Observing 75 Draco with a Manual Dobsonian Telescope

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Abstract: Students from Cuesta College and Arroyo Grande High School measured the position angle and the separation of the double star 75 Draco (WDS 20282+8125) with a manual Dobsonian telescope. The average position angle was 281.9° while the separation was 196.7″. These values compared favorably to the most recent observation reported in the Washington Double Star Catalog.

Introduction

Observations of 75 Draco were made as part of a Cuesta College research seminar held at Arroyo Grande High School. The primary goal of these observations were to compare data gathered on a manual Dobsonian telescope with previous observations gathered by other types of telescopes. Secondary goals were to contribute another observation to the series that began in 1884, and to learn the process of scientific research and how to write a scientific paper.

Our observations were made with an Orion SkyQuest XT10 manual Dobsonian telescope, which made it both interesting and challenging to make measurements and take accurate data. This telescope has a focal length of 1250 mm and an aperture of 10 inches (254 mm). We used a Celestron Micro Guide 12.5mm astrometric eyepiece, and a stopwatch that reads to the nearest 0.01 seconds for instrumentation. Our observations were taken on Saturday, November 10, 2012 (Besselian 2012.86) at Star Hill near Santa Margarita, CA at 35.32 N, 120.49 W.

We chose 75 Draco (WDS 20282+8125 STH 7 AC) for its far north position, which makes it drift slowly through our telescope's field-of-view, so our separation measurements would be easier to make on this manual telescope. A disadvantage of far northern positions is they increase field rotation between observations, an effect that is also increased with longer drift times.

Figure 1: Megan, Mckenzie, and Alexandria Calabrese, and Joe Richards analyze their 75 Draco data.

Calibration

To calibrate the Micro Guide eyepiece, we measured the time it took for the star Mirach to drift

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across the linear scale in the eyepiece. We used the average of three times, the known declination of Mirach, and the number of divisions on the Celestron Micro Guide scale to calculate the scale constant (z) of each division on the linear scale using the formula from Argyle (2012):

$$z = \frac{15.0411 \times time \times \cos(declination)}{divisions}$$

$$z = \frac{15.0411 \times 80.83 \times \cos(35.69)}{60}$$

$$z = 16.46 \text{ arc seconds per division}$$

Data used in the calibration is given in Table 1.

Table 1: Calibration measurements (time in seconds

Calibration Star	Mirach
Drift Time #1	81.13
Drift Time #2	80.56
Drift Time #3	80.79
Average Drift Time	80.83
Std. Dev.	0.2868
Declination	+35° 41' 18"
Declination (decimal)	35.688
Divisions	60
Scale Constant	16.46

Separation

We measured the separation of 75 Draco by lining up the stars parallel to the linear scale and estimating the number of division marks between them. We deleted two outliers.

Making measurement was challenging on a manual Dobsonian telescope. The stars were always drifting, which made it difficult to accurately estimate the number of division marks on the linear scale. The advantage of a telescope that tracks is that the double stars stay still in the field-of-view, making them easier to line up and measure.

To calculate the separation, we used the scale constant, which represents arc seconds per division mark, and multiplied it by the estimate of division marks. Table 2 gives the data and results of the separation measurement.

Table 2: Separation measurements

Observation	Divisions	Separation ″
#2	11.8	194.19
#3	12.0	197.48
#4	12.0	197.48
#5	12.0	197.48
#6	12.0	197.48
Std. Dev.	0.08	1.38
Average	**11.95**	**196.66**

Position Angle

The position angle proved more difficult and time consuming to find than the separation. We lined up either star in the system in front of the center point on the linear scale, the 30th division, and allowed it to drift through and eventually move out of the view of the telescope. If the star did not go through the center point, we reset the alignment of the telescope until it did. The eyepiece was rotated 180 degrees after every two measurements to reduce alignment bias and reduce the effects of field rotation. The point that it passed on the

Table 3: Position angle measurements

Observation	Position Angle °
#1	281.50
#2	282.00
#3	281.00
#4	283.00
Std. Dev.	0.85
Average	**281.88**

Table 4: Results compared to the last reported WDS observation

	Position Angle °	Separation "
Last WDS	282.10	196.60
Our Observation	281.88	196.66
Delta	-0.23	0.06

inner protractor of the eyepiece was recorded and later adjusted to accommodate the rotation of the eyepiece by 180 degrees, since zero degrees on the eyepiece differed by either 90 or 270 degrees, depending upon the orientation of the eyepiece.

Comparison with Previous Observations

Brian Mason from the United States Naval Observatory kindly provided past observations of this double star. The first observation of this system was made in 1884. The position angle was 285.3° while the separation was 198.35″. For the most recent observation in 2000, the reported position angle was 282.1° and the separation was 196.60″. Our results came very close to these recently reported values, which leads us to believe that they are reasonably accurate. See Table 4.

In Figures 2 and 3, the previous WDS observations are shown as a function of time, with our observations as the point on the right hand side. Our results are in line with the other observations.

Possible Companion?

During the review of our paper, Kent Clark brought to our attention a regular oscillation in the position angle and separation which could be an unseen companion. This can be clearly seen in Figures 2 and 3. This should be investigated further by more precise instrumentation.

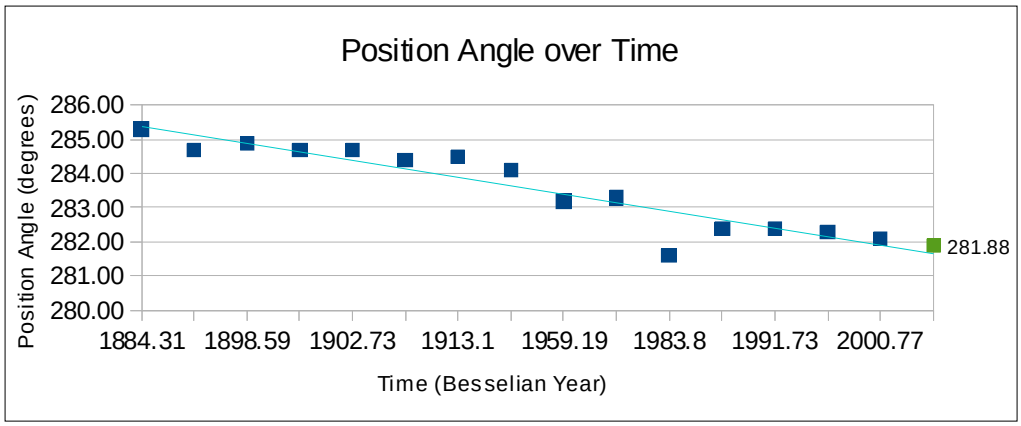

Figure 2: Position angle over time of the WDS observational data.

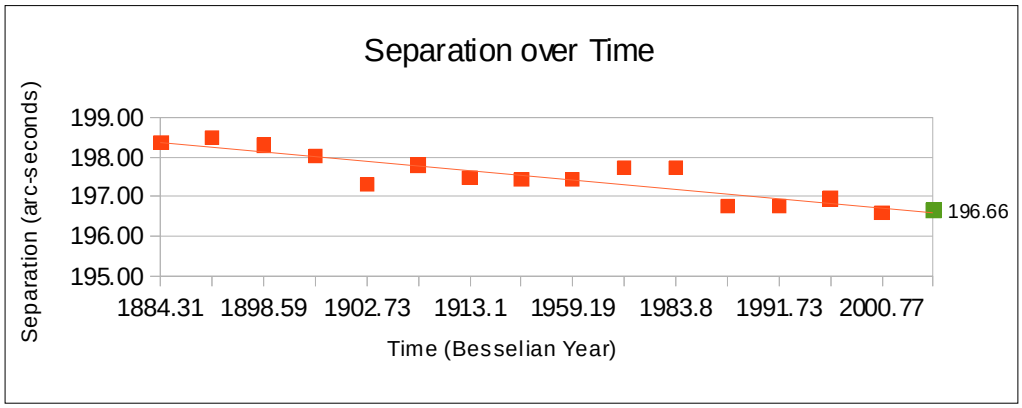

Figure 3: Separation over time of the WDS observational data.

Conclusion

Our observations compare favorably to other observations made in the past. Our average position angle was 281.9°, which is 0.2° different from the last observation of the double star at 282.1°. For the separation, the calculated result is 196.7″, which is a 0.1″ difference from the last reported result of 196.6″ in the Washington Double Star Catalog.

The high north position of the star caused it to take much longer to drift compared to other stars. When making measurements with manual telescopes, it can be useful to find a target star that is in the northern portion of the sky to make it easier to make separation measurements, but not too far north—otherwise it becomes time consuming to make position angle measurements. Also, the further north the double star is, the greater the field rotation will be between the measurements, and this could reduce the accuracy of the position angle measurements.

The goals of this research paper were met as we learned how to measure and calculate the position angle and separation of double stars. We also learned how to write a science paper and met the objective of determining the current separation and position angle between the two stars. The possibility of discovering a new companion in the star system was an unexpected and exciting result.

In closing we note that manual (non-tracking) Dobsonians are alt-azimuth telescopes, and thus suffer from field rotation. Also, estimating the separation of doubles stars as they cross the linear scale can be difficult. On the other hand, their advantage is that they are widely available and much lower cost than their motorized counterparts. If more people used manual Dobsonians for gathering data, they could make a substantial contribution to science and science education.

Acknowledgements

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