

## SPECKLE OBSERVATION OF VISUAL DOUBLE STARS AT BOSSCHA OBSERVATORY: SEPARATION AND MAGNITUDE DIFFERENCE LIMITS

I PUTU WIRA HADIPUTRAWAN<sup>†1</sup>, MAHASENA PUTRA<sup>1,2</sup>, MOCHAMAD IRFAN<sup>2</sup>, AND MUHAMMAD YUSUF<sup>2</sup>

<sup>1</sup>Department of Astronomy, Faculty of Mathematics and Natural Science, Institut Teknologi Bandung, Indonesia

<sup>2</sup>Bosscha Observatory, Faculty of Mathematics and Natural Science, Institut Teknologi Bandung, Indonesia

*E-mail: wira.hadiputrawan@gmail.com*

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### ABSTRACT

We present the results of visual double stars speckle observations from 2013 using a Zeiss Double Refractor 60 cm with visual focal length  $f = 1,078$  cm, and CCD SBIG ST-402 MEA. A Bessel V filter with  $\lambda = 550$  nm was placed in front of the CCD camera to reduce the chromatic aberration of the objective lens. The objects selected for this observation were calibration candidates and program stars with separations ranging from 0.9–6 arc second, and were located in both the northern and southern hemispheres. Seeing at Bosscha Observatory is generally 1–2 arc second, imposing a limit on visual double star separation below which the system cannot be resolved by long exposure imaging (longer than  $\sim 50$  ms). Speckle interferometry methods are used to resolve double stars with separations below the typical size of seeing effects. A series of images were captured in fast short-time exposures ( $\sim 50$  ms) using a CCD camera. The result of our experiment shows that our system can be used to measure separations of 0.9 arc second (for systems with small  $\Delta m$ ) and  $\Delta m \approx 3.7$  (for wide systems).

*Key words:* star: imaging - double star: visual - atmosphere effect - technique: interferometry.

### 1. INTRODUCTION

Ground-based observation are very dependent on atmospheric effects. Visual double stars which have separations smaller than the seeing disk cannot be resolved with long exposures. In 2012, Bosscha Observatory started using interferometry methods to make a series of image using fast short-time exposure (see Yusuf et al. 2012). This method is used to resolved visual double stars with separations below the typical size of seeing effects. In this paper we present the observational results of 2013.

### 2. OBSERVATIONS

The observation from June to August 2013 used instrument configurations and observation techniques similar to the previous project (see Yusuf et al. 2012). The target stars were divided into program stars and calibration candidates stars which were observed with 40 ms exposure times. The program star were chosen from **The Washington Double Star Catalog** and the calibration candidate stars from **Sixth Catalog of Orbit of Visual Double Star**.

### 3. RESULTS

All reductions were made with a version of REDUC dedicated to speckle interferometry. After processing a series of images REDUC provides an autocorrelogram which consist of a series of images that are processed by subtracting a median mask in order to reveal the peaks. The program star measurement uses the calibration candidate star as the calibrator. See Table 1 for the result for the program stars, Table 2 for the list of calibration candidates star taken from **Sixth Catalog of Orbit of Visual Double Star** and Table 3 for the cross-check of calibration candidates stars with WDS 17153-2636 used a the calibrator.

### 4. CONCLUSIONS

The result of our experiment shows that our system can be used to measure separations of 0.9 arc second (for systems with small  $\Delta m$ ) and  $\Delta m \approx 3.7$  (for wide systems).

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<sup>†</sup>The actual author of this document; additional dummy authors have been added for illustration purposes only.

Table 1  
THE MEASUREMENT RESULTS OF PROGRAM STARS

WDS ID	m <sub>1</sub>	m <sub>2</sub>	Epoch	$\rho$ ( $''$ )	$\sigma_\rho$ ( $''$ )	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )
16044-1122	5.16	4.87	2013.474	0.929	0.09	359.65	0.1
			2013.564	0.792	0.082	2.06	0.08
			2013.567	0.925	0.021	2.22	0.85
			2013.570	0.787	0.076	2.73	1.15
			2013.589	0.981	0.074	1.57	0.03
18031-0811	5.27	5.86	2013.540	1.452	0.076	287.2	0.61
20289-1749	4.97	6.88	2013.564	1.216	0.003	186.33	0.58
			2013.622	1.415	0.005	188.64	0.33
			2013.627	1.767	0.088	183.33	1.24
			2013.630	1.485	0.101	190.02	1.69
21199-5327	4.5	6.93	2013.625	7.061	0.009	269.38	0.04
22008-2827	5.7	6.77	2013.630	1.808	0.03	112.59	0.26
22143-2104	5.63	6.72	2013.592	5.156	0.014	112.15	0.22
			2013.622	5.146	0.024	111.37	0.21
22525-3253	4.50	8.20	2013.622	4.126	0.071	255.67	0.49
23333-2055 <sup>a</sup>	4.76	7.68	2013.589	..	..	..	..
			2013.630	..	..	..	..

<sup>a</sup> WDS 23333-2055 cannot be measured because this system has a magnitude difference beyond our instrumental limit.

Table 2  
THE CALIBRATION CANDIDATE STARS

WDS ID	m <sub>1</sub>	m <sub>2</sub>	$\rho$ ( $''$ )	$\theta$ ( $^\circ$ )
17153-2636	5.12	5.12	4.999	141.6
17191-4638	5.61	8.88	10.088	257.0
18055+0230	4.22	6.17	6.066	128.1
22266-1645	6.29	6.39	1.276	51.7

Table 3  
THE CROSS-CHECK OF CALIBRATION CANDIDATE STARS

WDS ID	Epoch	$\rho$ ( $''$ )	$\sigma_\rho$ ( $''$ )	$\theta$ ( $^\circ$ )	$\sigma_\theta$ ( $^\circ$ )
17191-4638	2013.627	11.758	0.011	250.91	0.1
18055+0230	2013.630	6.107	0.024	127.39	0.08
22266-1645	2013.589	1.03	0.088	58.51	0.18

## REFERENCES

Yusuf, M., Mandey, D., Hadiputrawan, W., Putra, M. & Irfan, M., 2012, Speckle Observation of Visual Double Stars at Bosscha Observatory, AIP Conference Proceedings (Eds. M.Djamal et al), 1589, 49  
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