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Properties of low mass planets detected by microlensing.

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Abstract. 4 planets have been detected so far with the microlensing methode. We will present the observational constraints to directly detect the lens and greatly improve our knowledge of the systems. By detecting the lens star we will obtain accurate determination of the mass of the planet and its orbital separation. We use the most extreme case OGLE-2005-BLG-390Lb (∼5.5 Earth mass orbiting a red dwarf at ∼2.6 AU) as an illustration.

A frozen super Earth: a well covered short-term deviation from a point-lens lightcurve was observed on the microlensing OGLE-2005-BLG-390 *(Beaulieu et al., 2006).* The modeling of the photometric data yields the mass ratio q=7.6 ± 0.7 10^{-5}, and the projected planet separation d=1.61 ± 0.008 (in units of R_E, the Einstein ring radius). We performed a Bayesian analysis, using Galactic models and a mass function, to derive probability distributions for the lens parameters and to constrain on the nature of the lens. The median values yield a host star of mass $0.22^{+0.21}_{-0.11}M_\odot$ located at a distance of 6.6±1.1 kpc within the galactic Bulge, orbited by a $5.5^{+5.5}_{-2.7}$ $M_\oplus$ planet at an orbital separation of $2.6^{+1.5}_{-0.8}$AU *(Beaulieu et al., 2006).* Then we derive the probability density of the T_{eff} of the lens star and the T_p of the planet (*Fig.1*).

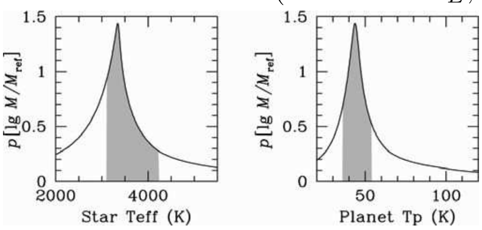

Fig.1: Bayesian probability density: T_{eff} of the lens star *(left)* and the equilibrium effective temperature of the planet T_p *(right)*. The shading indicates the central 68.3% intervals.

Obtaining more information about the microlensing planets: Unlike other techniques, microlensing does not offer much chance to study the planetary system in more detail because the phenomenon only occurs once for each star. Only a significant statistical sample will allow us to reach firm conclusions and finally answer the question of how special our own solar system is. Additional information about a specific event can be obtained once the lens star is directly detected. Bennett *(Bennett et al., 2006)*, using HST images have detected the lens star in the microlensing event OGLE-2003-BLG-235/MOA-2003-BLG-53, and therefore the uncertainties on the planetary parameters have been greatly reduced. In the case of OGLE-2005-BLG-390L we must wait few years till the angular separation between the source and the lens star, due to their relative motion,

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will be sufficient. This one increases by 6.8±1 masY^{-1}, so in 2011 it will be of ∼40 mas. Here high angular resolution with very high contrast observations are needed. They are currently beyond the reach of existing instrumentation.

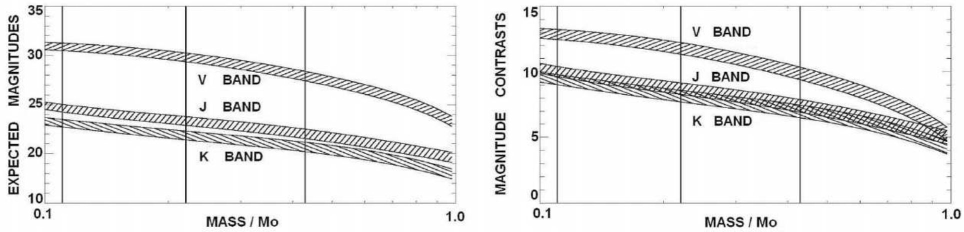

Fig.2 *Left:* the expected apparent magnitudes V, J and K of the lens star, and *right:* the expected contrast in magnitudes between the lens and the source as a function of *M*. The vertical lines show the prefered mass and the 1σ limits.

Adaptive optics on 8m class telescopes: The natural choice would be J band *(Fig 2.)*, where a ΔJ$= 9 \pm 1.5$ mag should be within the reach in a few years, but the constraint of such contrast at a separation of 1λ/D is very challenging. Moreover, new instrumentation like SPHERE are essentially more restricted (need for a bright target in the visual for its front sensor) than current systems. A "super NACO" with IR front sensor and coronography would be of choice.

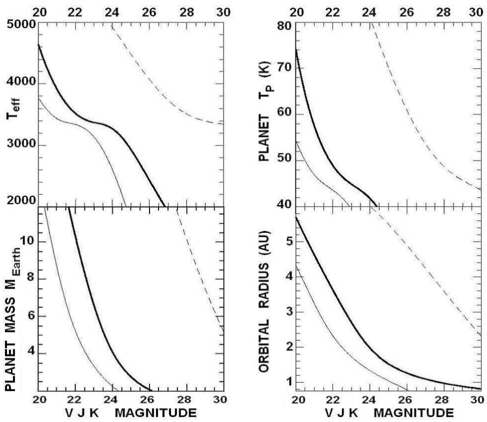

Fig.3: Star and the planet properties as function of the expected V, J and K magnitudes of the lens star. **1.** T_{eff} of the star, **2.** the equilibrium effective temperature of the planet T_p. **3.** planet mass M_p and **4.** the radius a of the planet orbit.

Interferometric observations:
The 6.81 ± 1 masY^{-1} relative motion of the source and the lens star would permit to separate them in a few years using the VLTI.
However the contrast between the two stars requires a stability of the interferometer of $10^{-3} - 10^{-4}$.
Another difficulty is that the source being a K=13.71 magnitude star, is currently too faint for AMBER anyway.
By detecting the lens star directly, we can constrain strongly all the parameters of the planetary system *(Fig 3.)*.
This is one peculiarity of the microlensing technique. However, it is currently beyond the reach of existing instrumentation, but may be at the limit of second generation VLT instruments.

An easier microlensing planet target: The easiest case is OGLE-2005-BLG-169, a ∼13$M_\oplus$ planet orbiting a 0.5$M_\odot$ dwarf at ∼2.7AU *(Gould et al., 2006)*. The relative proper motion between the source of magnitude I=20.6 and the lens of magnitude I∼20 is 8.4masYr^{-1}. Instead of separating the two components, it is possible to measure the variation of the centroid of the superimposed stars at several epochs, and therefore to constrain the lens. It will soon be within the reach of HST observations with the (now deceased) ACS camera, WFPC2, or on the ground with NACO type of adaptive optics on 8m class telescopes.

References

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