

# Astrometric Measurements of Ten Double Stars: Report of May 2012

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**Abstract:** From my home in Paso Robles, California, measurements of the separation and position angle of ten double stars were made. The ten double stars were  $\chi$  Tauri,  $\gamma$  Leporis, STF 630 in Orion, STF 696 in Orion, SAO 44187 in Canes Venatici, SAO 64970 in Corona Borealis, SAO 65262 in Corona Borealis, SAO 83374 in Bootes, SAO 100160 in Coma Berenices, and SAO 150336 in Lepus. The two goals of this project were to 1) measure the position angle and separation of the aforementioned double stars, and 2) learn the necessary techniques to conduct this research.

## Methodology

Observations were made from my home in Paso Robles, California (located at approximately  $35^{\circ} 37' 36''$  N and  $120^{\circ} 41' 24''$  W) using a Celestron model CPC 1100 telescope. The telescope is computerized, motorized, and was fitted with a Celestron MicroGuide 12.5mm astrometric eyepiece. The telescope is of Schmidt-Cassegrain design, with aperture of 11 inches on an alt-azimuth mount. The focal length reported by the manufacturer is 2,800 mm.

The Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star of the double star under study. The primary star was positioned on the mark 30, the drive was disabled, and the star was permitted to drift to the outer circle. The scale was rotated until the star lay on the 270 degree mark. The accuracy of this setting was verified by positioning the primary star on the 90 degree mark of the outer circular scale, and allowing the star to drift to the 270 degree mark.

Following the orientation, drift times were measured by placing the primary star on the 0 mark of the linear scale, and measuring the drift time from the 0 to the 60 mark using a stop watch precise to  $\pm 0.01$  seconds. The average drift time was used to calculate the scale constant, using the formula (Frey

2008)  $Z = [15.0411 \times T_{\text{average}} \times \text{the cosine of the declination angle}]$  divided by the number of reticle divisions. The formula can be expressed as:

$$Z = \frac{15.0411 T_{\text{ave}} \cos(\delta)}{D}$$



Figure 1. The author with his Celestron telescope

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Separation measurements were made by placing the pair of stars on the linear scale at the zero mark, and then counting the number of scale divisions between the stars. Because the scale has 60 divisions, it was only possible to estimate to the nearest  $\frac{1}{4}$  division. After each measurement, the double star was repositioned to the next major division, measurements were made, and an average and standard deviation were calculated.

The position angle measurements were made by aligning both stars on the linear scale with the primary star at the 30 division, disabling the tracking feature, and then allowing the stars to drift to the circular scales. The crossing of the primary star at the outer scale was approximated to the nearest degree as the scale has divisions of  $5^\circ$ . Following each measurement, the tracking feature was enabled and the process was repeated.

In this article, the author defines "seeing" as the number of stars in the Little Dipper seen without an instrument.

### Chi Tauri

#### Introduction

Chi Tauri is a spectroscopic binary star located in the constellation Taurus. The primary component is blue-white with a magnitude of 5.38, and the secondary component is yellow with a magnitude of 7.6. The right ascension is  $4^h 25^m 35^s$  and the declination is  $+25^\circ 37' 45''$ . Other catalog identifiers include 59 Tauri, ADS 3161, BD+25 707, CCDM 04226+2538,

Table 1: Separation (in arc seconds) and Position angle (in degrees) for  $\chi$  Tauri.

Reference name	Sep (as)	PA (deg)
Herschel Double Star List (McEvoy 2011) 1822 data	19.9	27
OAG (as given in the WDS - Tobal+ 2003) 1973 data	19.0	25.0
OAG (as given in the WDS - Tobal+ 2003) 1980 data	19.0	24.0
OAG (as given in the WDS - Tobal+ 2003) 1985 data	19.0	25.0
OAG (as given in the WDS - Tobal+ 2003) 1996 data	19.2	24.0
Washington Double Star (Worley+ 1996)	20.2	20
Sky Master 2000 Catalog (Meyers, 1997)	19.5	25
Astrogeek (Burton 2004)	19.1	25
Journal of Double Star Observations (Arnold 2009)	19.75	23.5
Measurements by the author 2011	21	20

GC 5292, HD 27638, HIP 20430, HR 1369, SAO 76573, STF 528, and WDS J04226+2538. Its precise coordinates are  $0422340.94+253745.5$

#### Observations

The measurements were made on 19 November 2011, from 6:35 pm to 8:00 pm Pacific Standard Time. The night was clear and calm, with seeing 3 - 4, a temperature of  $40 - 50^\circ\text{F}$ , and there was no moon.

After completing the orientation, 12 drift time measurements were made, with an average value of 31.32 seconds, a standard deviation of 0.25 seconds, a standard error of the mean of 0.07 seconds, which resulted in a scale constant of 7.08 arc seconds per division.

Fifteen separation measurements were taken with an average of 3.0 divisions, a standard deviation of 0.14 divisions, and a standard error of the mean of 0.04 divisions. The calculated separation was 21.0 arc seconds.

Twelve position angle measurements were taken with an average value of  $20.2^\circ$ , a standard deviation of  $0.7^\circ$ , and a standard error of the mean of  $0.13^\circ$ . Historic measurements plus the author's measurements are given in Table 1.

### STF 696 in Orion

#### Introduction

Known since ancient times, the constellation Orion is easily recognized and contains a collection of large and impressive single and double stars. The white primary star has a magnitude of 5, and the blue secondary star has a magnitude of 6.8.

The right ascension of the double star is  $05^h 22^m 50^s$ , and its declination is  $+03^\circ 32' 40''$ . Other catalog designations include ADS 3962A, AG +03 632, ALS 14774, BD+03 871, GC 6607, HD 35149, HIP 25142, HR 1770, PPM 148857, SAO 112697, SKY 8533, STF 696, TYC 105-2800-1, UBV 5109, and WDS J05228+0333A. Its precise coordinates are  $052250.00+033240.0$ .

#### Observations

These measurements were made on 5 March 2012 from 9:50pm to 10:40pm PST. The night was hazy and calm. The temperature was  $60-55^\circ\text{F}$  with humidity of 40%, and the moon was full.

After completing the orientation, 9 drift time measurements were made, with an average value of 28.72 seconds, a standard deviation of 0.30 seconds, and a standard error of the mean of 0.10. The result was a scale constant of 7.19 arc seconds per division.

The primary star was placed on the linear scale,

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Table 2: Separation (in arc seconds) and Position angle (in degrees) for STF 696

Reference name	Sep (as)	PA (deg)
Washington Double Star Catalog (Mason 2012) 1782 data	32.8	31
O A G (Tobal 2003) 1974 data	32.0	34.0
O A G (Tobal 2003) 1980 data	32.0	33.0
O A G (Tobal 2003) 1992 data	31.3	30.1
O A G (Tobal 2003) 1993 data	31.8	32.5
Eagle Creek (Muenzler 2003)	32	28
Journal of Double Star Observations (Arnold 2006)	32.6	29.1
Washington Double Star Catalog (Mason 2009)	31.5	30
Measurements by the author 2012	31.9	30

and 9 separation measurements were taken. The average value was 4.5 divisions with a standard deviation of 0.0 divisions and a standard error of the mean of 0.0 which resulted in a separation of 31.9 arc seconds.

Ten position angle measurements were taken with an average value of 30°, a standard deviation of 0.7°, and a standard error of the mean of 0.1°. Historic measurements of STF 696 plus the author's measurements are given in Table 2.

### STF 630 in Orion

#### Introduction

This double star consists of a pair of blue stars, with magnitudes of 6.5 and 7.7. The right ascension of the double star is 05h 02m 00s, and its declination is +01° 36' 32".

Other catalog designations include A 2630 BC, ADS 3623BC, AG +01 518, BD +01 886B, HIP 23421, PPM 148338, SAO 112341 SKY#7881, STF 630 TYC 98-2440-1, and WDS J05020+0137BC. Its precise coordinates are 050200.03+013631.9.

#### STF 630 - Observations

The night of 5 March 2012 was hazy with no wind and the temperature was 65 - 50 °F. Moon rise occurred at 7:54 pm so there was little impact even though the moon was 2/3 full. The session began at 6:40 pm and ended at 9:50 pm Pacific Standard Time.

After completing the orientation, 9 drift time measurements were made, with an average value of 28.72 seconds, a standard deviation of 0.30 seconds and a standard error of the mean of 0.10 which re-

Table 3: Separation (in arc seconds) and Position angle (in degrees) for STF 630

Reference name	Sep (as)	PA (deg)
Herschel Double Star (McEvoy 2011) 1782 data	14.3"	49°
Washington Double Star Catalog (Mason 2012) 1783 data	13.7"	53°
O A G (Tobal 2003) 1971 data	14.0"	50.0°
O A G (Tobal 2003) 1980 data	14.0"	50.0°
O A G (Tobal 2003) 1992 data	14.7"	53.1°
O A G (Tobal 2003) 1995 data	14.9"	54.7°
O A G (Tobal 2003) 1998 data	15.0"	51.9°
Washington Double Star Catalog (Mason, 2012)	14.4"	49 °
Tycho 2 (from the WDS site)	14.4"	49.6°
Measurements by the author 2012	14.1"	48 °

sulted in a scale constant of 7.12 arc seconds per division.

Twelve separation measurements were taken with an average value was 2 marks with a standard deviation of 0.1 marks and a standard error of the mean of 0.03. The calculated separation was 14.1 arc seconds.

Twelve position angle measurements were taken with an average value of 48°, a standard deviation of 0.87°, and a standard error of the mean of 0.15°. Historic measurements of STF 630 plus the author's measurements are given in Table 3.

### Gamma Leporis

#### Introduction

Lepus is a constellation lying just south of the celestial equator. One of the 48 constellations listed by the 2nd century astronomer Ptolemy, it remains as one of the 88 modern constellations. The double gamma Leporis is a multiple star system and a member of the Sirius moving group of stars. The primary star is a white-yellow dwarf with a magnitude of 6.3, and the red secondary star has a magnitude of 6.5. Other catalog identifiers include ADS 4334A, BD -22 1211, FK5 217, GC 7197, GCRV 3567, GJ 216A, HD 38393, HIP 27072, HR 1983, PPM 249307, ROT 920, SAO 170759, SKY# 9411, SRS 30217, UBV 5897, and WDS J05193-1831. Its precise coordinates are 054427.79-222654.2

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Table 4: Separation (in arc seconds) and Position angle (in degrees) for  $\gamma$  Leporis

Reference name	Sep (as)	PA (deg)
Washington Double Star Catalog (Mason+ 2012) 1800 data	95.8	348
Washington Double Star Catalog (Mason+ 2012) 1825 data	94	350
O A G (Tobal+ 2003) 1973 data	97	350
O A G (Tobal+ 2003) 1980 data	96	351
Bright Star Catalog (Hoffleit+ 1991) 1991 data	96.5	'-
O A G (Tobal+ 2003) 1994 data first	99	350
O A G (Tobal+ 2003) 1994 data second	98.6	350
O A G (Tobal+ 2003) 1995 data first	97	350
O A G (Tobal+ 2003) 1995 data second	97.8	349.5
Eagle Creek Observatory (Muenzler 2003)	94.9	351
Washington Double Star Catalog (Mason+ 2012)	95.6	348
Tycho 2 (as reported by the WDS)	97	349
<i>AUTHOR'S data 2012</i>	95	350

### Observations

These measurements were made on 9 March 2012, from 8:50 pm to 10:00 pm Pacific Standard Time. The night was hazy; the temperature was 60 - 50 °F with humidity of 20% and a full moon.

Once the MicroGuide eyepiece orientation was completed, 12 drift time measurements were made, with an average value of 29.51 seconds, a standard deviation of 0.36 seconds and a standard error of the mean of 0.10 which resulted in a scale constant of 6.85 arc seconds per division.

The stars were placed on the linear scale, and 10 separation measurements were taken. The average value was 13.9 divisions with a standard deviation of 0.2 divisions and a standard error of the mean of 0.07. The average value was used to calculate the separation, which was 95 arc seconds.

Twelve position angle measurements were taken with an average value of 350°, a standard deviation of 0.9°, and a standard error of the mean of 0.2°. Historic measurements of  $\gamma$  Leporis plus the author's measurements are given in Table 4.

Table 5: Separation (in arc seconds) and Position angle (in degrees) for SAO 150336 in Lepus

Reference name	Sep (as)	PA (deg)
O A G (Tobal+ 2003) 1971 data	40.0	19
O A G (Tobal+ 2003) 1980 data	40.0	18
Eagle Creek Observatory (Muenzler 2003)	39.2	18
Journal of Double Star Observations (Anton 2008)	39.5	18.1
TYCHO 2 (as listed in the WDS)	39.3	18.5
Washington Double Star Catalog (Mason+ 2012)	39	19
<i>Measurements by the author 2012</i>	38.2	20

## SAO 150336 in Lepus

### Introduction

This double star consists of blue primary and secondary stars with magnitudes of 6.3 and 6.5. The right ascension of the double star is 05h 19m 17s, and its declination is -18° 31' 12". Catalog designations include V\* TX Lep, \*\*S 476B, ADS 3910B, ALS 17336, BD-18 1056, CCDM J05193-1831B, GC 6525, GCRV 56060, GEN# +1.00034797, HD 34797, HIP 24827, HR 1754, IDS 05149-1837B, 2MASS J05191831-1830344, PPM 215591 ROT 767, SAO 150336, SKY# 8416, TYC 5906-1519-1, UBV M 10844, UVBY98 100034797 V, and WDS J05193-1831B. Its precise coordinates are 042234.94+253745.5.

### Observations

These measurements were made on 9 March 2012 from 8:50 pm to 10:00 pm Pacific Standard Time. The night was hazy and calm with temperatures from 65 - 55 °F. The moon was full, and there was a gentle breeze.

Once the MicroGuide eyepiece orientation was completed, 12 drift time measurements were made, with an average value of 29.51 seconds, a standard deviation of 0.36 seconds and a standard error of the mean of 0.10 seconds. The result was a scale constant of 7.01 arc seconds per division.

The primary star was placed on the linear scale, and 10 separation measurements were taken. The average value was 5.5 divisions with a standard deviation of 0.2 divisions and a standard error of the mean of 0.05 divisions. The average value was used to calculate the separation, which was 38.2 arc seconds. Eleven position angle measurements were taken with an average value of 20°, a standard deviation of 0.9°, and a standard error of the mean of 0.2°.



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tion of  $0.9^\circ$ , and a standard error of the mean of  $0.2^\circ$ . Historic measurements of SAO 150336 plus the author's measurements are given in Table 5.

### SAO 44187 in Canes Venatici

#### Introduction

This double star consists of two orange stars with magnitudes of 7.5 and 8.1. The right ascension is 12h 28m 04s, and its declination is  $+44^\circ 47' 39''$ . Catalog designations include ADS 8561A, ASCC 409178, BD+45 2038, CCDM J12281+4448A, CSI+45 20381 1, GC 16998, GCRV 7495, GSC 03020-02112, HD 108574, HIP 60831, NLTT 30820, PPM 400176, SAO 44187, SKY# 23325, STF 1645, TYC 3020-2112-1, UBV 11206, and WDS J12281+4448a. Its precise coordinates are 122804.45+444739.5.

#### Observations

These measurements were made on 20 April 2012 from 8:50 pm to 9:50 pm Pacific Daylight Time. The night was hazy and calm with temperatures from  $65 - 55^\circ\text{F}$  and humidity of 55%. There was no moon.

Once the MicroGuide eyepiece orientation was completed, 10 drift time measurements were made, with an average value of 39.81 seconds, a standard deviation of 0.62 seconds and a standard error of the mean of 0.19 seconds. The result was a scale constant of 7.08 arc seconds per division.

Twelve separation measurements were taken which resulted in an average value of 1.4 divisions with a standard deviation of 0.04 divisions and a standard error of the mean of 0.01 divisions. The average value was used to calculate the separation, which was 10 arc seconds.

Twelve position angle measurements were taken with an average value of  $156.9^\circ$ , a standard deviation

Table 6. Separation (in arc seconds) and Position Angle (in degrees) for SAO 44187 in Canes Venatici

Reference name	Sep	PA
O A G (Comellas+ 2003) 1973 data	10.0"	$158^\circ$
O A G (Comellas+ 2003) 1980 data	10.0"	$157^\circ$
Eagle Creek Observatory (Muenzler 2003)	10.2"	$158^\circ$
Journal of Double Star Observations (Bertoglio 2007)	9.78"	$157.3^\circ$
TYCHO 2 (as listed in the WDS)	9.83"	$157.6^\circ$
Washington Double Star Catalog (Mason+ 2012)	9.7"	$157^\circ$
Measurements by the author 2012	10"	$157^\circ$

of  $1.3^\circ$ , and a standard error of the mean of  $0.2^\circ$ . Historic measurements of SAO 44187 plus the author's measurements are given in Table 6.

### SAO 100160 in Coma Berenices

#### Introduction

This double star consists of a yellow primary and blue secondary star with magnitudes of 5.1 and 6.3. The right ascension is 12h 35m 07s, and its declination is  $+18^\circ 22' 37''$ . Catalog designations include 24 COM, ADS 8600A, AG+18 1196, BD+19 2584, CSV 101298, GC 17147, GCRV 7572, HD 109511, HIP 61418, HR 4792, IRC +20244, N30 2908, NSV 5748, PLX 2902, PMC 90-93 337, PPM 129167, RAFGL 48535, SAO 100160, SKY# 23522, STF 1657, TYC 1446-2469-1, UBV 11303, and WDS J12351+1823A. Its precise coordinates are 123507.76+182237.4.

#### Observations

These measurements were made on 21 April 2012 from 8:50pm to 10:00pm Pacific Daylight Time. The night was hazy and calm with temperatures from  $70-65^\circ\text{F}$  and humidity of 65%. There was no moon.

Once the MicroGuide eyepiece orientation was completed, 10 drift time measurements were made, with an average value of 30.03 seconds, a standard deviation of 0.22 seconds and a standard error of the mean of 0.07 seconds. The result was a scale constant of 7.14 arc seconds per division.

Twelve separation measurements were taken which resulted in an average value of 3 divisions with a standard deviation of 0.08 divisions and a standard error of the mean of 0.02 divisions. The average value was used to calculate the separation, which was 20 arc seconds.

Twelve position angle measurements were taken with an average value of  $273^\circ$ , a standard deviation of  $1.4^\circ$ , and a standard error of the mean of  $0.3^\circ$ . Historic measurements of SAO 100160 plus the author's measurements are given in Table 7.

### SAO 83374 in Bootes

#### Introduction

This double star consists of two blue stars with magnitudes of 7.11 and 7.56. The right ascension is  $14^{\text{h}} 51^{\text{m}} 27^{\text{s}}$ , and its declination is  $+44^\circ 55' 42''$ . Catalog designations include ADS 9277A, AG+28 1407, BD+28 2332, GCRV 8451, HD 127067, HIC 70786, HR 5415, N30 3281, PPM 103349, ROT 2080, SAO 83374, STF 1850, UBV 12680, and WDS J14286+2817A. Its precise coordinates are 142833.29+281725.9.

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Table 7. Separation (in arc seconds) and Position Angle (in degrees) for SAO 100160 in Coma Berenices

Reference name	Sep	PA
O A G (Comellas+ 2003) 1973 data	20"	271°
Eagle Creek Observatory (Muenzler 2003)	20.3"	271°
Journal of Double Star Observations (Daley 2004)	20.14"	270.4°
Journal of Double Star Observations (Arnold 2007)	20.24"	270.5°
Journal of Double Star Observations (Schlimmer 2008)	19.98"	270.7°
Journal of Double Star Observations (Bertoglio 2010)	20.17"	270.5°
Journal of Double Star Observations (Schlimmer 2010)	19.85"	270.9°
Astrogeek (Burton 2012)	20.2"	271°
Washington Double Star Catalog (Mason+ 2012)	22.1"	273°
Measurements by the author 2012	20"	273°

### Observations

These measurements were made on 20 May 2012 from 9:40pm to 10:40pm Pacific Daylight Time. The night was clear and calm with temperatures from 70-60°F and humidity of 45%. There was no moon, and "seeing" was 3-4.

Once the MicroGuide eyepiece orientation was completed, 12 drift time measurements were made, with an average value of 32.43 seconds, a standard deviation of 0.19 seconds and a standard error of the mean of 0.05 seconds. The result was a scale constant of 7.16 arc seconds per division.

Ten separation measurements were taken which resulted in an average value of 3.6 divisions with a standard deviation of 0.16 divisions and a standard error of the mean of 0.05 divisions. The average value was used to calculate the separation, which was 26 arc seconds.

Twelve position angle measurements were taken with an average value of 261°, a standard deviation of 0.9°, and a standard error of the mean of 0.2°. Historic measurements of SAO 83374 plus the author's measurements are given in Table 8.

## SAO 64970 in Corona Borealis

### Introduction

This double star consists of a blue-white primary of magnitude 7.16, and a blue secondary star of magnitude 10.4. The right ascension is 16<sup>h</sup> 00<sup>m</sup> 55<sup>s</sup>, and its declination is +39° 10' 39". Catalog designations include ADS 9838A, AG+34 1437, AGKR 14207,

Table 8. Separation (in arc seconds) and Position Angle (in degrees) for SAO 83374 in Bootes

Reference name	Sep	PA
Washington Double Star Cat. (Mason+ 2012) 1823 data	25.8"	262°
O A G (Comellas+ 2003) 1973 data	26"	263°
O A G (Comellas+ 2003) 1980 data	26"	262°
O A G (Tobal+ 2003) 1991 data	20.3"	271°
O A G (Tobal+ 2003) 1973 data	25.6"	263.4°
O A G (Tobal+ 2003) 1992 data	25.7"	264.6°
O A G (Tobal+ 2003) 1993 data	25.7"	264°
O A G (Tobal+ 2003) 1994 data	25.7"	264.2°
O A G (Tobal+ 2003) 1995 data	25.6"	263.1°
Washington Double Star Catalog (Worley+ 1996)	25.6"	262°
Washington Double Star Catalog (Mason+ 2012)	25.2"	261°
Measurements by the author 2012	26"	261°

BD+34 2709, CSI +34 2709 2, GC 21385, GCRV 9165, HD 142742, HIC 77933, PPM 78912, SAO 64970, STT 302, TD1 18686, TYC 2575-1509-1, UBV 13522, and WDS J15549+3422A. Its precise coordinates are 155456.85+3412145.0.

### Observations

These measurements were made on 27 May 2012 from 9:30pm to 10:40pm Pacific Daylight Time. The night was clear and calm with temperatures from 60-50°F and humidity of 55%. There was in ¼ phase, and "seeing" was 3-4.

Once the MicroGuide eyepiece orientation was completed, 10 drift time measurements were made, with an average value of 34.31 seconds, a standard deviation of 0.34 seconds and a standard error of the mean of 0.11 seconds. The result was a scale constant of 7.10 arc seconds per division.

Eleven separation measurements were taken which resulted in an average value of 4.1 divisions with a standard deviation of 0.13 divisions and a standard error of the mean of 0.04 divisions. The average value was used to calculate the separation, which was 29 arc seconds.

Twelve position angle measurements were taken with an average value of 50°, a standard deviation of 0.7°, and a standard error of the mean of 0.1°. Historic measurements of SAO 64970 plus the author's measurements are given in Table 9.

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Table 9. Separation (in arc seconds) and Position angle (in degrees) for SAO 64970 in Corona Borealis

Reference name	Sep	PA
Washington Double Star Cat. (Mason+ 2012) 1843 data	28.6"	54°
O A G (Comellas+ 2003) 1980 data	29"	56°
Journal of Double Star Observations (Arnold 2008)	29.63"	50.8°
Washington Double Star Catalog (Mason+ 2008)	29.6"	51°
Measurements by the author 2012	29"	50°

### SAO 65262 in Corona Borealis

#### Introduction

This double star consists of a blue-white primary of magnitude 7.16, and a blue secondary star of magnitude 10.4. The right ascension is 15<sup>h</sup> 39<sup>m</sup> 22<sup>s</sup>, and its declination is +36° 38' 09". Catalog designations include ADS 9838A, AG+34 1437, AGKR 14207, BD+34 2709, CSI +34 2709 2, GC 21385, GCRV 9165, HD 142742, HIC 77933, PPM 78912, SAO 64970, STT 302, TD1 18686, TYC 2575-1509-1, UBV 13522, and WDS J15549+3422A. Its precise coordinates are 155456.85+3412145.0.

#### SAO 65262 in Corona Borealis - Observations

These measurements were made on 28 May 2012 from 9:20pm to 10:40pm Pacific Daylight Time. The night was a little hazy and calm with temperatures from 60-50°F and humidity of 55%. There was ½ full, and "seeing" was 3.

Once the MicroGuide eyepiece orientation was completed, 10 drift time measurements were made, with an average value of 33.7 seconds, a standard deviation of 0.07 seconds and a standard error of the mean of 0.02 seconds. The result was a scale constant of 6.78 arc seconds per division.

Ten separation measurements were taken which resulted in an average value of 4.6 divisions with a standard deviation of 0.11 divisions and a standard error of the mean of 0.03 divisions. The average value was used to calculate the separation, which was 31 arc seconds.

Ten position angle measurements were taken with an average value of 16.7°, a standard deviation of 0.8°, and a standard error of the mean of 0.2°. Historic measurements of SAO 65262 plus the author's measurements are given in Table 10.

#### Acknowledgements

Grateful appreciation is given to Russell Genet,

Figure 10. Separation (in arc seconds) and Position angle (in degrees) for SAO 64970 in Corona Borealis

Reference name	Sep	PA
Washington Double Star Cat. (Mason+ 2012) 1783 data	36.4"	21°
O A G (Comellas+ 2003) 1995 data	32.2"	15°
Eagle Creek Observatory (Muenzler 2003)	34.7"	19°
Journal of Double Star Observations (Arnold 2006)	31.58"	16.5°
Journal of Double Star Observations (Bertoglio 2010)	31.26"	15.3°
Washington Double Star Cat. (Mason+ 2012) 2009 data	31.10"	17°
Measurements by the author 2012	31"	17°

adjunct professor of Astronomy at Cuesta College, for his instruction about the methodology and instrument usage.

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