

# Student Measurements of 3 Binary Star Systems

Mark Brewer<sup>1,2</sup>, Anthony Rogers<sup>1,2</sup>, Henry Harder<sup>1</sup>, Robert Lazak<sup>3</sup>, Travis Gillette<sup>4</sup>, Sean Gillette<sup>4</sup>, Michael Sweatt<sup>1</sup>, Rachel Keele<sup>5</sup>, Melody Keele<sup>1</sup>, Brandon Smith<sup>1</sup>, Abraham Mercado<sup>1</sup>, Hannah Cheske<sup>1,2</sup>, Karryn Zoltan<sup>1</sup>, and Ema Stewart<sup>1</sup>.

1. Victor Valley Community College 2. High Desert Astronomical Society (HiDAS) 3. Whittier College 4. Vanguard Preparatory School 5. Biola University

**Abstract:** Participants from the Mojave Desert took part in a summer seminar held at the Luz Observatory. Visual measurements were made of the double stars STFA 1744, STFA 35, and STF 2758AB. An 8-inch Schmidt-Cassegrain telescope with an astrometric eyepiece and a stopwatch were used to determine the scale constant, separation, and the position angle. The Washington Double Star Catalog (WDS) was used as comparison.

## Introduction

A Summer Double Star Seminar was held by the High Desert Astronomical Society (HiDAS) for students interested in measuring and reporting on double stars. The participants (Figure 1) learned to calibrate the scale constant for the astrometric eyepiece, measure the separation in arc seconds, and measure the position angle in degrees. Three double stars with large separation angles were selected from the Washington Double Star Catalog to insure each double star could be visually recorded by each observer. Each binary star system allowed the participants to identify the separation along the linear scale.

## Equipment and Procedures

An 8-inch Meade Schmidt-Cassegrain telescope, mounted on a Celestron CG-5 Equatorial Mount and equipped with a 12.5mm Celestron Micro Guide astrometric eyepiece, was used for the observations. (See Figure 2.) A stopwatch that recorded to the nearest hundredth of a second was used for timing.

Drift times were used to find the scale constant. The astrometric eyepiece was rotated so that the primary star's free movement through the field-of-view moved directly along the linear scale from the 0 to the 60 division mark. The participants timed ten



Figure 1. The participants, from left to right: Anthony Rogers, Mark Brewer, Hannah Cheske, Rachel Keele, and Robert Lazak. The Seminar was held at the Lewis Center for Educational Research.

drifts along the scale. The average drift time was used to determine the scale constant,  $Z$ :

$$Z = \frac{15.0411 T \cos(\text{declination})}{D}$$

where  $Z$  is the scale constant in arc seconds per division,  $T$  is the average time in seconds,  $\cos(\text{declination})$  is the cosine of declination, and  $D$  is the displacement of the linear scale.

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Figure 2: Anthony Roger's 8-inch Meade Schmidt-Cassegrain telescope.

The separation was determined by aligning both the primary and secondary stars along the linear scale. The double star was repositioned at different marks along the scale to lower bias. The first ten participants recorded measurements, and then separation was determined. The separation was multiplied by the scale constant to give the separation in arc seconds.

The position angle was determined by aligning both stars on the linear scale, with the primary star on the central 30 division mark. The observer then turned off the drive motor, allowing both stars to drift to the inner protractor ring. When the primary star reached the protractor, the drive motor was turned

back on, and the primary star's position was recorded to the nearest degree. The eyepiece was rotated 180 degrees every run to lower bias (Frey 2008).

### Observations and Analysis (WDS STFA 1744)

Astrometric measurements were made of the double star STFA 1744. At right ascension 13 hr 23 min 55.4 sec and declination 54° 55 min 31.5 sec, the magnitude of the primary star is listed in the Washington Double Star Catalog (WDS) as 2.2 and the secondary star as 3.9. The listed epoch (2010) for the separation is 14.5 arc seconds, and the position angle is listed as 152°.

Observations were made on June 20, 2011 (B2011.47) in the parking lot of the Luz Observatory located in Apple Valley, California. The participants' observations reported in Table 1 below were compared to the Washington Double Star Catalog (Mason, 2009).

### Observations and Analysis (STFA 35)

Astrometric measurements were made of the double star STFA 35. At right ascension 17 hr 32 min 15.9 sec and declination 55° 11', the magnitude of the primary star STFA 35A is listed in the Washington Double Star Catalog (WDS) as 4.9 and the secondary star as 4.9. The listed epoch (2010) for the separation is 62.0 arcsec, and the position angle is 221°.

Observations were made on July 11, 2011 (B2011.526) in the parking lot of the Luz Observatory located in Apple Valley, California. The participants' observations for STFA 35, reported in Table 2 below, were compared to the Washington Double Star Catalog (WDS).

### Observations and Analysis (STF 2758AB)

The double star STF 2758AB is listed as having right ascension 21 hr 06 min 09 sec and declination 38° 45'. The magnitude is listed in the WDS for the primary star as 5.2, and the secondary star as 6.1.

Table 1: WDS STFA 1744

Parameters	# Obs.	Mean	Standard Deviation	Stand. Error of Mean	WDS Value	Diff.	% Diff.
Scale Constant (a.s. / division)	10	9.7	1.0	0.3	N/A	N/A	N/A
Separation (a.s.)	10	15.1	0.4	0.1	14.5	1.0	4.1%
Position angle (degrees)	10	329.4	2.7	0.9	332.0	2.6	-0.8%

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Table 2: WDS STFA 35

Parameters	# Obs.	Mean	Standard Deviation	Stand Error of Mean	WDS Value	Difference	% Difference
Scale Constant (a.s. / division)	N/A	9.7	N/A	N/A	N/A	N/A	N/A
Separation (a.s.)	10	65.1	0.4	1.3	62	3.1	4.9%
Position angle (degrees)	10	222.9	2.3	0.7	221	1.9	1.0%

Table 3: STF 2758AB

Parameters	# Obs.	Mean	Standard Deviation	Stand Error of Mean	WDS Value	Difference	% Difference
Scale Constant (a.s. / division)	N/A	9.7	N/A	N/A	N/A	N/A	N/A
Separation (a.s.)	10	30.8	0.24	0.1	31.4	-0.6	1.9%
Position angle (degrees)	10	332.4	1.1	0.3	332	0.4	0.1%

The listed epoch (2010) for the separation is 31.4 arcsec, and the position angle is 332°.

Observations were made on July 11, 2011 (B2011.526) in the parking lot of the Luz Observatory located in Apple Valley, California. The participants' observations for STF 2758AB, reported in Table 3 below, were compared to the Washington Double Star Catalog (WDS).

### Conclusions

The participants learned how to determine the scale constant, and measure the separation and position angle of a double star. Weather conditions were ideal for observing and most of the participants had little or no difficulty taking measurements. The most challenging part of the project was recording the position angle. A number of participants had trouble with this measurement when the drive motors were turned off and the star drifted out of view. This was solved by turning on the drive motor once the primary star reached the inner protractor ring, giving the participants an ample amount of time to read the position angle. The seminar accomplished more than its expressed goal of allowing participants, with little or no observational experience, to measure a double star

and prepare a paper for publication, by allowing them to measure and report on several separate systems of binary stars. Our observations were similar (within 5%) of the most recently reported observations in the Washington Double Star Catalog.

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### References

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