Student Measurements of the Double Star Eta Cassiopeiae

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Abstract: The double star Eta Cassiopeiae was measured at Vanguard Preparatory School. Digital measurements were made with a 14-inch telescope equipped with a CCD camera. The plate scale was determined to be 0.50 arcseconds per pixel. The separations and position angles were determined to be 13.3 arcseconds and 340.4 degrees, by the use of astronomy software. Previous observations reported in the Washington Double Star Catalog were used as a comparison. The camera angle was found to be the ultimate issue in the skewed data gathered for the double star.

Introduction

The Vanguard Double Star Workshop met on the dates of March 7 and 8, 2014. A Celestron 14-inch Schmidt Cassegrain telescope, a Santa Barbara Instrument Group (SBIG) ST8 CCD camera, and the vector components were used. The astronomy software Astrometrica for data reductions was used. Adjustments to the focus of the telescope-CCD camera combination were learned. The plate scale, separations, and position angles of the chosen double star were determined. Eta Cassiopeiae was chosen for its brightness, visibility in the night sky, and because it’s a true double star. The importance of collimating a Schmidt Cassegrain telescope for digital measurements of a double star was learned.

Eta Cassiopeiae was first determined to be a double star by William Herschel in 1799. This double star consists of a primary star, Eta Cas α, a yellow-orange star of magnitude 3.4, and Eta Cas β, an orange dwarf of magnitude 7.5. They are located about 19.4 light years from Earth. Eta Cassiopeiae can be found in the constellation of Cassiopeia. The Washington Double Star Catalog (WDS) lists the location and identifier of the double star at right ascension 004905.14+574859.4 and named STF 60AB. Over a thousand measurements have been reported in the WDS. The first epoch for separation and position angle was reported to be 11.3 arcseconds and 62 degrees, and the last epoch to be recorded was 13.3 arcseconds and 324 degrees.

The double star Eta Cassiopeiae can also be found in the online database called Set of Identifications, Measurements, and Bibliography for Astronomical Data (SIMBAD). The database lists multiple identifiers for the double star: SAO 21732, HIP 3821, HR 219, and USNO 793. SIMBAD offers plots and images of the

Figure 1: Field orientation for the double star Eta Cassiopeiae.
double star with field orientation for precise astrometry. Figure 1 is an image from the Aladin Sky Atlas which was found through SIMBAD’s database.

**Equipment and Procedure**

A 14 inch Celestron Schmidt Cassegrain telescope on a fork mount equipped with a Santa Barbara Instrument Group (SBIG) ST8 CCD camera was used for capturing and analyzing the plate scale, separation, and position angle of the double star Eta Cassiopeiae. The plate scale was determined by the following equation:

\[
 Z = \frac{(206264.806)(0.009)}{3910}
\]

where 206264.806 is one radian in one arcsecond, 0.009 is the pixel size of one two-dimensional pixel in millimeters, and 3910 is the focal length in millimeters.

The separation was determined by the following equation:

\[
 c^2 = a^2 + b^2
\]

where \( c^2 \) is the separation in arcseconds, \( a^2 \) is the difference in the x-axis squared, and \( b^2 \) is the difference in the y-axis squared.

The position angle was determined by the following equation:

\[
 \tan \theta = \frac{b}{a}
\]

where \( \theta \) is the position angle in degrees, \( b \) is the difference in the y axis, and \( a \) is the difference in the x axis.

**Observations**

Observations and analysis were made on Friday, March 7 and Saturday, March 8, 2014 (B2014.1799 and B2014.1825) in the small abandoned park of Vanguard Preparatory. Multiple images were gathered for precise measurements of the double star Eta Cassiopeiae. The centroid of the double stars was determined by tightening the focus of the double star for precise measurements. The astronomy software Astrometrica was used to locate the x and y values for the measurements of the separations and position angles. The team determined the plate scale of the telescope/CCD camera combination to be 0.50 arcseconds per pixel. The separations and position angles were determined to be 13.3 arcseconds, and 340.4 degrees. A comparison of the last epoch listed in the Washington Double Star Catalog was gathered. A difference of 0.1 arcseconds for separation and 17.4 degrees for position angle was determined. The large difference in position angle was due to not taking into account the camera angle not being zero degrees.

**Conclusions**

The setup and operation of a Schmidt Cassegrain telescope with a CCD camera attached was learned. The importance of adjusting the focus, so the object was visually the smallest for pin-point accuracy was determined noteworthy. The plate scale, separations, and position angles measurements for comparison to the Washington Double Star Catalog were determined. The importance of calibrating the position angle of the camera, as it is very difficult to insert the camera such that its orientation is exactly north-south, was noted.
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The camera angle should have been determined by calibration measurements such as drifts either before or after the observations were made.

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References.

