ASTROPHYSICAL STUDIES OF VISUAL DOUBLE STAR BY AMATEURS

F. M. RICA[1,2]*, R. BENAVIDES[1,3] & E. MASA[1,4]

[1]LIADA's Double Star Section (Argentina); [2]Astronomical Society of Mérida (Spain);
[3]Astronomical Society of Córdoba (Spain); [4]Astronomical Society of SYRMA (Valladolid, Spain)

* e-mail: frica0@terra.es

Abstract

LIADA's Double Star Section has as main goal to perform measures of relative astrometry of neglected and unconfirmed pairs, as well as to determine the astrophysical parameters for their members and classify them, according to their nature, as phisical, common origin, common proper motion or optical pairs. BVIJHK photometry, relative astrometry and kinematical data against other astrophysical parameters, are obtained from literature to characterize the stars and the systems. Spectral types and luminosity classes are determined by using several tables, two colours and reduced proper motion diagrams. According to their nature double stars are classified by using several professional criteria. New binaries have been discovered. Since 2001 LIADA has studied about 500 visual double stars, has discovered about 175 true binary and has discovered several white dwarfs, subdwarfs and nearby stars.

Introduction

LIADA's Double Star Section started studing wide visual double stars in 2001. Our group is composed of amateurs and has as main goal to perform measures of relative astrometry of these neglected and unconfirmed pairs, as well as to determine the astrophysical parameters for their members and, according to their nature, to classified them as phyisical, common origin, common proper motion or optical pairs.

CCD cameras, micrometric eyepieces, photographic plates from Digitalized Sky Survey (DSS) and other surveys were used to perform our astrometric measures. We use astrometric catalogs such as Two Micron All Sky Survey (Cutri 2000, hereafter 2MASS) and Astrographic Catalog 2000 to increase the astrometric data. This measures in addition to BVIJHK optical-to-infrared photometry (from Tycho-2 and 2MASS mainly) and historical relative astrometry (from WDS) allowed us to obtain spectral types, photometric parallaxes, relative motions and other astrophysical parameters to classify visual double stars as physical, common origin or optical. We used several professional criteria to make the classification.

Consulting astronomical literature

Astronomical literature was consulted in order to obtain photometry, astrometry and kinematic data against others. VizieR, Simbad (Wenger et al. 2003) and the "services abstract" tools were used from the website of Centre De Données Stellaires de Strasbourg (CDS). Photometry in B, V and I bands came from Hipparcos (ESA 1997) and Tycho-2 catalogs (Hog E. et al. 2000). Infrared J, H and K photometry came from 2MASS. Proper motions mainly came from Tycho-2 and UCAC-2 catalogs. Historical astrometric data were kindly supplied by Mason. Spectral types and other astrophysical data were taken from several sources. Brian Mason maintains the Washington Double StarCatalog (WDS) at the U.S. Naval Observatory.

Spectral Types and luminosity classes estimates

Spectral types and luminosity classes are determined from BVJHK photometry and stellar proper motion. Several color-spectral type relations are used from literature (Bessell & Brett 1988, Kron 1988). In addition to this two color diagrams and several reduced proper motion diagrams (Jones 1972, Salim Salir 2002, Nelson 2003) are used to obtain the luminosity class. These diagrams relate the observational photometric data and proper motions with a parameter that is characteristic of a stellar population (dwarfs, giants, subdwarfs, white dwarfs...). Spectral types are corrected by reddening by using several maps (Neckel, 1980; Paresce 1984; Burstein, Heiles 1984; Schlegel, Finkbeiner, & Davis 1998).

Studing the nature of the visual doubles

Several criteria were used to determine if the components are gravitationally bounded. These criteria make use of photometric, astrometric, kinematic and spectroscopic data. Relative proper motions are calculated by plotting rectangular coordinates $x = \rho * \sin \theta$ and $y = \rho * \cos \theta$ (prior correction of θ by precession and proper motion) against time. The slope of the weighted linear fit give the value of the relative proper motion in $arcsec*yr^{-1}$. The criteria used to determine if the components can describe a Keplerian motion analyzed photometric, astrometric, kinematical and spectroscopic data (Dommanget 1956; Sinachopoulos 1992; van de Kamp 1961). The Halbwachs' criterion (1986) which make use of the relation between common proper motion and angular separation is also used.

Results

Our results obtained since 2001 are listed in Table 1. 868 measures for 392 dobule stars were added to WDS catalog. Many papers were published in Double Star Observers, Journal of Double Star Observations and Webb Society's circulars. A Double Star Section is edited in AstronomíA, the main spanish astronomical magazine, since two years ago. Nowaday we are studing 174 uncataloged common proper motion pairs which 143 are new binaries discovery by us.

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Figure 1. The search for information in astronomical literature is needed when an astronomical investigation is carried out. ADS and CDS web sites centralizes images from surveys, astronomical literature and catalogs.

Figure 2. The spectral distribution of the energy of a star is compared with those one obtained in published tables in literature. An automatic routine determines the spectral type with best fit to the observed photometry.
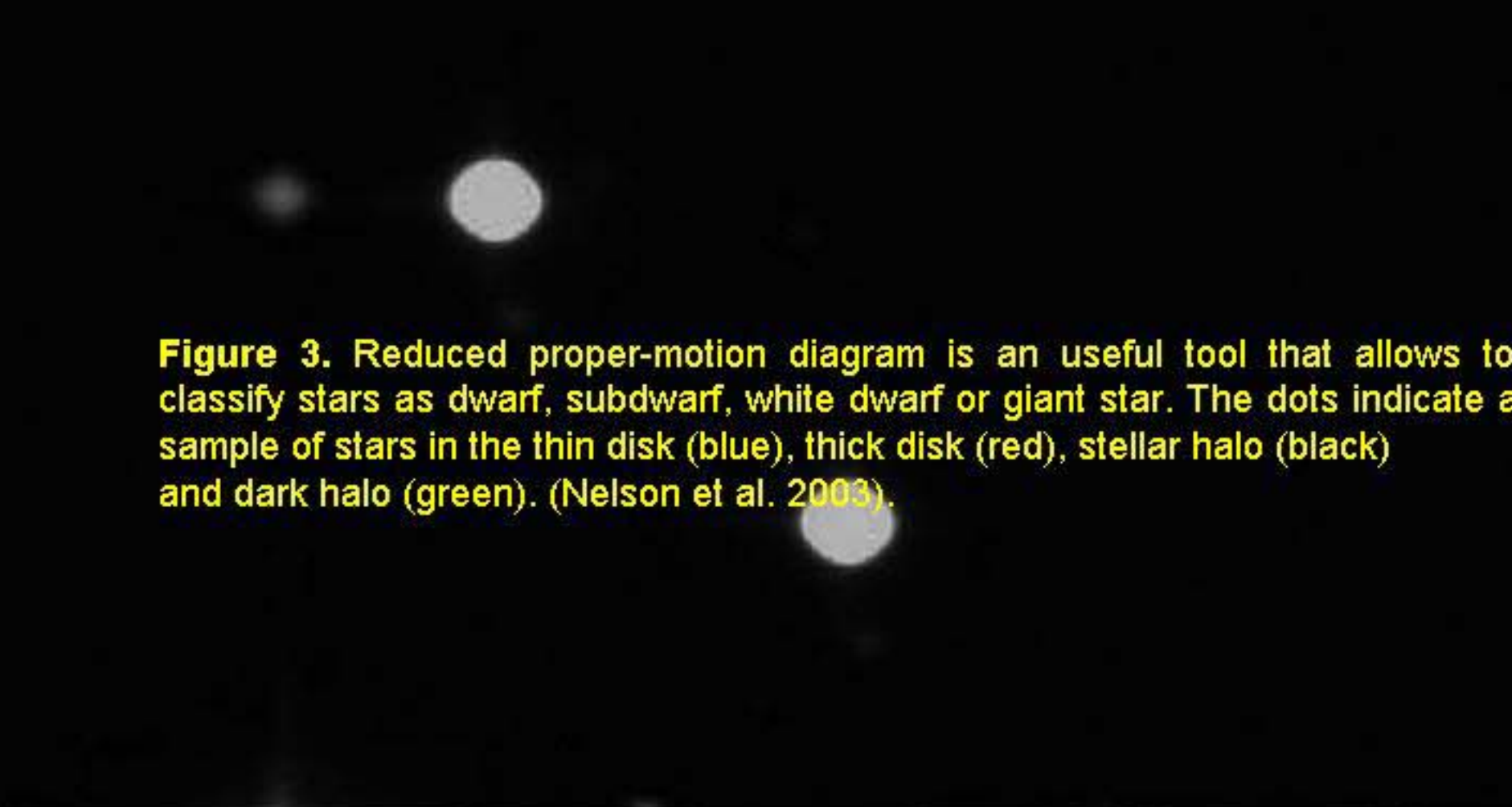

Figure 3. Reduced proper-motion diagram is an useful tool that allows to classify stars as dwarf, subdwarf, white dwarf or giant star. The dots indicate a sample of stars in the thin disk (blue), thick disk (red), stellar halo (black) and dark halo (green). (Nelson et al. 2003).
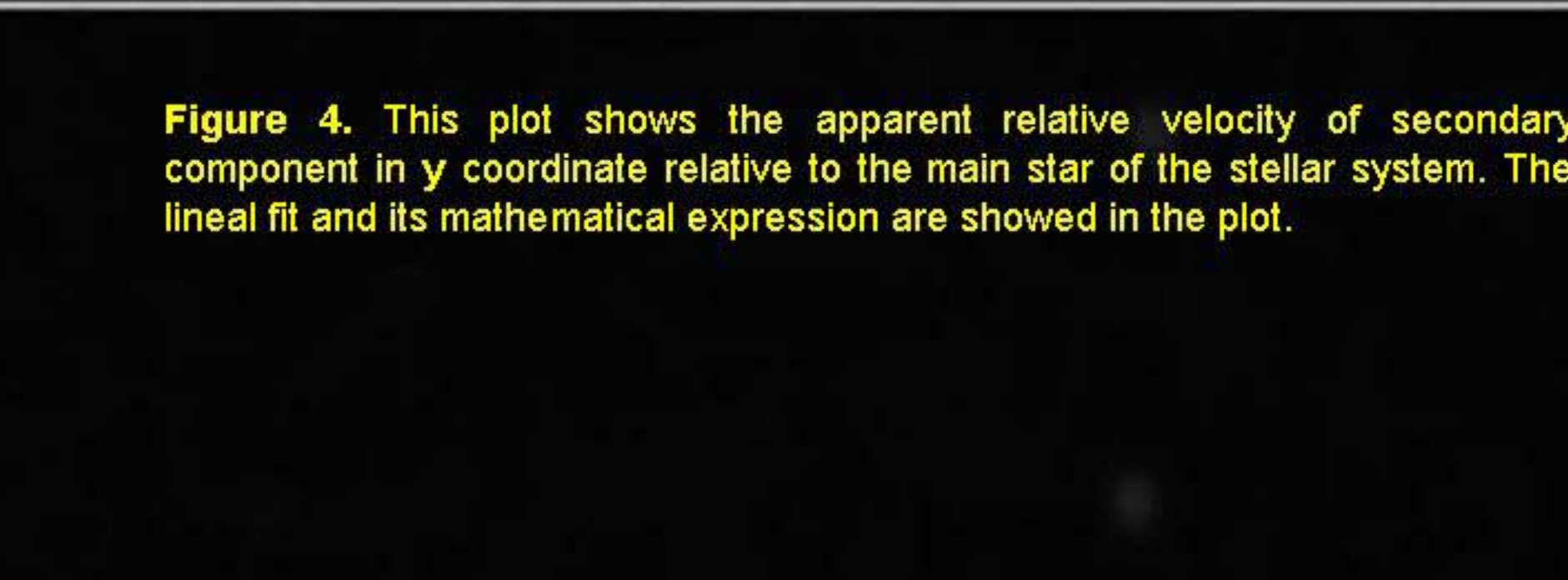

Figure 4. This plot shows the apparent relative velocity of secondary component in y coordinate relative to the main star of the stellar system. The lineal fit and its mathematical expression are showed in the plot.

Figure 5.
[Left] Members of LIADA's Double Star Group have discovered about 150 wide new visual binary stars. The image shows one of those new binaries.

[right] Since several months ago LIADA's Double Star Group is calculating new orbital parameters for binaries. The image shows a new orbit for A 1205.
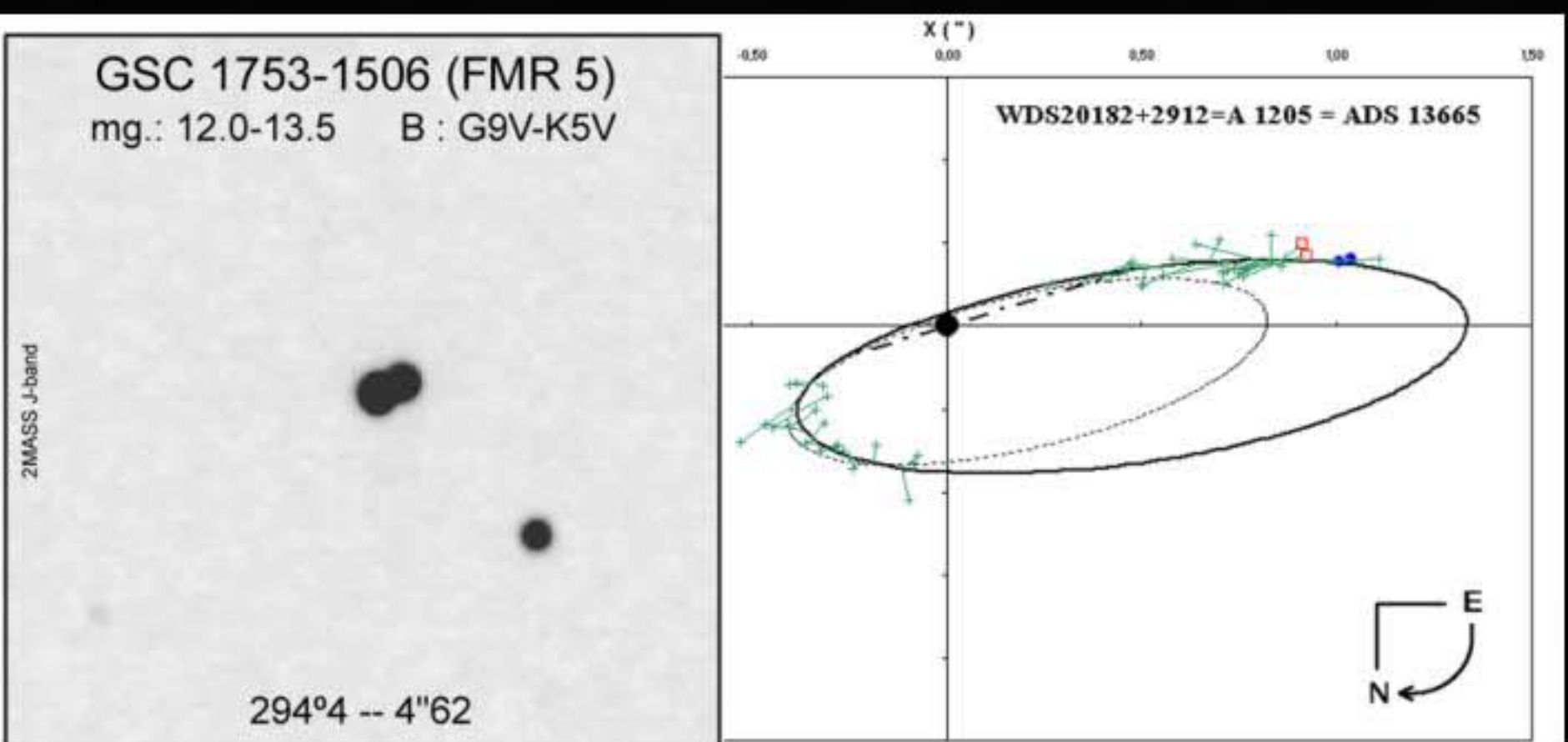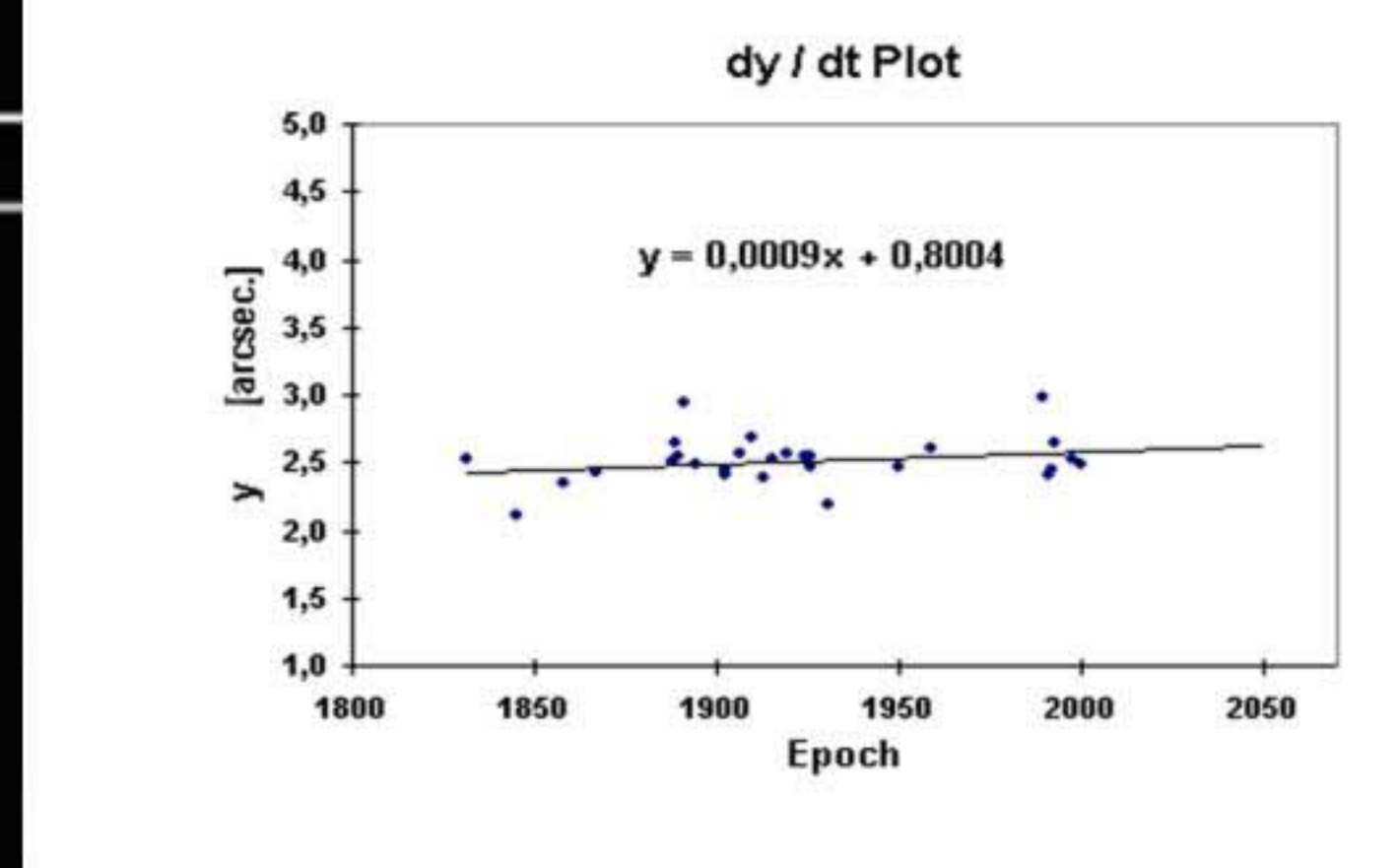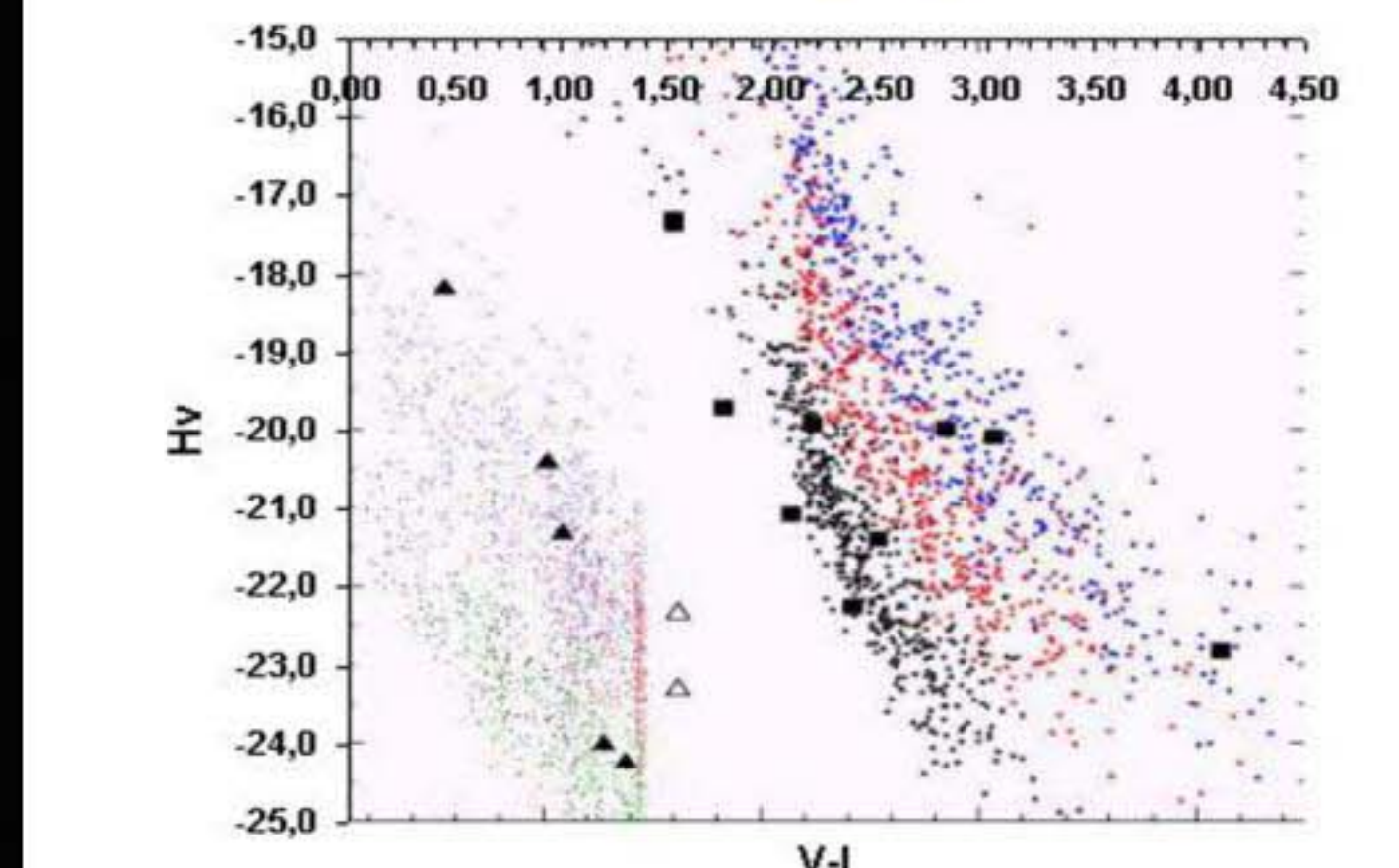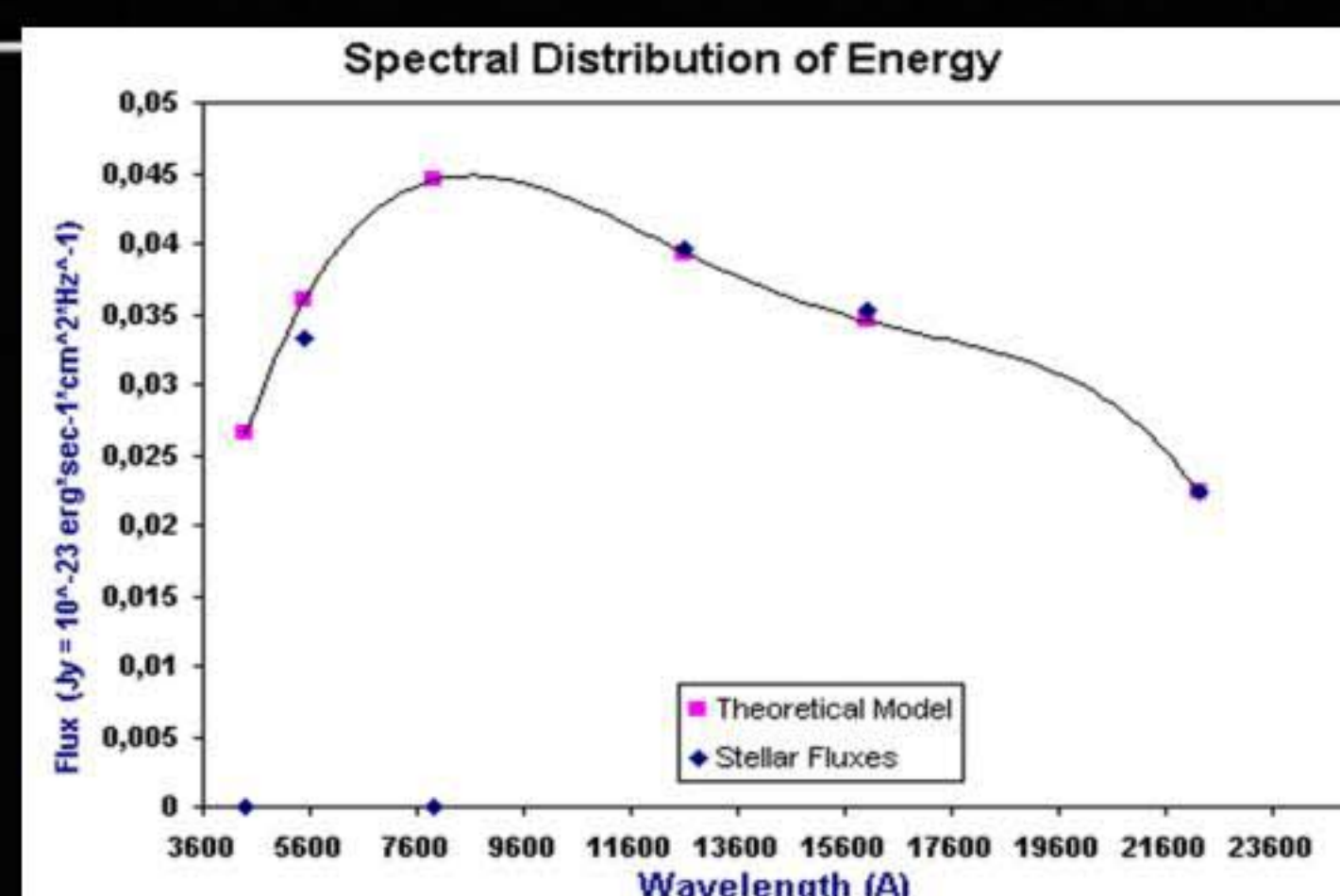
Figure 6.
[Left] Double Star Section of LIADA edite a circular twice a year where the results of the group and formation articles are published.

[right] The Journal of Double Star Observations (JDSO) publishes articles on any and all aspects of astronomy involving double and binary stars. LIADA usually publish their results in JDSO.

Table I. LIADA's Results

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Measures............ 868
Doubles studied..... 392
  - Optical.......... 228
  - Physical......... 37
  - Commom Origin.... 24
Doubles Discovered.. 23
Orbits calculated...  5
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