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Spectroscopic orbits of potential interferometric binaries

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Abstract. We are obtaining high-resolution, red-wavelength spectra at McDonald and Kitt Peak National Observatory to improve the orbits of known spectroscopic binaries that are potential targets for ground-based optical interferometers. The combination of such observations will produce three-dimensional orbits from which very accurate masses and orbital parallaxes can be obtained for double-lined systems. This spectroscopic program will be expanded and placed on the menu of the 2 meter Automatic Spectroscopic Telescope of Tennessee State University once it commences routine operation.

Key words: binaries: spectroscopic

1. Introduction

As several ground-based interferometers such as the Palomar Testbed Interferometer (PTI) (Colavita et al. 1999), the Naval Prototype Optical Interferometer (NPOI) (Hummel et al. 2003), the Infrared Optical Telescope Array (IOTA3) (Traub et al. 2003), and the Center for High Angular Resolution in Astronomy (CHARA) array (ten Brummelaar et al. 2003) begin routine science operation, the period overlap of spectroscopic and visual binaries will be greatly enhanced, providing an opportunity to determine very accurate masses plus orbital parallaxes more accurate than those from *Hipparcos* for a significant number of systems.

The Eighth Catalogue of the Orbital Elements of Spectroscopic Binary Systems (SB8) (Batten, Fletcher, & MacCarthy 1989) lists 1469 systems. For many of those systems only one component was detected in the spectrum, currently making them useless for accurate mass determination. In addition, many orbits were based on moderate-resolution photographic plates, obtained well before the advent of radial-velocity spectrometers and CCD detectors. Such orbits of double-lined binaries are not good enough to be usefully combined with the interferometric results.

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2. Sample

To improve this situation, we searched SB8 for double-lined binaries that might be resolved interferometrically and could profit significantly from renewed spectroscopic observation with modern CCD detectors. An initial list included 83 stars north of $-30°$ and generally brighter than $V = 7.5$. In the hope of turning useless single-lined systems into valuable double-lined ones (e.g. Stockton & Fekel 1992), we also added to our list 50 single-lined binaries with mass functions greater than 0.05 $M_\odot$.

Table 1 lists 33 systems that we are currently observing. Given are the HD number, the *V* mag, spectral type of the primary, the orbital period, and the greater nodal separation (GNS). This last quantity is the predicted lower limit to the angular separation (in milliarcseconds) of the components, unaffected by projection on the sky, as computed by Taylor, Harvin, & McAlister (2003).

The program stars have spectral classes of A, F, or G and are mostly dwarfs or subgiants. The orbital periods range from 3 to 219 days. The GNS values of the double-lined binaries range from 0.6 to 12.2 milliarcseconds.

3. Observations

We are currently obtaining spectrograms at two observatories. Our observations at McDonald Observatory are acquired with the 2.1 m telescope and the Sandiford Cassegrain echelle spectrograph. Those spectra cover the wavelength

Table 1. Current Observing List

HD	V (mag)	Spectral Type	P (days)	GNS (mas)
8374	5.6	F1m	35.4	4.9
9021	5.8	F6V	134.1	...
9312	6.8	G5IV	36.6	...
20210	6.2	F0m	5.5	...
30453	5.9	F0m	7.0	0.9
40084	5.9	G5III	219.1	3.8
40183	1.9	A2V	4.0	3.2
42083	6.2	A5III	106.0	9.3
44691	5.6	A8m	9.9	1.8
61859	6.0	F7V	31.5	5.9
73619	7.5	Am	12.9	...
82191	6.6	Am	9.0	0.9
86146	5.1	F5V	9.3	1.3
102713	5.7	F5IV	32.9	...
103578	5.5	A3IV	6.6	...
108642	6.5	A2m	11.8	...
112486	5.8	A8m	5.1	0.8
120005	6.6	F5	39.3	...
120064	6.0	F6IV	36.0	5.3
123299	3.6	A0III	51.4	...
123999	4.8	F8IV	9.6	3.5
125377	4.5	A3Vm	206.6	...
141458	6.8	A0V	28.9	1.8
148367	4.6	A5Vm	27.2	5.8
149632	6.4	A1IV	10.6	1.3
168913	5.6	F0m	5.5	1.3
171978	5.8	A2V	14.7	0.6
182490	6.2	A1III	7.4	0.8
203439	6.0	A1IV	20.3	1.6
203454	6.4	F8V	3.2	...
205539	6.3	F2IV	12.2	2.2
214686	6.9	F7V	21.7	5.5
221950	5.7	F6V	45.5	12.2

range 5600Å to 7000Å and have a resolving power of 60,000. Additional spectroscopic observations are collected with the Kitt Peak National Observatory coudé feed telescope, coudé spectrograph, and a Texas Instruments CCD. The observations are centered at 6430 Å, cover a wavelength range of about 80 Å, and have a resolution of over 30,000. Typical signal-to-noise ratios of the spectra are 250.

4. Results

We have detected the secondaries of seven single-lined binaries, HD 9021, HD 9312, HD 20210, HD 102713, HD 103578, HD 108642, and HD 120005. Fig. 1 shows a spectrum of HD 20210 in the 6430 Å region. Our spectra of HD 148367 show three sets of lines, and our radial velocities of HD 108642 have systematic residuals, so those two systems are at least triple.

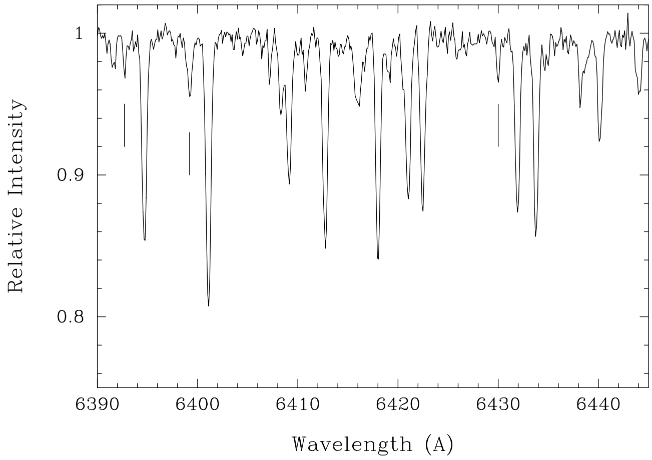

Fig. 1. Spectrum of HD 20210. Tick marks = component B.

Preliminary results show significant revisions for some systems. For example, the masses of HD 168913, given in SB8 as 1.1 and 0.93 $M_{\odot}$, have been revised to 1.32 and 1.12 $M_{\odot}$ and have much smaller uncertainties. Indeed, the previous results of Tomkin (2003) show that, in favorable cases where both components have sharp lines and are of similar brightness, radial velocities from the McDonald Observatory 2.1 m telescope produce orbital elements that result in minimum masses with accuracies of 0.2% and linear separations good to 0.1%. We anticipate similar results when our expanded program is placed on the 2 m Automatic Spectroscopic Telescope of Tennesse State University. Clearly, our observations will result in significantly improved orbits, enabling very accurate masses and parallaxes to be determined once interferometric observations have been carried out. The work of Boden, Creech-Eakman, & Queloz (2000) and Hummel et al. (2001) demonstrates the excellent results possible from the combination of high quality spectroscopic and interferometric observations.

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