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Advanced Modeling of Microlensing Events

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ABSTRACT

The search for exoplanets is one of the most exciting challenges. From the first exoplanets discovered around the pulsar PSR B1 257+12 back in 1992 until today there are over 5200 exoplanets discovered. And the number will continue to rise in the coming years with the advent of the latest generation telescopes. There are various techniques for finding exoplanets such as transit, radial velocity, pulsar timing, direct imaging etc. But among these, gravitational microlensing is one of the most fascinating. Gravitational microlensing is a particular technique to detect exoplanets otherwise unavailable with other techniques such as transits or radial velocity. We have a microlensing event when the light from a distant source is deflected by a lens passing through the source and the observer. The result, in the simplest case, is a bell-shaped peak in the light curve. Planets can be detected studying the anomalies in the lightcurve (additional peaks or dips, longer distortions, etc.). But microlensing is not important only for exoplanets. The fact that with this technique it is possible to reach distances of the order of the galactic center allows us to discover objects ranging from the disk to the bulge allowing us to have a much more complete overview of the study of the stellar populations of our galaxy. And in particular with the study of binary systems we can detect faint objects that are impossible to reveal with other techniques, such as brown dwarfs, mysterious objects of which little is known yet and which are presumed to

populate our galaxy in great abundance. Microlensing is undoubtedly the best method to discover these objects, since having extremely low luminosities they are difficult to see with telescopes except when they play the role of lens. Moreover, in some cases the orbital motions of the system can also be detected, allowing us to study their dynamics in more detail. The typology of microlensing events is enormous and in this thesis we will analyze some of the cases that can occur. In the first part we focus on the fundamental concepts of microlensing theory for the exoplanets search. The second part is dedicated to the modeling of microlensing events, which is based on the VBBinaryLensing code. In the third part we analyze some microlensing events, each with certain characteristics, to highlight how vast the case history of these events is. Finally there will be the conclusions where the results achieved and future prospects are discussed.