



## Research Networking Programmes

Short Visit Grant  or Exchange Visit Grant

*(please tick the relevant box)*

### Scientific Report

**Scientific report (one single document in WORD or PDF file) should be submitted online within one month of the event. It should not exceed eight A4 pages.**

***Proposal Title:*** Gaia and the Unseen

***Application Reference N°:*** 5748

1) Purpose of the visit

We planed to investigate the expected Gaia results for the study of Brown Dwarfs (BDs). Young hot BDs will be observed by Gaia due to their high luminosity, older cooler Bds will not be observed directly but many will be indirectly detected in multiple systems that are the main providers of physical constraints for BD models. Hence the impact of Gaia is multiple, object dependant and complicated - even the estimates of objects expected has a large range: 0.5 to 20 million depending on the binarity. We attempt to restrict these estimates and elaborate on the probable information that indirect detections will provide from masses, ages, luminosities and chemical abundances.

Outside of Gaia detections we will also investigate the impact of Gaia on the 2000+ currently known brown dwarfs. In particular on:

- The ground based determination of BD parallaxes - which will remain important for individual objects too faint for Gaia
- The discovery and characterisation of critical BD benchmark systems.

## 2) Description of the work carried out during the visit

During the visit we investigated the various possibilities for the study of brown dwarfs. These included literature searches, adoption of reasonable parameters for the estimation of Gaia's impact, definition of target lists based on what brown dwarfs are known today and simple simulations. During the two week visit, in addition to many one-on-one discussions, two group meetings were called to brainstorm and discuss various ideas including a formal presentation of the schedule and nominal precision goals of Gaia. The visit was very fruitful in that it introduced many of the group new to Gaia to the expectations and schedule.

## 3) Description of the main results obtained

We investigated the areas where Gaia will contribute or have an impact, in particular:

1. Find direct distances, proper motions, colors and variability for between 4-600 L dwarfs (mainly early Ls), and a limit on the binarity of those objects.

Action: For these objects ground based spectroscopic followup is required to fully exploit the Gaia results. A list of all Brown Dwarfs expected with Gaia is being prepared and will be part of the publication output.

2. Find many BDs indirectly that are unresolved companions of brighter stars due to observation of orbital motions.

Action: The literature on companions is being collated and an estimate of the expected percentage will be part of the publication output.

3. Characterize the primary stars in benchmark binary systems directly finding astrometric/photometric and sometimes spectroscopic details of the primaries, and indirectly by improving stellar models.

Action: Based on UH work on the substellar IMF it was estimated that the wide companion rate for brown dwarfs is around 10-20%, with some variability with spectral type. Simple extrapolations are being carried out to estimate the expected number of companion systems.

4. Provide a PM catalog for the discovery of many other common proper motion systems that will become useful benchmark systems. These could either be bonafide binary systems gravitationally bound or members of recognised moving groups.

Action: To fully exploit this aspect a complete proper motion catalog for brown dwarfs is required and the two institutes have

agreed to try and identify a student or postdoc to work on the building of this catalog.

5. Measure direct masses of a couple of isolated Brown Dwarfs via their astrometric micro-lensing effect.

Action: The OATo group are very active in the gravitation experiment with Jupiter, GAREQ, a few simple simulations will be carried out by Smart in collaboration with this group to see how probable this event is.

6. Provide the kinematical framework for age determination of many brown dwarfs via their motions
7. Increase the value of BD as galactic evolution indicators because of a better understanding of our galaxy

Action; Both point 6 and 7 requires experience with the interpretation of velocities within a galactic model. It was decided to talk with Shanghai Astronomical Observatory colleagues that will be visiting UH this summer and work in this field to see if some collaboration was possible.

8. Increase the robustness of many statistical properties currently being used, e.g. the brown dwarf desert, the wide binary limit.

Action: This point was deemed to be a natural result of points 3 and 4 so no extra specific action was needed.

#### 4) Future collaboration with host institution (if applicable)

The host and the visitor have a long history of collaboration and many points have been left to future collaboration. In particular:

1. Production of a draft "white paper" on the Gaia BD content.
2. Joint observational proposals for the followup of Gaia BDs and BD benchmarks. For example the production a joint ESO large program to obtain xshooter spectra of all southern brown dwarfs visible to Gaia.
3. Identification of a suitable phd or postdoc to coordinate some of the longer term programs.

Finally both parties discussed at length the upcoming Mind-the-Gap meeting in the University of Hertfordshire that resulted in an additional evening session focused on Gaia and BDs, and the content, participants and format of the planned Torino GREAT workshop on Gaia and the Unseen - The Brown Dwarf Problem that will be taking place in March 2014 for which Smart is the Chair and Jones is one of the Scientific Organizing Committee.

- 5) **Projected publications / articles resulting or to result from the grant (*ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant*)**

A publication discussing the areas developed here will be produced and published in an appropriate journal or presented at an appropriate meeting.

- 6) **Other comments (if any)**