A SPECKLE SURVEY OF SOUTHERN HIPPARCOS VISUAL DOUBLES AND GENEVA-COPENHAGEN SPECTROSCOPIC BINARIES

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RESUMEN

Presentamos un survey de estrellas dobles visuales de Hipparcos y de binarias espectroscópicas identificadas en el survey de Geneva-Copenhagen, utilizando la técnica de interferometría de motas con el telescopio SOAR de 4m + HRCam. Estos sistemas representan la mejor posibilidad de utilizar los datos de *Gaia* para determinar masas estelares con muy alta precisión. Muchos de estos sistemas ya tienen fracciones de masas (aún cuando no tienen órbitas espectroscópicas - órbitas astrométricas determinarán sus masas individuales), información de metalicidad, y distancias de Hipparcos. Estos objetos serán usados para mejorar nuestro conocimiento sobre la relación masa-luminosidad, especialmente para estrellas de baja metalicidad. Nuestro survey creará el primer archivo de todo el cielo, restringido en volúmen, para las dos muestras principales, complementando un esfuerzo similar que se ha completado recientemente con el telescopio WIYN de 3.5-m en el hemisferio norte. La extensión al hemisferio sur permitirá ampliar la muestra a un rango mas amplio de metalicidades.

ABSTRACT

We present a speckle survey of Hipparcos visual doubles and spectroscopic binary stars identified by the Geneva-Copenhagen spectroscopic survey with the SOAR 4m telescope + HRCam. These systems represent our best chance to take advantage of *Gaia* parallaxes for the purpose of stellar mass determinations. Many of these systems already have mass fractions (although generally no spectroscopic orbit - an astrometric orbit will determine individual masses), metallicity information, and Hipparcos distances. They will be used to improve our knowledge of the mass-luminosity relation, particularly for lower-metallicity stars. Our survey will create the first all-sky, volume-limited, speckle archive for the two primary samples, complementing a similar effort that has been recently been completed at the WIYN 3.5-m telescope in the Northern Hemisphere. This extension to the Southern Hemisphere will fill out the picture for a wider metallicity range.

Key Words: (stars:) binaries: visual — astrometry — techniques: high angular resolution — surveys

1. THE SPECKLE SURVEY

The prospect of exquisite-precision parallaxes that will be enabled by the *Gaia* satellite dramatically changes the landscape of observational stellar astrophysics: If one considers the *Hipparcos* double stars that lie within 250 pc of the Solar system, a parallax determined by *Gaia* would (conservatively) yield an uncertainty well under 1% for all these objects. Howevever, to make full use of these high-quality data, binaries should be resolved, and their orbits determined (as was the case with *Hipparcos*). Indeed, *Gaia* will not resolve equal-brightness systems with separations smaller than ∼0.1 arcsec (final processed data ∼2022). A single sweep of the on-board star mapper will detect stars 0.3/0.7 arcsec (along/cross scan) apart (Altman & Bouquilllon 2016). Also, in some cases the "blob" will introduce large astrometric residuals. Thus, further improvements on the Mass-Luminosity relationship (MLR) using *Gaia* parallaxes, photometry and spectroscopy, hinges upon resolving these systems from the ground or space. We also need to follow these objects on medium to long term-scales to determine their orbits.

In the volume within 250 pc, there are 591 *Hipparcos* double star discoveries and 160 spectroscopic binaries from the Geneva-Copenhagen spectroscopic survey in the declination range of -20° to -90° (see Figure 1). These two samples are important as a source of new binaries from which one can derive masses, component luminosities, and effective temperatures in the coming years. The northern hemisphere counterpart of these objects have been systematically observed at the WIYN Telescope by Horch, van Altena, and their collaborators (e.g. Horch et al. 2011). On the other hand, Tokovinin (2012, Tokovinin et al. 2014) has shown the abil-

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ity of HRCam at the CTIO/SOAR 4m telescope for binary star research, allowing diffraction-limited speckle imaging (∼35 mas) at optical wavelengths for objects down to V∼12, and producing significant results. In this poster we present some aspects of our on-going speckle survey, started in 2014 with SOAR+HRCam, and which will complement and significantly extend those previous efforts, allowing us to compile a unique all-sky, volume-limited speckle survey of these two primary samples.

The immediate scientific return of our survey will be threefold. First, for the Hipparcos sample, we will be able to combine the astrometry obtained by us with data from the literature (Hipparcos and other sources) to identify all Southern fast-moving pairs. In cases where there is at least one other observation besides Hipparcos, we will be able to make a determination as to whether orbital motion is observed. Second, we anticipate resolving roughly 20% of the spectroscopic sample for the first time. This will provide a list of stars for which mass ratios already exist and whose orbital periods will typically be short ($P < 10$ years). With follow up observations over the next several years, we can then determine orbits and individual masses of the components. Third, for all resolved systems, we will be able to derive magnitudes and colors for the components. This is important for connecting mass information to luminosity and temperature. In the longer term, if sustained observations of the interesting systems discovered by our survey can be made, orbital information will be forthcoming on a timescale comparable to that of *Gaia* parallaxes, completing the path to high-precision masses, luminosities, and colors for the stars in these systems.

So far 12 nights (spread over 3 semesters) have been granted through the Chilean reserved time, with lots of binaries confirmed, many new binaries found, and with several multiple systems discovered (Tokovinin et al. 2015, 2016).

Our survey, when complete, will open the door to many sensitive tests of stellar evolution theory, and a large number of new points on the MLR. With this we will truly be able to investigate effects such as metallicity and age on the MLR for the first time. In cases where one component has evolved off the main sequence, age determinations will also be possible.

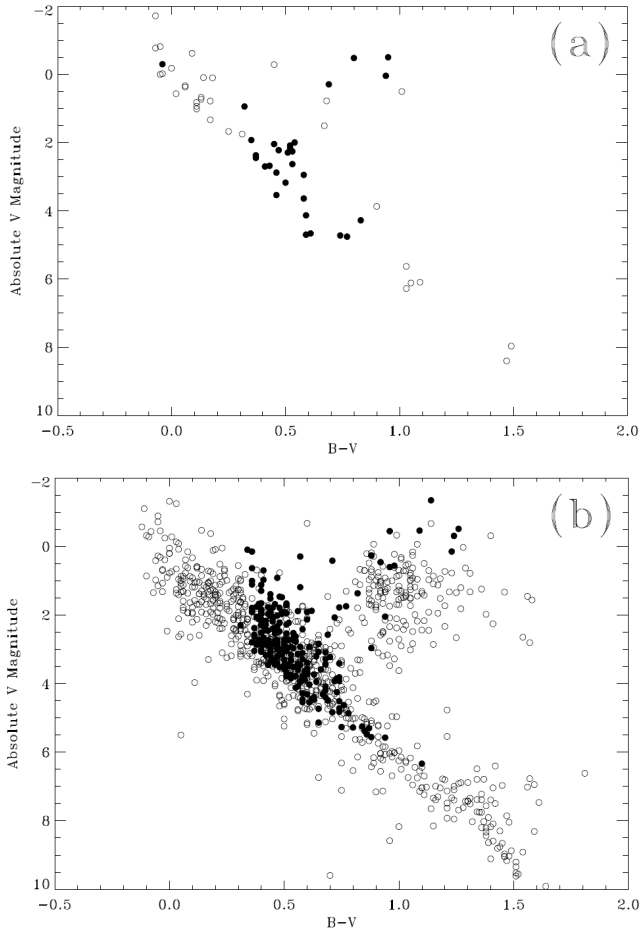

Fig. 1. H-R diagrams for two samples of binaries. (a) Binaries with ≤1% uncertainty in the semi-major axis, drawn from the latest update of the USNO Orbit Catalog by Hartkopf, Mason, & Worley (2001). These are systems that can yield high-precision masses at present. (b) The double stars discovered by *Hipparcos* within 250 pc of the Sun, the key sample of our SOAR survey. Stars with high-precision metallicities in the literature are shown as filled circles. The sample in the lower panel will dramatically improve our knowledge of the MLR and stellar astrophysics.

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