to the team, such as: computing facilities, research assistants, etc.

The computing facilities at the institute of the PI (OATo) is more than sufficient for the expected data flow. This can be guaranteed as there is already significant experience with the instruments and programs being proposed. Many of the collaborators are 100% research either as staff, postdocs or doctoral students and hence can dedicate large amounts of time when needed.

To facilitate this proposal we have already obtained various funds to support collaborations:

A Royal Society International Joint Project grant (2007/R3) for the exchange of staff between OATo and CAR-UH.

A Maria Curie FP7 European Community Grant IPERCOOL - Interpretation and Parameterisation of Extremely Red COOL objects. This is a four year International Staff Exchange Program between OATo, CAR-UH, Brazil National Observatory in Rio and the Shanghai Astronomical Observatory. This program will build a real time database of all observations coming from the various spectroscopic, photometric and parallax programs being run by the different institutes and make it available for interpretation within the consortium. The European Union has funded 8 exchange FTEs between the various institutes to work on the development and exploitation of this database.

A Maria Curie FP7 European Community Grant PARSEC (PARallaxes of Southern Extremely Red Cool objects. This is a two year Senior International Incoming Fellowship for A. Andrei from Brazil National Observatory to the OATo. His main project will be to follow the evolution of the ESO 2.2m parallax programs on L dwarfs, but this interconnects in many ways with this proposal and tools and procedures developed there will be applicable here.

8. Special remarks:

9. Justification of requested observing time and lunar phase

Lunar Phase Justification: The parallax observations can be carried out under any lunar phase.

Time Justification: (including seeing overhead) We used the SOFI ETC to estimate required exposure times, assuming 1 arcsec seeing, typical La Silla sky brightness, and an airmass of 1.5. To achieve a s/n of 50 in J and including overhead we find that on average we require 30 minutes per target, or 2 objects/hour. A 5 point dithering strategy will be adopted to remove all sky effects.

The choice of 60 targets spread evenly in right ascension is chosen to have some redundancy and in the 4 nights per run we will aim to have two observations per target. Over the 96 nights we then expect to observe each target on 40-45 nights. Allowing for some bad weather, the difference between summer and winter nights we would still reasonably expect a minimum of 30 observations per target. Following Tinney et al [1] we estimate a per exposure error of better than 10mas. Simulations with these parameters, confirmed with real data, predict $\sigma_\pi \sim$ 1-2mas. Hence a relative error better than 10% for all of our targets which have $\pi >$ 30mas.

The 2n3w2n split is for two reasons to decrease the possibility of getting no observations should there be an extended bad weather spell, and, to improve the sampling of the parallax eclipse - the time between the first and last night is approximately 1/50th of the parallax ellipse.

To minimise the differential refraction correction we will observe only objects within one hour of the meridian. Note also that infrared parallax observations of brighter targets can begin between civil and nautical twilight.

Calibration Request: Standard Calibration

10. Report on the use of ESO facilities during the last 2 years

082.C-399 & 081.C-0552 6+6N NTT time. z band imaging of T dwarf and high redshift quasar candidates. A T8.5+M4 binary discovered, various isolated T dwarf discoveries including four T8.5+ dwarfs and the first T9 ULAS J0034-00, and the coolest yet ULAS1335+1130, the first UKIDSS high-z quasar (z=5.86) and a $z = 6.14$ quasar
082.C-0946 & 083.C-0446 3+7N 2.2m time. Parallaxes of Southern Extremely Cool objects. Preliminary results publication in preparation, time requested to finish the program.

11. Applicant's publications related to the subject of this application during the last 2 years

Smart, et al., 2010 A&A In press: Cool dwarfs stars from the Torino Observatory Parallax Program
A. Andrei 2010 Submitted to AA: PARSEC I: Proper Motions and First Parallaxes.
F. Marocco 2010 Submitted to AA: Parallaxes and physical properties of 11 mid-to-late T dwarfs
Lucas, P. W. 2010 Submitted to Nature, Discovery of a very cool brown dwarf amongst the ten nearest stars
Smart, et al., 2010 A&A, 511, 30: A distance to the T9 cool dwarf ULAS J003402.77-005206.7
Clarke, J. R. A., et al., 2010 MNRAS 402, 575: A search for southern ultracool dwarfs in young moving groups.
Leggett, S. K., et al., 2010 ApJ 710, 1627: Mid-Infrared Photometry of Cold Brown Dwarfs
Goldman, B., et al., 2010 arXiv:1002.2637: A new benchmark T8-9 brown dwarf and a couple of new...
Quanz, S. P., et al., 2010 ApJ 708, 770: Search for Very Low-Mass Brown Dwarfs and Free-Floating Planetary...
Day-Jones, A. C., et al., 2009 arXiv:0912.5339: The current population of benchmark brown dwarfs.
Zhang, Z. H., et al., 2009 arXiv:0911.4255: Benchmark ultra-cool dwarfs in widely separated binary systems.
Smart, R. L., 2009 MmSAI 80, 674: Brown dwarf parallax programs..
Goldman, B., et al., 2009 A&A 502, 929: Polarisation of very-low-mass stars and brown dwarfs.
Andrei, A. H., et al., 2009 A&A, 505, 385 The Large Quasar Reference Frame
Burningham, B., et al., 2009 MNRAS 395 1237: The discovery of an M4+T8.5 binary system.
Leggett, S. K., et al., 2009 ApJ 695 1517: The Physical Properties of Four 600 K T Dwarfs.
Souchay, J., et al., 2009 A&A 494 799: The construction of the large quasar astrometric catalogue.
Subasavage, J. P., et al., 2009 AJ 137 4547: The Solar Neighborhood. XXI. Parallax from the CTIOPI 0.9
Zhang, Z. H., et al., 2009 A&A 497 619: New Ultra-cool dwarfs form the SDSS.
Burningham, B., et al. 2008 MNRAS 391 320: Exploring the substellar regime down to 550K
Day-Jones, A., et al. 2008 MNRAS 388 838: Discovery of a wide ultracool dwarf-white dwarf binary
Pinfield D.J., et al. 2008 MNRAS 390 304: Fifteen new T dwarfs discovered in the UKIDSS LAS
Smart, R. L., et al., 2008 IAUS 248 429: L and T dwarfs in Gaia/SIM.
Goldman, B., et al., 2008 A&A 490, 763: Binarity at the L/T brown dwarf transition.

12. List of targets proposed in this programme

Run	Target/Field	α(J2000)	δ(J2000)	ToT	Mag.	Diam.	Additional info	Reference star
A	0059s01	00:59:10.90	-01:14:01.3	0.3	18.06	0	T9	
B	0139n00	01:39:39.77	+00:48:13.8	0.3	18.43	0	T7.5	
C	0024n00	00:24:22.94	+00:22:47.9	0.3	18.16	0	T4.5	
D	0518s28	05:18:59.95	-28:28:37.2	0.3	15.97	0	T1p	
E	0729s39	07:29:00.02	-39:54:04.3	0.3	15.92	0	T8p	
F	0247s16	02:47:49.78	-16:31:13.2	0.3	17.18	0	T2	
G	0823n00	08:23:27.46	+00:24:24.4	0.3	18.52	0	T4	
H	0837s00	08:37:56.19	-00:41:56.0	0.3	18.52	0	T3.0	
I	0901s03	09:01:16.23	-03:06:35.0	0.3	17.90	0	T7.5	
J	0926n07	09:26:24.76	+07:11:40.7	0.3	17.48	0	T3.5	
K	0938s00	09:38:29.28	-00:11:12.6	0.3	18.53	0	T4.5	
L	0939s24	09:39:35.48	-24:48:27.9	0.3	15.98	0	T8	
M	0949s15	09:49:08.60	-15:45:48.5	0.3	16.14	0	T2	
N	1017n01	10:17:21.40	+01:18:17.9	0.3	18.53	0	T8p	
O	1034s00	10:34:34.52	-00:15:53.0	0.3	18.86	0	T6.5p	
P	1157n06	11:57:00.49	+06:11:05.2	0.3	16.92	0	T1.5	
Q	1207n02	12:07:47.17	+02:44:24.9	0.3	15.58	0	T0	
R	1209s10	12:09:56.13	-10:04:00.8	0.3	15.91	0	T3	
S	1238n09	12:38:28.51	+09:53:51.3	0.3	18.95	0	T8.5	
T	1302n13	13:02:17.21	+13:08:51.2	0.3	18.11	0	T9	
U	1335n11	13:35:53.45	+11:30:05.2	0.3	17.90	0	T9	
V	1404s31	14:04:49.41	-31:59:32.9	0.3	15.57	0	T2.5	
W	1511n06	15:11:14.66	+06:07:43.1	0.3	16.01	0	T0	
X	1516n02	15:16:03.03	+02:59:29.2	0.3	17.23	0	T0:	

Target Notes: Listed are 24 of the expected 60 parallax targets, this list will be finalized once reduction of inhouse Gemini and Subaru spectroscopic data is finished. We have put one object per run to fulfill the pdfLaTeX compilation requirements. When actually observing we will observe all targets within 1 hour of the meridian.

12b. ESO Archive - Are the data requested by this proposal in the ESO Archive (http://archive.eso.org)? If yes, explain why the need for new data.

No

13. Scheduling requirements

1. Run Splitting

Run	**splitting**
A	2,3w,2
B	2,3w,2
C	2,3w,2
D	2,3w,2
E	2,3w,2
F	2,3w,2
G	2,3w,2
H	2,3w,2
I	2,3w,2
J	2,3w,2
K	2,3w,2
L	2,3w,2
M	2,3w,2
N	2,3w,2
O	2,3w,2
P	2,3w,2
Q	2,3w,2
R	2,3w,2
S	2,3w,2
T	2,3w,2
U	2,3w,2
V	2,3w,2
W	2,3w,2
X	2,3w,2

14. Instrument configuration

Period	Instrument	Run ID	Parameter	Value or list
86	SOFI	A	Imaging-LargeField	J
86	SOFI	B	Imaging-LargeField	J
86	SOFI	C	Imaging-LargeField	J
86	SOFI	D	Imaging-LargeField	J
87	SOFI	E	Imaging-LargeField	J
87	SOFI	F	Imaging-LargeField	J
87	SOFI	G	Imaging-LargeField	J
87	SOFI	H	Imaging-LargeField	J
88	SOFI	I	Imaging-LargeField	J
88	SOFI	J	Imaging-LargeField	J
88	SOFI	K	Imaging-LargeField	J
88	SOFI	L	Imaging-LargeField	J
89	SOFI	M	Imaging-LargeField	J
89	SOFI	N	Imaging-LargeField	J
89	SOFI	O	Imaging-LargeField	J
89	SOFI	P	Imaging-LargeField	J
90	SOFI	Q	Imaging-LargeField	J
90	SOFI	R	Imaging-LargeField	J
90	SOFI	S	Imaging-LargeField	J
90	SOFI	T	Imaging-LargeField	J
91	SOFI	U	Imaging-LargeField	J
91	SOFI	V	Imaging-LargeField	J
91	SOFI	W	Imaging-LargeField	J
91	SOFI	X	Imaging-LargeField	J

3a. Run	Period	Instrument	Time	Month	Moon	Seeing	Sky	Mode	Type
	...continued from box 3, first page.								
K	88	SOFI	4n=2+2	feb	n	n	THN	v	
L	88	SOFI	4n=2+2	mar	n	n	THN	v	
M	89	SOFI	4n=2+2	may	n	n	THN	v	
N	89	SOFI	4n=2+2	jun	n	n	THN	v	
O	89	SOFI	4n=2+2	aug	n	n	THN	v	
P	89	SOFI	4n=2+2	sep	n	n	THN	v	
Q	90	SOFI	4n=2+2	nov	n	n	THN	v	
R	90	SOFI	4n=2+2	dec	n	n	THN	v	
S	90	SOFI	4n=2+2	feb	n	n	THN	v	
T	90	SOFI	4n=2+2	mar	n	n	THN	v	
U	91	SOFI	4n=2+2	may	n	n	THN	v	
V	91	SOFI	4n=2+2	jun	n	n	THN	v	
W	91	SOFI	4n=2+2	jul	n	n	THN	v	
X	91	SOFI	4n=2+2	sep	n	n	THN	v	

4b. Co-investigators:

…continued from page 1

B.	Bucciarelli	1346
E.	Costa	1823
M. T.	Crosta	1346
A.	Day-Jones	1823
B.	Goldman	1489
M. G.	Lattanzi	1346
P.	Lucas	1668
R.	Mendez	1823
F.	Marocco	1346
J. L.	Penna	1599
Z.	Qi	1680
A.	Vecchiato	1346
Y.	Yu	1680