OGLE-2007-BLG-050: Detection efficiency to planetary companion with finite source and parallaxes

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Abstract

The resulting detection efficiency diagram for OGLE-2007-BLG-050 is \(\pm (0.13,0.05)\). Source properties from Color-Magnitude Diagram and measurement of finite source and parallax effects permit a measurement of the angular Einstein radius \(\theta_E\) and the parallax \(\pi \) leading to an estimate of the lens mass \(M\) and its distance to the observer \(D\). The detection efficiency diagram in the physical space \((\theta_E, \pi)\) where \(\theta_E\) is the mass planet and \(\pi\) the projected separation with the lens, can then be built.

1. Introduction

We analyze OGLE-2007-BLG-050, a high magnification microlensing event \((\Delta m_\text{peak} = 4.12)\) which peaked on May 1, 2007, with pronounced finite-source effects. We compute detection efficiency on this event to see its sensitivity to the presence of planets around the lens star, following the method proposed by Gaudi & Sackett (2000) and used in particular by Gaudi et al. 2002 and Cassan et al. 2008 (in prep.). Both finite-source and parallax effects permit a measurement of the angular Einstein radius \(\theta_E\) and the parallax \(\pi\), leading to an estimate of the lens mass \(M\) and its distance to the observer \(D\). The detection efficiency diagram is shown in Figure 1.

2. Observational data and extended-source pixel-let fit

This microlensing event was identified by the OGLE III Early Warning System (EWS, Udalski et al. 2003) and was monitored by Microlensing Follow-Up Networks (mFUN, Yoo et al. 2004) and by Probing Lensing Anomalies Network (PLANET, Albar et al. 1998). The following study is based on the \(\mu\) arcsec data from New Zealand, South Africa, Chile, USA, and 160+ bands, and on the OGLE data and the MOA data in hand.

The fact that the X-ray spot is close to unity.

3. Binary lens models and detection efficiency

To characterize the planetary detection efficiency of OGLE-2007-BLG-050, we follow the Gaudi & Sackett (2000) method which consists in fitting binary lens models with the 3 binary parameters \((\delta q, \delta \phi, d)\) (planet-source mass ratio, \(\phi\) angle of the source trajectory relative to the binary axis). To perform the calculations of binary light curves, we use a binary-light finite-source algorithm developed by Dong et al. (2008) (Appendix A). The resulting grid of \(\theta_E\) as a function of \(d\) and \(\phi\) are shown in Figure 2 for some values of \(q\).

4. Source properties from Color-Magnitude Diagram and measurement of \(\theta_E\)

To determine the dereddened color and magnitude of the microlensed source, we use the best fit instrumental color and magnitude of the source on an instrumental \((I,F)-CMD\) (Figure 6).

5. Parallax effects - Lens mass and distance estimates

The long timescale of the event enables to obtain constraints on the microlensed planet. The \(\pi\) fit yields to the determination of the components \(\theta_E\) and \(\pi\), of the parallax \(\pi\) on the sky in north and east celestial coordinates by mapping a grid of \(\theta_E\) (Figure 5).

6. Detection efficiency diagram in physical units \((\theta_E, \pi)\)

Having an estimate of the angular Einstein radius \(\theta_E\), the distance \(D\) of the lens from the observer and the lens mass \(M\), we derive estimates of the physical parameters \((\theta_E, \pi)\) for the tested planetary models and calculate the associated detection efficiency, where \(\epsilon\) is the projected separation between the planet and the star and \(\pi\) is the planet mass.

References