Measurements of 61 Cygni (STF2758AB, WDS 21069+3845)

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Abstract: I present results of measuring the proper motion of 61 Cygni using position measurements made over a period of 1 1/2 years.

Between May 2006 and November 2007 I imaged the double star 61 Cygni (STF2758AB). I used my refractor with 130 mm diameter objective with a focal length of 1040 mm and a CCD camera, SBIG ST237A, with a pixel size of 7.4 micrometer giving a scale of 1.47 arc seconds per pixel on the sky. My main goal was to measure the proper motion of the stars and eventually to detect their parallax like Friedrich Wilhelm Bessel did in 1838 [1]. On 28 nights during the 18 months, I took at least 30 images every night. Best results came with short exposure times of 1 second and ½ second. The images were measured using Astrometrica software by Herbert Raab [2] using the UCAC2 reference star catalog. Depending on sky conditions between 20 and 40 reference stars down to 14 mag could be used by the software to determine right ascension and declination of 61 Cygni A and B referred to the UCAC2 reference frame.

My goal to detect proper motion was easily achieved, see figure 1. I was even able to detect the parallactic movement of both stars, so my measurement precision was quite good, see Figure 2.

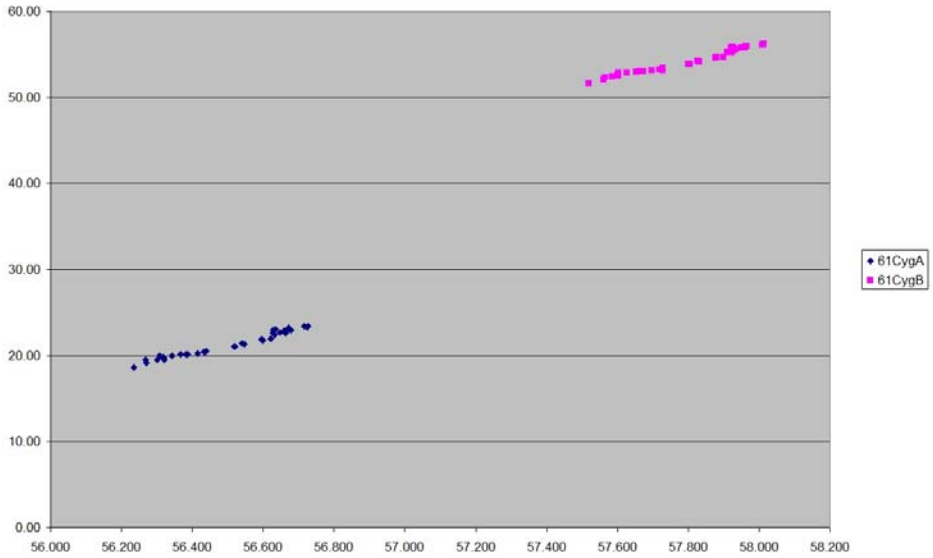

Figure 1: proper motion of 61 Cygni A and B plotted. On the x-axis are the seconds of right ascension, on y-axis the seconds of declination. The slight "waviness" of the proper motion is due to parallax.

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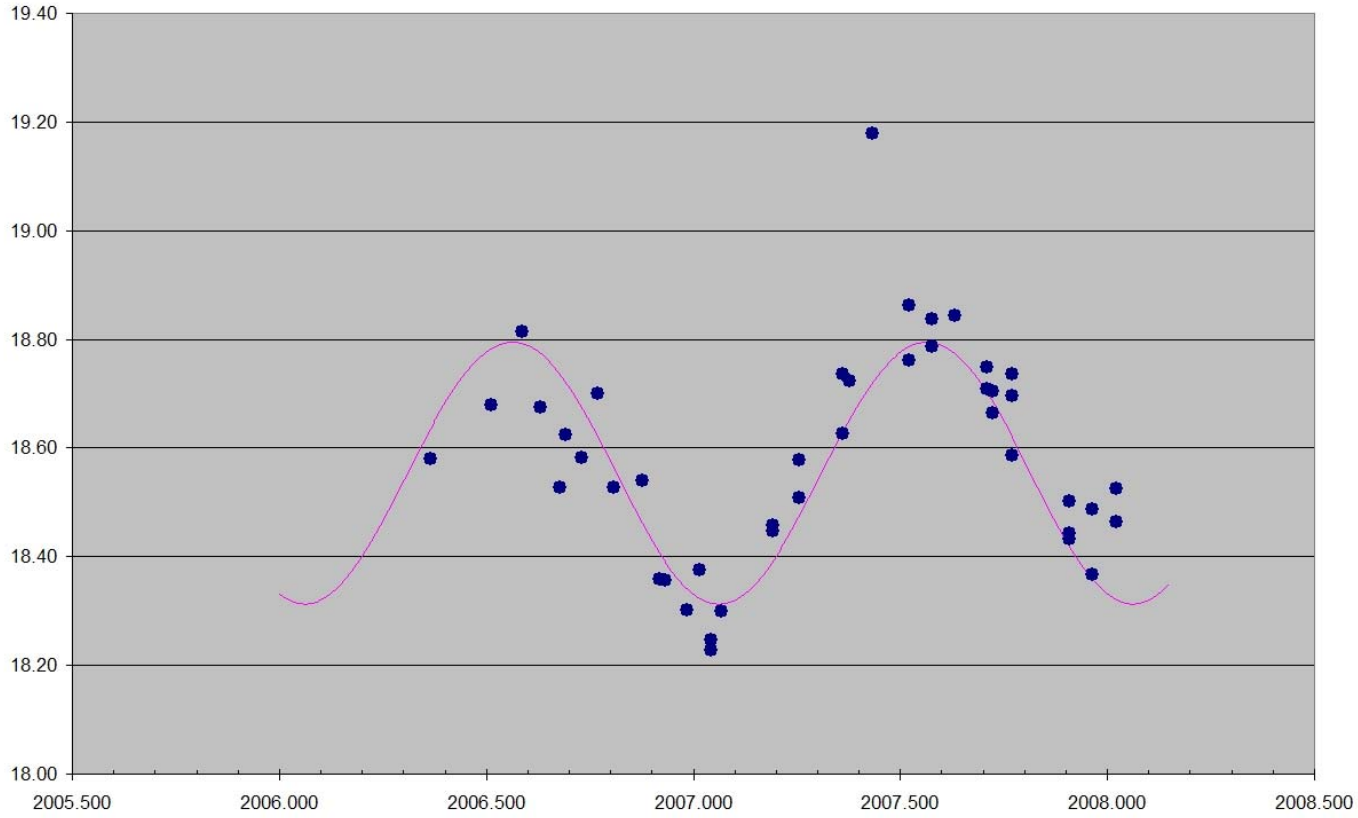

Figure2: Change of declination of 61 Cygni A after removing proper motion for this star. On the x-axis is plotted the time of observation in years, on the y-axis is plotted the observed arc seconds of declination. Proper motion correction was applied. The parallactic movement is clearly visible as a sinusoidal wave. Plotted is also the expected motion of the star due to a parallax of 0.287 arc seconds which fits the observations quite well.

Using the formulae (16.1) and (16.2) in [3] I also calculated the distance and position angle from the means of every measurement series on these nights. On several nights I made two or more independent series in hope of improving precision. I plotted the distance and the PA and found that the slow increase of distance and PA due to the orbital motion of the pair was visible very well in the plots. To check my results I compared them to the ephemeris calculated from the elements in [4] (PkO2006b), using Brian Workman's spreadsheet [5]. Distance is represented satisfactorily by this ephemeris, but my position angles are consistently 0.4 to 0.5 degrees larger than the ephemeris gives, see Figure 3.

In a discussion on the yahoo group "binary-stars-uncensored" [6], several astronomers provided help in explaining the difference in PA. Thanks to James Daley and Florent Losse for providing their measurements of the pair which agree very well with mine. So errors in the measurement or reduction process are improbable. Ross Shuart discussed the measures and compared them to the Hipparcos results and several available elements. He found that Hipparcos measures and my results agree more with the elements by Josties 1981 given in [7]. I have calculated an ephemeris from these elements and plotted it also in figure 3 and 4. My measures in 2006/2007 (see Table 1) seem to be better represented by them.

Conclusion: the orbital motion of 61 Cygni was easily measurable using CCD images with a focal length of only one meter over a time span of 1 ½ years. A CCD image of 61 Cygnii is shown in Figure 5. The ephemeris given by the elements from PkO2006b represents the distance measures very well but should be improved as suggested by the measures of position angle.

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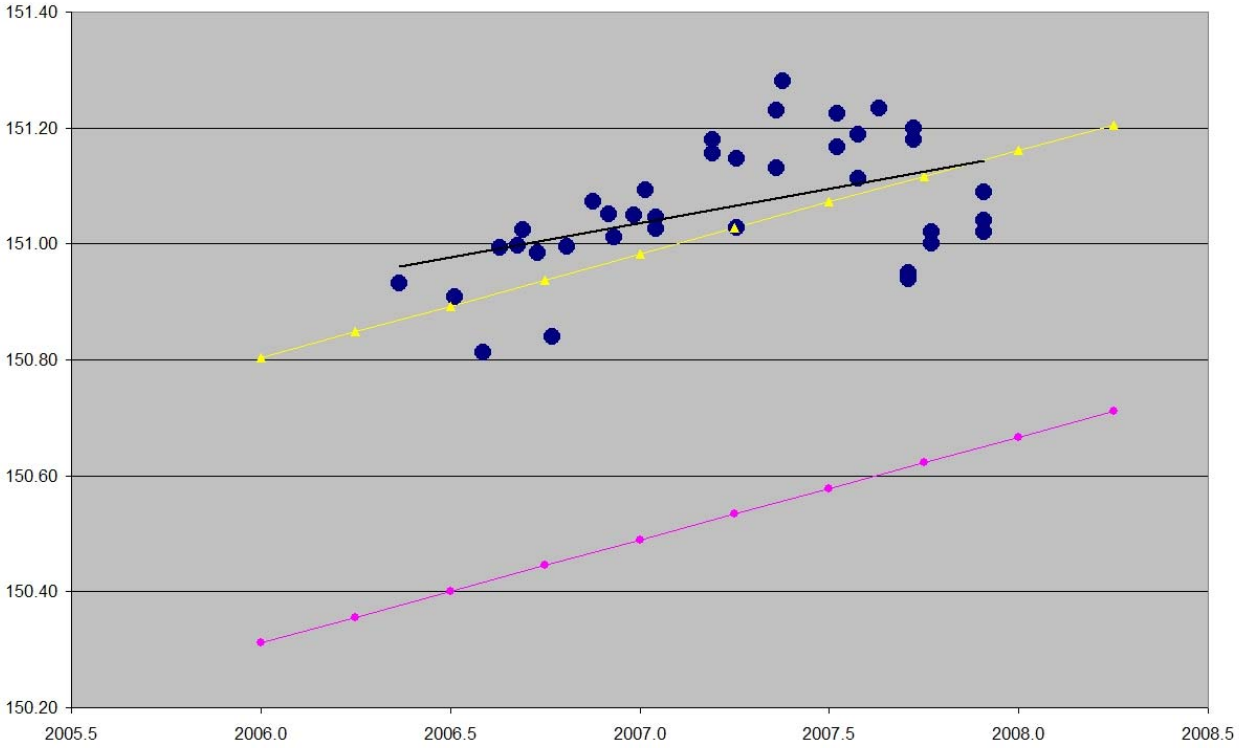

Figure3: Measurements of the position angle plotted over time. The black line is a linear fit to my observations. Red line is from the values given by the elements from PkO2006b. Yellow line is from the values given by the elements by Josties 1981.

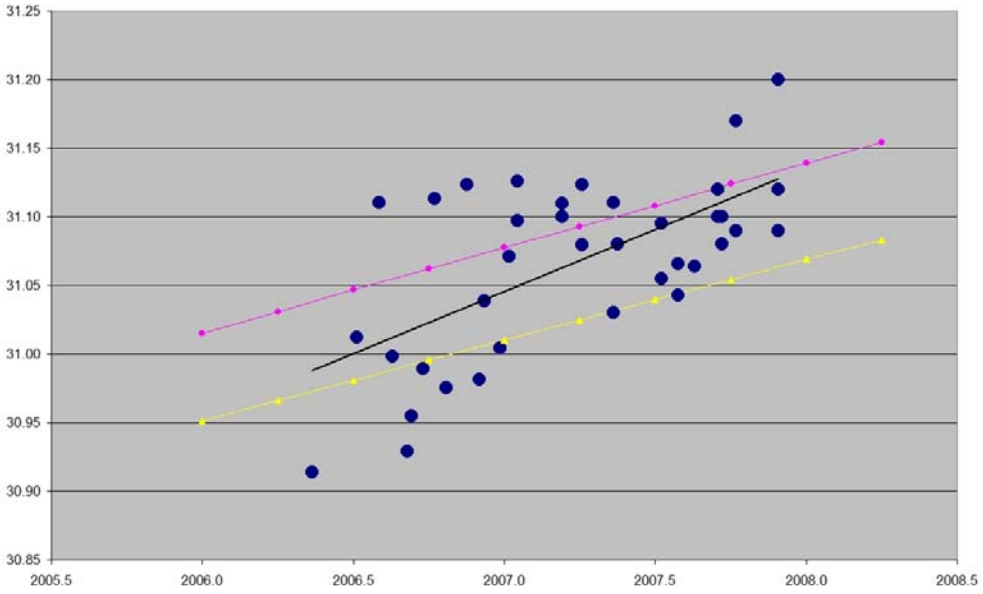

Figure 4: Measurements of separation angle plotted over time. The black line is a linear fit to my observations. Red line is the values given by the elements from PkO2006b. Yellow line is the values given by the elements by Josties 1981.

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Year	Separation (as)	PA (degrees)
2006.364	30.91	150.93
2006.512	31.01	150.91
2006.586	31.11	150.81
2006.630	31.00	150.99
2006.679	30.93	151.00
2006.693	30.95	151.02
2006.731	30.99	150.98
2006.769	31.11	150.84
2006.808	30.98	150.99
2006.876	31.12	151.07
2006.917	30.98	151.05
2006.934	31.04	151.01
2006.986	31.00	151.05
2007.016	31.07	151.09
2007.043	31.13	151.03
2007.043	31.10	151.05
2007.191	31.10	151.18
2007.191	31.11	151.16
2007.257	31.12	151.15
2007.257	31.08	151.03
2007.361	31.03	151.23
2007.361	31.11	151.13
2007.377	31.08	151.28
2007.522	31.05	151.22
2007.522	31.09	151.17
2007.577	31.07	151.11
2007.577	31.04	151.19
2007.632	31.06	151.23
2007.708	31.12	150.94
2007.708	31.10	150.95
2007.722	31.08	151.20
2007.722	31.10	151.18
2007.769	31.09	151.02
2007.769	31.17	151.00
2007.908	31.20	151.02
2007.908	31.09	151.04
2007.908	31.12	151.09

Table 1: Measures of position angle and separation of STF2758AB:

Figure 5: CCD image of 61 Cygnii taken on July 20, 2007. North is up and the image size is approximately 16 x 12 arcminutes.

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