Parallax effects in microlensing events caused by free-floating planets

L. Hamolli, [1] M. Hafizi[1], F. De Paolis, [2 3] A.A. Nucita[2 3]

[1]Department of Physics, Faculty of Natural Sciences, University of Tirana, Albania,

[2]Dipartimento di Matematica e Fisica "*Ennio De Giorgi*", Università del Salento, Via per Arnesano, I-73100 Lecce, Italy

[3]Istituto Nazionale di Fisica Nucleare, Sezione di Lecce, Via per Arnesano, I-73100 Lecce, Italy,

1. Introduction

Free-floating planets are recently drawing a special interest among the scientific community. Gravitational microlensing is up to now the exclusive method for the study of this Galactic population. In this work we find that the planned Euclid space-based observatory can allow discovering a substantial number of microlensing events caused by free-floating planets. Making use of a synthetic population, we investigated the importance of using the parallax effect as an additional source of information. In particular, the aim of our work is the investigation of the best Earth positions in its orbit around the Sun for observing parallax effects induced in microlensing events of free-floating planets.

Several microlensing surveys, as MOA (Microlensing Observations in Astro- physics) Collaboration [1] and OGLE (Optical Gravitational Lensing Experiment) Collaboration [2] have been undertaken since about two decades towards the Galactic bulge with the aim of searching for MACHOs (Massive Astrophysical Compact Halo Objects) and exoplanets. These surveys have allowed the detection of several thousands of microlensing events, a fraction of them due to objects different from stars. Microlensing observations are affected by the presence of the Earth atmosphere that is a source of Poisson noise, which sets up an unavoidable lower limit to the mass of lens. A way to circumvent this limit is to go in space. At present, there are two space-based missions which are planned for detecting microlensing events towards the Galactic bulge: the Wide-Field Infrared Survey Telescope (WFIRST) [3] and Euclid, an ESA mission planned to be launched in 2017.

Here, we focus on the observations towards the Galactic Bulge planned to be performed by Euclid, with duration of about ten months, not necessarily consecutive. The Galactic coordinates of the Euclid line of sight are $b = -1.7^o$, $l = 1.1^o$, the distance of observation can be considered $D_s = (7-10)$ kpc, with mean value at $D_s = 8.5$ kpc and the observing image rate (cadence) is expected to be about 20 min [4].

We investigated how the Earth parallax motion affects the microlensing curves, in particular for free-floating planets. We limited our calculations to point-like source and lens approximation, without considering the finite dimensions of sources and lenses. We use numerical methods for generating synthetic microlensing events observable from the Euclid mission in different positions of the Earth around its orbit.

The first step was the calculation of the microlensing rate Γ for all the interesting source and lens populations including bulge and disk stars as well as free-floating planets. By considering a detailed three dimensional galaxy model, we noted that the bulge population of free-floating planets provides the most important contribution in the number of the expected microlensing events. For estimating the ratio of events with resolvable parallax effect in different periods of the year, we generated numerically a large number of synthetic events towards the Euclid field of view by Monte Carlo method and checked their observability via the Euclid telescope. We find that the best time periods for this observations are December and June. For more details, we refer to the papers by Hamolli et al. [5,6].

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