DOUBLE STAR MEASUREMENTS IN OCTANS

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ABSTRACT:

This report details the results of 17 double star measurements made on April 2023 in the constellation Octans with the objective of updating the position angle (θ) and angular separation (ρ) values.

METHODOLOGY:

During the last month of April of this year 2023, a series of measurements of double stars belonging to the Octans constellation were performed due to the fact that there are no records after 2015 and some pairs have not been measured for more than 20 years despite having been discovered during the first half of the 19th century and 2 of them in the years 1900 and 1901.

The capture process was quite difficult because this constellation is at very low altitude and the pairs to be detected were between 20º and 40º, which caused the atmospheric turbulence to produce the undesirable and annoying optical distortion that we all know and suffer daily with the consequent increase of the error in the determinations.

For the measurements, a 150/750 (f5) Newtonian telescope with Dobson mount without tracking and a Logitech C270 camera modified to capture images with a resolution per pixel of 0.7728" and a frame size of 1280 x 720, controlled by SharpCap Version 3.1 software, further processing them with the free Reduc analysis software (developed by French astronomer Florent Losse) to obtain the angular separation (ρ) and position angle (θ) values, which were the objective of the measurement process.

The pixel scale was calculated as follows:

Resolution per Píxel = (Pixel size [µm]/Telescope focal length [m]) x 206265

Where:

- 2.81×10^{-6} m is the eigenconstant of a Logitech C270 camera.
- 750×10^{-3} m is the focal length of the telescope used.
- The factor "206265" is a conversion constant from radians to sexagesimal degrees.

Replacing the values:

Resolution per Píxel = (2.81×10^{-6} m/750×10^{-3} m) x 206265 = 0.77281"/pixel.

This analytically calculated per-pixel resolution value could be more accurately determined by calculating it by empirical tests using the drift method, i.e., timing the time it takes for a pair or star to obliquely traverse the field of view, multiplying that time by the cosine of the declination angle to project the path time horizontally, and knowing the size of each pixel in the camera, relate these values to the distance traveled by the pair obtaining the fraction of an arcsecond per pixel.

This method of empirical determination is much more reliable than the analytical calculation used because one can never be sure that the focal length of a standard manufactured telescope deviates by a few millimeters from the value stated by its manufacturer, as Richard

Harshaw explains in his paper “Calibrating a CCD Camera for Speckle Interferometry”, published in Journal of Double Star Observations | September 2015 | Vol. 11 No. 1S.

Since the telescope used has a Dobson mount without tracking, for the calculation of the camera orientation angle to obtain the position angle of the secondary component with respect to the primary component, the drift method was used, which consists of leaving the field of view fixed while the couple drifts.

For this purpose, the "Synthetic Drift" function of the Reduc was used, and of the 4 options it gave to choose from, only 2 of them corresponded to the southern hemisphere, so "West right, North up" and "West left, North down" were chosen according to the drift that occurred in each measurement.

The selection criteria were as follows:

Options that correspond to the southern

Options that correspond to the northern

Because the captures were made with a Dobson without tracking, the Lucky Imaging method was used so that the field of view remained fixed while the pair was drifting.

This method consists of capturing a video in AVI and then decomposing it into all the FIT frames that compose it to finally measure each one of them using the Reduc, which does it automatically discarding between 30% and 60% of the frames to reduce the distorting values.

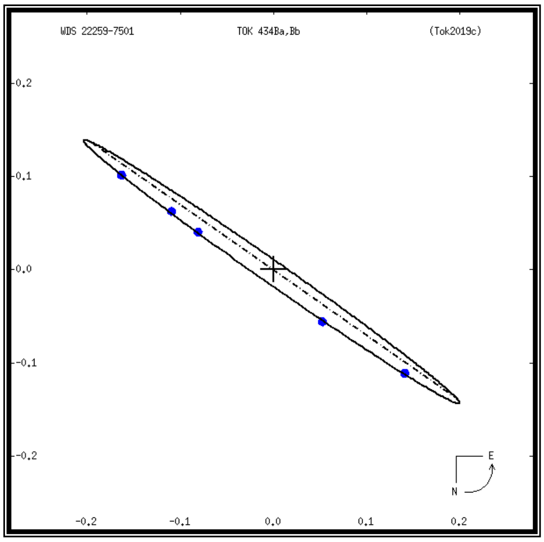
However, not all the measurements were automatic since on several occasions they had to be made manually because the torque was too tight or because the secondary component was not displayed at first because it was too faint; in this sense, the Reduc has some functions that could be used to try to overcome these difficulties manually.

The choice of the double stars to be measured was made on the basis of those in the WDS (Washington Double Star) Catalog, and taking into account the limitations of the 150 mm telescope used and the polluted sky conditions where the captures were made, only those pairs with an angular separation greater than 3 arcseconds and a maximum apparent magnitude for the principal component of 9 while for the secondary component it was 11 were selected.

With these selection constraints, 22 double stars were originally chosen, but 5 of them had to be discarded after several attempts because their secondary component could not be perceived due to their low brightness, because of the large brightness imbalance between the two components, or because the pair was too close and could not be resolved.

In this way, 110 15-second videos were recorded on different nights, obtaining about 250 frames of each one for the 22 pairs originally chosen, totaling 27,500 frames, which were reduced to 21,500 after discarding the 5 pairs that could not be measured.

With respect to their orbital periods, of the 17 pairs measured, only WDS 21232-7501 and WDS 22259-8703 have diagrams:



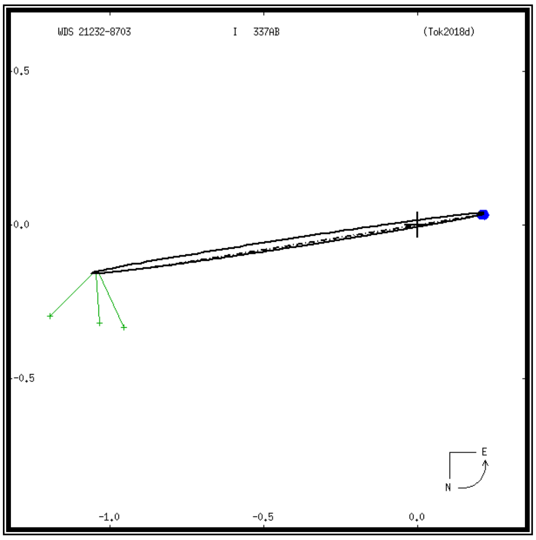
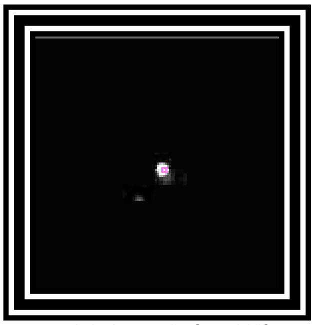


Tabla 1: Table of Measurements.

WDS	NAME	NUMBER OF HISTORICAL MSRMNTS AND YEARS OF FIRST AND LAST MSRMNTS	POSITION ANGLE AND SPACING RECORDED IN WDS	MAGNITUDE	MEASURED POSITION ANGLE AND ERROR	MEASURED SEPARATION AND ERROR	NUMBER OF MSRMNTS PERFOMED	AVERAGE DATE OF MEASUREMENTS
21014-7525	HJ5230	16 1835 – 2015	162.50º – 15.475″	8.34 – 9.78	162.5º ± 1.2º	15.17″ ± 0.40″	5	2023.288
21199-7501	DUN238AB	22 1835 – 2015	79.30º – 20.925″	6.19 – 8.85	79.9º ± 2.2º	21.31″ ± 0.83″	5	2023.285
22025-7719	HJ5301AB	18 1835 – 2016	201.90º – 10.459″	8.26 – 10.02	201.8º ± 2.2º	10.12″ ± 0.28″	5	2023.283
21522-8551	HJ5261	26 1837 – 2016	195.30º – 4.875″	8.34 – 8.61	195.2º ± 4.8º	4.59″ ± 0.48″	5	2023.301
21509-8243	HJ5278	29 1835 – 2015	61.50º – 3.338″	5.56 – 7.26	60.8º ± 9.1º	2.30″ ± 0.58″	5	2023.337
21334-8002	HJ5262	13 1836 – 2016	91.70º – 24.246″	6.47 – 10.38	91.8º ± 0.7º	23.78″ ± 0.39″	5	2023.338
21232-8703	HJ5192AB,C	18 1900 – 2000	318.40º – 17.910″	8.82 – 9.02	317.7º ± 1.5º	18.03″ ± 0.33″	5	2023.302
21067-8042	GLI263	13 1850 – 2016	244.10º – 4.752″	7.25 – 9.55	247.0º ± 10.9º	4.52″ ± 0.50″	5	2023.321
20417-7521	DUN232	39 1826 – 2016	19.20º – 16.622″	6.51 – 7.07	19.9º ± 1.6º	16.65″ ± 0.58″	5	2023.293
19131-7836	HJ5073	13 1835 – 2015	342.80º – 22.656″	8.88 – 10.35	342.9º ± 1.0º	22.90″ ± 0.28″	5	2023.307
12023-8538	HJ4490	22 1837 – 2015	145.70º – 24.843″	6.17 – 8.97	145.5 ± 2.3º	24.95″ ± 0.73″	5	2023.309
10056-8405	HJ4310AB	26 1837 – 2015	261.50º – 4.352″	7.68 – 8.38	261.3º ± 6.7º	4.33″ ± 0.38″	5	2023.302
09524-8425	GLI128	15 1850 – 2015	51.00º – 11.991″	8.76 – 9.77	51.73 ± 1.9º	12.09″ ± 0.36″	5	2023.303
09333-8601	DUN82	26 1837 – 2015	276.10º – 15.427″	7.13 – 7.60	275.6º ± 1.4º	15.46″ ± 0.39″	5	2023.305
03099-8332	HJ3582	12 1835 – 2010	300.60º – 19.440″	7.66 – 10.88	298.9º ± 1.2º	18.56″ ± 0.31″	5	2023.338
01492-8821	CP028	13 1901 – 2016	214.70º – 7.133″	8.02 – 10.54	214.8 ± 11.0º	7.25″ ± 0.54″	5	2023.269
01374-8217	GLI14	18 1850 – 2016	53.10º – 5.451″	7.60 – 8.40	53.4º ± 4.8º	5.29″ ± 0.42″	5	2023.305

IMAGES OF MEASURED DOUBLE STARS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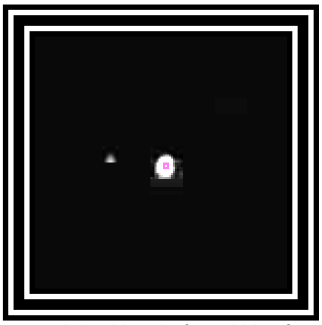
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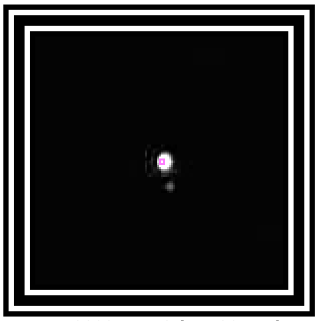
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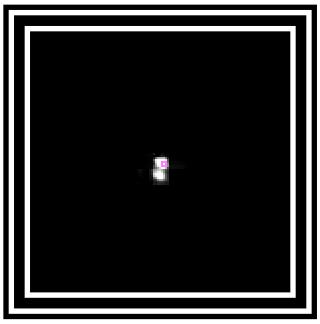
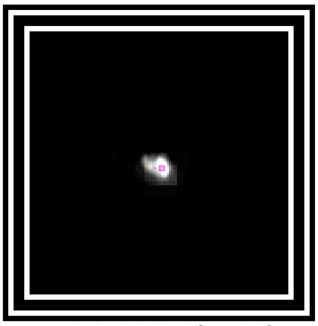

WDS 21522-8551 (HJ5261)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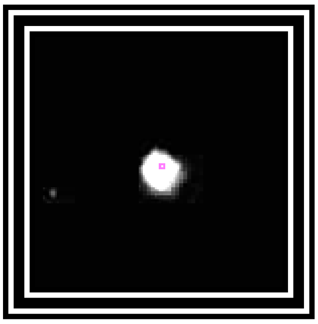
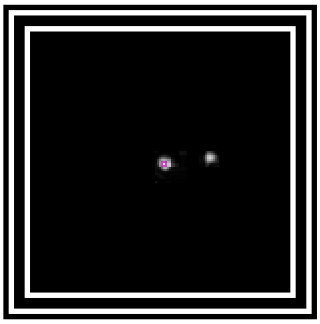
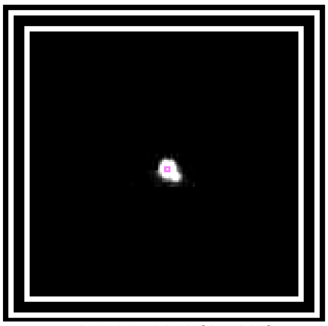

WDS 21334-8002 (HJ5262)


WDS 21232-8703 (HJ5192AB,C)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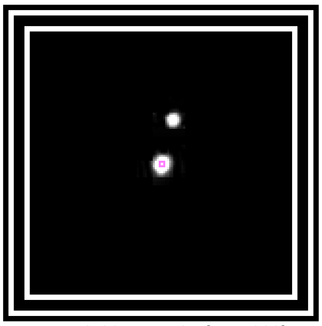
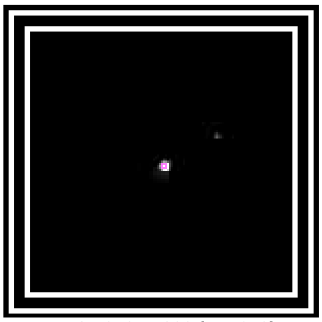

WDS 20417-7521 (DUN232)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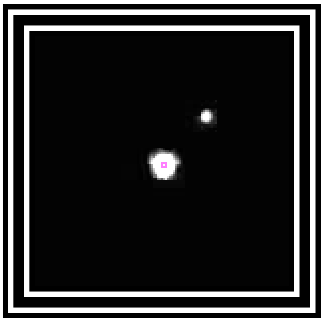
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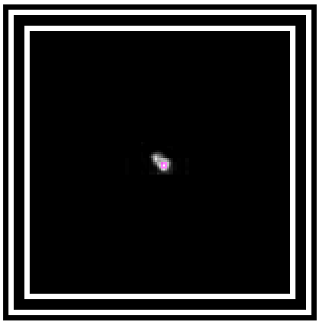
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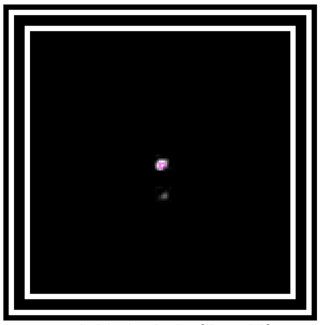

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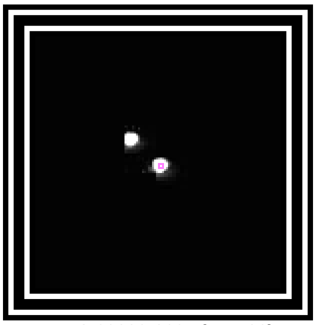
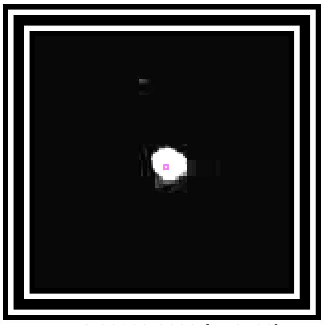
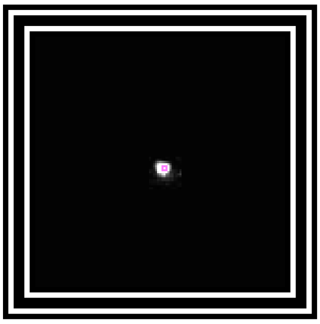


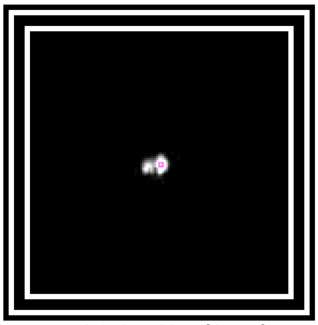
WDS 09333-8601 (DUN82)



WDS 03099-8332 (HJ3582)



WDS 01492-8821 (CP028)



WDS 01374-8217 (GLI14)

DISCUSSION:

Due to the low altitude of the Octans constellation where the chosen pairs are located, the captures were obtained with a large optical dispersion which caused some measurements to yield an error larger than the standard indeterminacies.

Indeed, of all the measurements made on the 17 pairs chosen, 25% of them were at an altitude between 20º and 25º, 30% between 25º and 30º, 20% between 30º and 35º and 25% between 35º and 40º.

This disadvantage of the low altitude could have been partly compensated by the use of a speckle interferometer (which could not be used because it was not available), not only to measure the closed pairs that finally had to be discarded because they could not be resolved, but also to minimize the measurement errors due to atmospheric turbulence in the more open pairs.

These errors could also have been reduced by using a telescope with a larger aperture (hence higher resolution), although it would have been interesting to compare the results obtained with both in order to draw a more confident conclusion.

CONCLUSIONS:

The values resulting from the measurements are within the average standards of the existing records in the WDS.

The values of the last measurements of the chosen pairs were updated on an average of approximately 8 years.

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- Reduc Manual (http://www.astrosurf.com/hfosaf/reduc/manual.htm)
- Arias Nicolás A., 22/08/2021, Double Stars, Actors in a Story (https://youtu.be/Tlqr2wHpb8c)
- El Observador de Estrellas Dobles Magazine Nº 18/2017 Pp. 25 to 31, article on Closed Systems Measurements with the Lucky Imaging technique (file:///E:/Users/Usuario/Documents/Curso%20de%20Astronom%C3%ADa/10%20Astrometr%C3%ADa/Estrellas%20Dobles%20y%20Variables/Estrellas%20Dobles/Revista%20El%20Observador%20de%20Estrellas%20Dobles/El%20Observador%20de%20Estrellas%20Dobles%20N%C2%BA%2018%20(Enero-Junio%20de%202017).pdf)

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- Losse Florent, Reduc Software (www.astrosurf.com/hfosaf/uk/tdownload.htm#reduc)
- JDSO (Double Star Journal Observations), general information and archives (http://www.jdso.org/)