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SEARCH FOR ECLIPSING BINARIES TOWARDS THE GALACTIC BULGE WITH OGLE-II AND 2MASS DATA

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RESUMEN

El levantamiento OGLE-II ("Optical Gravitational Lensing Experiment") obtuvo como sub-producto un catálogo de $\sim$ 220,000 candidatas a estrellas variables. Los datos fueron tomados en la banda I y consisten de imágenes y curvas de luz. Por otro lado, en la misma época, el "Two Micron All Sky Survey" (2MASS) produjo datos de la totalidad del cielo que contienen posiciones precisas y flujos en el infrarrojo (en las bandas J, H y K_S) de cerca de 470 millones de estrellas. En este trabajo, presentamos una forma sistemática de identificar sistemas binarios eclipsantes en el levantamiento OGLE-II que tengan contrapartidas en el catálogo 2MASS. Para hacer esto utilizamos el Análisis de Componentes Principales como herramienta de selección.

ABSTRACT

The Optical Gravitational Lensing Experiment (OGLE) produced as a by-product a catalog of $\sim$ 220,000 candidates to variable stars. The data were collected in the I band and consist of images and light curves. On the other hand, at the same epoch, the Two Micron All-Sky Survey (2MASS) covered the whole sky providing accurate positions and fluxes for $\sim 4.7 \times 10^8$ point sources in the J, H and K_S photometric bands. In this work, we present a systematics for the identification of eclipsing binaries in OGLE-II that have infrared counterparts in the 2MASS survey. To do this, we used the Principal Component Analysis as a selection tool.

Key Words: binaries: eclipsing — catalogs — methods: data analysis — surveys

1. INTRODUCTION

Thousands of light curves of variable stars have been obtained as by-products of several surveys in search for gravitational microlensing events towards the Magellanic Clouds and Bulge of the Galaxy (Paczynski et al. 1994; Grison et al. 1995; Alves et al. 1998).

The huge quantity of photometric data obtained in these surveys requires automatic methods for the classification of the variable stars in different classes. Eclipsing binaries were extracted from these surveys by means of different methods (Udalski et al. 1998; Wyrzykowski et al. 2003; Devor 2005). The last author developed an automated pipeline that identifies eclipsing binaries and fits their light curves to a simple binary system model. He found 10000 eclipsing binaries in the galactic bulge fields searching the OGLE-II data. In this work, we present an alternative method for detecting eclipsing binaries in a large data set.

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2. SELECTION OF ECLIPSING BINARIES: THE METHOD

2.1. *2MASS counterparts of OGLE II variables*

To search for counterparts of the 200000 OGLE variable stars (Wozniak et al. 2002) we built a query to the 2MASS database and selected sources coincident to better than 2 arcsec in position. Additionally, the cc_flg flag and ph_qual flag were examined to avoid poor quality identifications. A total of 86356 objects fulfill the above criteria and were considered 2MASS counterparts of the OGLE sources.

2.2. *Characteristics of the Light Curves*

We summarized the properties of each source with a set of 9 parameters: the color index $J - K_{\rm S}$, the $K_{\rm S}$ magnitude, the I median magnitude of the light curve, a Q-parameter similar to the definition in Johnson & Morgan (1953), the scatter in the light curve, σ^*, its asymmetry S (similar to *skewness*), the spread of the tales of the distribution, k^*, (similar to *kurtosis*), and the maximum and minimum with respect to the median of the light curve, ($V_{\rm max}$ e $V_{\rm min}$, respectively). Formally,

$$\sigma^* = \frac{(P_{75} - P_{25})}{1.349}\,, \tag{1}$$

$$S = \frac{(P_{95} - P_{50})}{(P_{50} - P_5)} - 1\,, \tag{2}$$

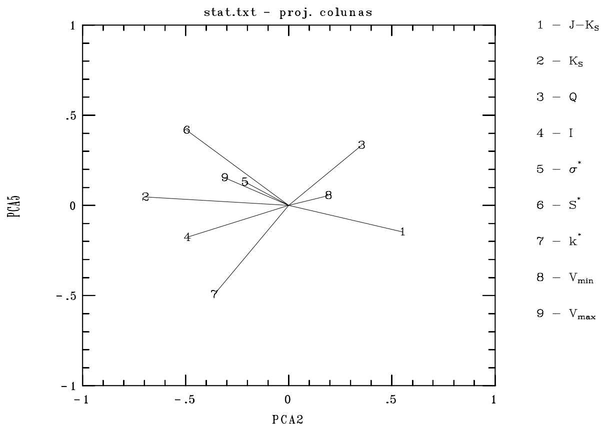

Fig. 1. Projection of the 9 input attributes on the plane of components PCA5 × PCA2.

$$k^* \ = \ \frac{(P_{95} - P_5)}{\sigma^*}, \qquad (3)$$

where P_X is the percentile X on the cumulative distribution defined by the light curve.

2.3. *Principal Component Analisys (PCA)*

The set of 86356 objects versus 9 attributes may be submitted to PCA analysis. We show here the results corresponding to PCA on the correlation matrix of the problem.

Figure 1 shows the projection of the attributes on the plane PCA5× PCA2. This diagram suggests that when projecting the individual objects in the same plane, eclipsing objects would show up in the upper part of the diagram. Since the majority of the variables with 2MASS counterparts are bright, pulsating objects, we found that a step further in discriminating eclipsing binaries is possible by selecting only objects to the left of the origin in the plane PCA5×PCA2. This produces 15876 candidates to eclipsing binaries. These candidates were searched for eclipses using the *string-length* method citep1983iue..prop.1682D. 1537 objects were found to have periodic light curves. Of these, 281 are eclipsing binaries. The results are summarized in Table 1 and a few examples are shown in Figure 2.

3. CONCLUSIONS

The number of eclipsing objects in OGLE that have 2MASS counterparts is surprisingly small when compared to the number of binaries in the OGLE sample as a whole (Devor 2005). The reason for this is a combination of shallower sensitivity of 2MASS when compared to OGLE and the presence of a population of bright red objects that are identified as regular and semiregular pulsating objects and that show up easily in the 2MASS survey.

TABLE 1

BINARIES OGLE-2MASS

Type	Number
Algol	110
β Lyrae	48
W UMa	123
Total Number: 281	

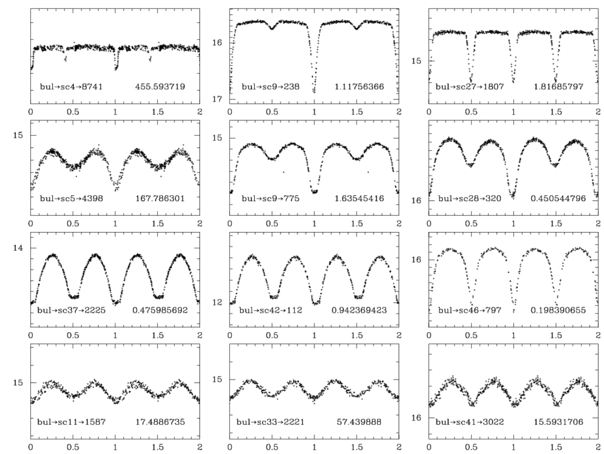

Fig. 2. Examples of OGLE eclipsing binaries with 2MASS counterparts. From top to bottom: EA, EB, EW type and Ellipsoidals.

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