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# Exoplanet discovery and characterisation through robotic follow-up of microlensing events: Season 2010 results

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**Abstract.** Microlensing searches for planets are sensitive to small, cold exoplanets from 1–6 AU from their host stars and therefore probe an important part of parameter space. Other techniques would require many years of observations, often from space, to detect similar systems. Microlensing events can be characterised from only ground-based observations over a relatively short ($\leqslant$100 d) timescales. LCOGT and SUPA/St Andrews are building a robotic global network of telescopes that will be well suited to follow these events. Here we present preliminary results of the Galactic Bulge observing season 2010 March–October.

**Keywords.** planetary systems, techniques: photometric

## 1. Introduction

Our knowledge of cool exoplanets, with orbital separations of 1–few AU, remains scant. Due to the long orbital periods of these planets, many years of radial velocity or photometric (transit) observations are necessary to explore this region of exoplanet parameter space, yet it is of tremendous interest as it includes not only Jovian planets in their formation region beyond the snowline, but also the habitable zone for Sun-like stars. Microlensing offers a way to detect and characterise exoplanets from ∼1–6 AU from their host stars from ground-based observations taking only a couple of months.

The survey teams photometrically monitoring the Galactic Bulge, MOA (Hearnshaw *et al.* 2006) and OGLE (Udalski *et al.* 1992), detect >600 microlensing events in progress per year and issue public alerts. Anomalous deviations in a lightcurve from the smooth point-lens-point-source model can indicate that the lensing object may be a binary. Well-sampled lightcurves are necessary to infer the lens and source characteristics

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(Mao & Paczyński 1991; Gould & Loeb 1992), and to detect planetary anomalies which may have a durations as short as ~2 hrs.

## 2. Robotic Telescope Network

As microlensing events do not repeat but span many weeks, a highly responsive, multi-site follow-up network is necessary to monitor them from the ground. Data taken must be reduced as near to real-time as possible to allow early detection of anomalies, and directly influences observation strategy within hours.

We use the 2 m Faulkes-North (Hawai'i) and -South (Australia) and Liverpool (La Palma) robotic telescopes to provide follow-up observations of microlensing events in near real-time response to alerts received.

We have developed a new, adaptive software system called ObsControl, to take advantage of the robotic network's flexible queue-scheduled observing mode. This uses a new command line package, rcstool, to submit requests to the telescope's Java-based observation databases. The system calls on webPLOP (Snodgrass *et al.* 2008, Horne *et al.* 2009) to prioritise the targets and rapidly requests appropriate observations. Data returned are reduced by our fully automated pipeline and the photometry is made publicly available. Target priorities are automatically re-evaluated in the light of new data. We respond to anomaly alerts issued by the ARTEMiS system (Dominik *et al.* 2007), by the follow-up teams and from the surveys. We can request additional observations as necessary, but human authorisation is needed for target-of-opportunity overrides.

## 3. Season 2010 Results and Future Plans

During our observing season, 2010 March to October, we received 598 event alerts from MOA, of which 197 were selected for observation. In addition, we responded to 30 out of 43 anomaly alerts received. Early modeling work on these anomalies identified 5 candidate lensing planetary systems. MOA-2010-BLG-477, is an example of the sensitivity of this technique to Jovian ($\sim$1.75 $M_J$) planets in cool orbits, where much lower irradiation from the host star means their evolution can be contrasted with that of Hot Jupiters. M-dwarf stars being the most numerous, the lens star is assumed to have a mass of $< M_* > \sim 0.5\, M_\odot$. However, for some events, like MOA-2010-BLG-0073, the lens star mass can be inferred if orbital motion and parallax significantly affect the shape of the lightcurve. Preliminary work suggests a $0.0052 \pm 0.0006\, M_\odot$ ($\sim 5.5\, M_J$) Jovian planet orbiting a $0.0074 \pm 0.008\, M_\odot$ brown dwarf with a projected separation of $0.73 \pm 0.07$ AU.

In addition to our current facilities, LCOGT and SUPA/St Andrews are building a network of $\geqslant 12 \times 1$ m and $\sim 22 \times 0.4$ m robotic telescopes at $\geqslant 6$ longitudinally-distributed sites in both hemispheres. This will enable us to provide continuous coverage of high priority microlensing events. We anticipate the first of the new telescopes coming online in 2011–2012.

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