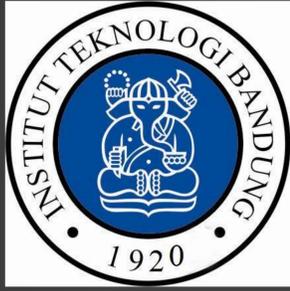


Speckle Observation of Visual Double Stars at Bosscha Observatory : Separation and Magnitude Difference Limits



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Background

The aim of visual double star observation is to build the apparent orbit of the system. From the observation we can get **separation (ρ)** and **position angel (θ)** of the system. Within the whole period we can build the **apparent ellipsis**. Ground-based observation very depending on **atmosphere effect**. Visual double star which has separation smaller than seeing disk can not be resolved when it take a long exposure time. Since 2012 Bosscha Observatory started to use **speckle interferometry** method to make a series of image using fast short-time exposure. This method is used to resolved the visual double star with separation below typical size of seeing effect. In this poster we present the observation result during 2013.

Introduction

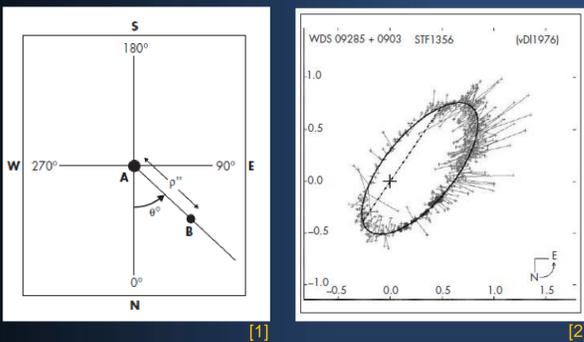


Fig 1. Separation and PA of visual double star from the observation lead to build apparent orbit when the system observed in whole period.



Fig 2. Seeing effect, from I-V indicates the diffraction pattern.

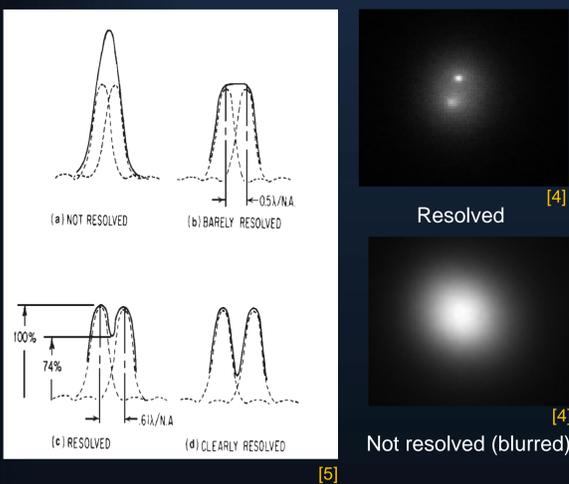


Fig 3. Left image : Dotted line indicates diffraction pattern from two point source depend on their distance. Solid line indicates the combination of diffraction pattern. Right image : the example image of visual double star which can resolved when seeing is good and blurred when seeing is very bad.

Observation Data

Tanggal Pengamatan	Data yang Diperoleh	WDS ID	Jumlah frame citra
22 Juni 2013	STF 1998 AB	16044-1122	999
16 Juli 2013	SHJ 243 AB (CC)	17153-2636	1.998
	STF 2262 AB	18031-0811	1.998
25 Juli 2013	STF 1998 AB	16044-1122	1.983
	SHJ 243 AB (CC)	17153-2636	1.964
	SHJ 323 AB	20289-1749	2.148
26 Juli 2013	STF 1998 AB	16044-1122	1.945
27 Juli 2013	STF 1998 AB	16044-1122	999
3 Agustus 2013	STF 1998 AB	16044-1122	1.998
	SHJ 243 AB (CC)	17153-2636	1.945
	SHJ 345 AB (CC)	22266-1645	1.998
	B 1900	23333-2055	1.998
4 Agustus 2013	HN 56 AB	22143-2104	1.998
	SHJ 345 AB (CC)	22266-1645	240
15 Agustus 2013	BSO 13 AB (CC)	17191-4638	2.118
	SHJ 323 AB	20289-1749	1.998
	HN 56 AB	22143-2104	1.998
	HJ 5367	22525-3253	999
16 Agustus 2013	BSO 13 AB (CC)	17191-4638	2.018
	HJ 5258	21199-5327	604
17 Agustus 2013	BSO 13 AB (CC)	17191-4638	2.008
	SHJ 323 AB	20289-1749	2.997
	SHJ 345 AB (CC)	22266-1645	2.755
18 Agustus 2013	SHJ 243 AB (CC)	17153-2636	1.998
	STF 2272 AB (CC)	18055+0230	1.998
	SHJ 323 AB	20289-1749	1.998
	BU 276	22008-2827	1.998
	B 1900	23333-2055	1.998

Table 1. Observation log during 2013. The first column is observation date, second column are the target stars which are divided into **program star** and **calibration candidates star (CC)**, third column is WDS-ID of the star and the fourth column is total frame taken with exposure time **40 millisecond**. The program stars are selected from *The Washington Double Star Catalog* and the calibration candidates star are from *Sixth Catalog of Orbits of Visual Binary Stars*.

Results

WDS ID	m ₁	m ₂	Tanggal Pengamatan	ρ (")	σ_ρ (")	θ (°)	σ_θ (°)
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
			2013,564	1,216	0,003	186,33	0,58
20289-1749	4,97	6,88	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
			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	4,76	7,68	2013,589
			2013,630

Table 2. The measurement result of program star (the third column is epoch of observation). From this result we know the limit of the instrument. The WDS 23333-2055 can not be measured because this system has difference magnitude beyond our instrument limit.

WDS ID	m ₁	m ₂	ρ (")	θ (°)
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. Left : Calibration candidates star used to calibrate the measurement of program star. Bottom : the cross-check of calibration candidates star with the WDS 17153-2636 used to be the calibrator.

WDS ID	Tanggal Pengamatan	ρ (")	σ_ρ (")	θ (°)	σ_θ (°)
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

Results (continued)

All reductions are made with a version of REDUC dedicated to speckle interferometry[6]. It implements the autocorrelation functions and cross-correlation. The measurements are performed on the autocorrelation image. After processing a series of images REDUC provides an autocorrelogram and a series of images that are processed by subtracting a median mask in order to reveal the peaks. The program star measurement use the calibration candidate star as the calibrator.



Fig 4. The autocorrelogram of WDS 17153-2636 data taken August 16, 2013.

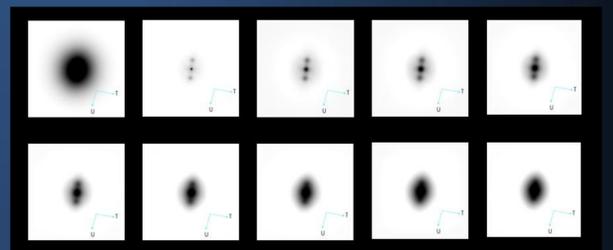


Fig 5. The autocorrelogram of WDS 16044-1122 data taken June 22, 2013

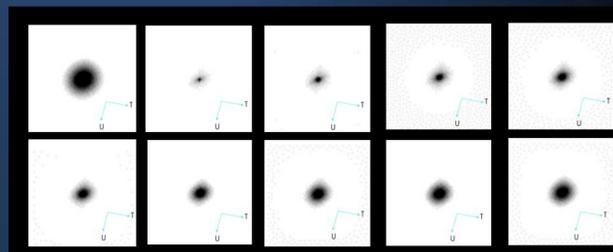


Fig 6. The autocorrelogram of WDS 23333-2055 data taken August 3, 2013

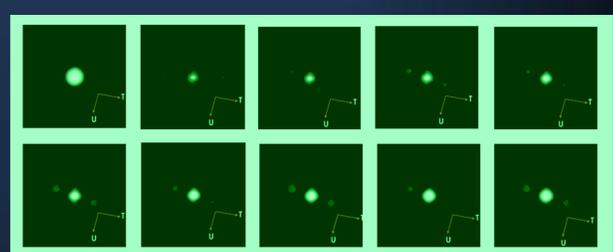


Fig 7. The autocorrelogram of WDS 22525-3253 data taken August 15, 2013

NB. The orientation symbol, U = North, T = East

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REFERENCES :

- [1] Argyle, B. 2004. *Observing and Measuring Visual Double Stars*. Springer-Verlag, London.
- [2] Muhammad Yusuf, Denny Mandey, I Putu Wira Hadiputrawan, Mahasena Putra, Mochamad Irfan, 2014, "Speckle Observation of Visual Double Stars at Bosscha Observatory", AIP Conference Proceedings (Eds. M. Djamal et al.), Vol. 1589, pp. 49-52.
- [3] http://www.ayton.id.au/gary/Science/Astronomy/Ast_viewing.htm
- [4] <http://www.astro.caltech.edu/~nlaw/thesis/thesisch1.html>
- [5] Smith, W. J. 2000. *Modern Optical Engineering*. Mc-Graw Hill. New York.
- [6] <http://www.astrosurf.com/hfosaf/uk/tdownload.htm>