Conversion Formula for the Celestron Micro Guide Eyepiece Used to Determine Position Angles

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Abstract: The Celestron Micro Guide eyepiece is used to measure the position angle of double stars. Mathematical formulas are used to convert values from one circular scale to another. This enables observers to measure values on an easy to read scale and convert the readings to values on another scale where the numerals are often more difficult to read. The latter are used to obtain position angles. Observations were made in all four quadrants to test the formula.

Introduction

Visual measurements of double stars use astrometric eyepieces to measure the separation and position angle. The Celestron Micro Guide astrometric eyepiece has two circular scales for measuring the position angle depending on the type of telescope being used. The inner scale numerals are larger and easier to read than the outer scale numerals that are smaller and difficult to read, despite focusing the eyepiece. A spreadsheet formula generated by the authors allows the observer to ascertain the outer scale values and position angles from inner scale values.

Position Angle Measurements

The outer two protractor-like or circular scales on the Celestron Micro Guide eyepiece measures the position angle. These scales are mirror images of one another. See Figure 1 for the pattern of the circular scales used in this eyepiece (Note: the actual reticle has a different appearance; only certain numbers are highlighted here). The inner circle scale (white numbers on black ovals) shows key values. Zero degrees on the inner scale is opposite 180 degrees on the outer scale; these scale values are reversed on the opposite side of the reticle. The values of 90 and 270 degrees are in the same position on both scales. Inner scale values increase in a counter-clockwise direction; outer scale values increase in a clockwise direction. Newtonian telescopes must use the outer scale to obtain the proper position angle values (Argyle, p.153). Smaller numerals on the outer scale make it difficult to read for some observers. This is especially true when the telescope being used has an alt az mount and uses the drift method for obtaining position angles (Frey, 2008). It may also be difficult to read the outer scale values when it is necessary to lower the illumination of the reticle so that the dimmer secondary star can still be detected.

Drift Method Technique

The drift method for determining position angles involves the following technique:

1. Rotate the eyepiece until the primary and secondary stars are aligned on the linear scale. Be sure the primary component is oriented toward the 60-division mark and the secondary toward the zero mark.

2.Turn off the drive motors.

3. Move the telescope to a position so the primary star can drift through the center (the 30th division mark) of the linear scale. This often takes several tri-

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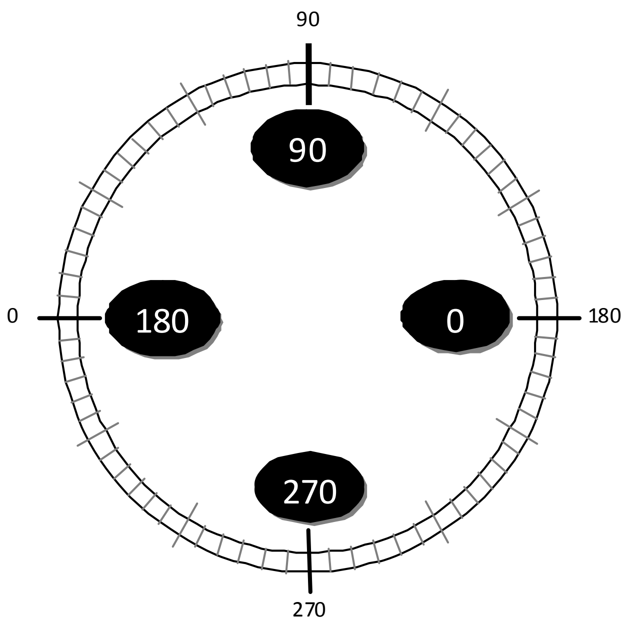

Figure 1: Celestron Micro Guide Astometric Reticle

als to accomplish.

4. Once this orientation is successful, allow the double star pair to drift to the circular scales.

5. As the primary star crosses the inner circular scale, record the angle and estimate to the nearest degree.

Conversion Formula

Two multiple "IF" formulas have been generated by the authors using a Microsoft Excel spreadsheet that allows an observer to record the value on the inner scale where the numerals are easier to read and convert it to the corresponding outer scale value. The outer scale value is then converted to the corresponding position angle.

Changing the inner scale value to the number on the outer scale does not give you the position angle directly. To get the position angle, 90 must be added to the outer scale value. And if this value exceeds 360 then 360 must be subtracted from this value to obtain the correct position angle.

Table 1 shows hypothetical examples of Inner Scale Values for all four quadrants of the circular scales, the corresponding calculated Outer Scale Values, and the calculated Position Angles.

Inner Scale Value: input from the observer based on recorded measurement and entered into cell A3.

Outer Scale Value: The value generated in cell B3 is produced from the following formula.

```
=IF(A3>360,"NA",IF(A3>180,540-A3,IF(A3>=0,180-A3)))
```

where cell A3 contains the input value from the inner scale. Formulas for values in column B are identical except for the corresponding row number.

Position Angle: The value generated in cell C3 is produced by simply adding 90 to the outer scale value in cell B3. If the value in C3 is less than or equal to 360, it corresponds to the position angle. If the value exceeds 360 then 360 must be subtracted from the value to obtain the correct position angle. The second "IF" formula makes this conversion.

```
=IF(B3+90<360,B3+90,IF(B3+90>=360,B3+90-360))
```

Note that this formula only applies to the Celestron Micro Guide astrometric eyepiece when used with a Newtonian telescope. If the reticle eyepiece made by a company other than Celestron is used, the formula does not apply.

Table 1: Excel Spreadsheet Examples for Converting Inner Scale Values to Position Angles

	A	B	C
2	Inner Scale Value	Outer Scale Value	Position Angle
3	45	135	225
4	115	65	155
5	192	348	78
6	288	252	342

Observations

Position angle measurements were carried out on four different double stars, each with a position angle in a different quadrant, and the data used to test the formula. The resulting values were compared with position angles from the Washington Double Star Catalog. All observations were made using the inner circular scale. The results are shown in Table 2; all values are in degrees. Eight trials were carried out for each double star and the mean value of the inner scale values determined (Mean ISV). The outer scale values and position angles were determined from the formulas. The calculated position angle is compared with the position angle from the Washington Double Star Catalog, PA(WDS). The DPA row corresponds to the difference between the position angles determined by observation/calculation and the values obtained from the WDS Catalog.

The values of the position angles determined from

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the formulas are very close to those obtained from the WDS. The 2.0° difference between the observed and WDS value for 61-Cygni is probably due to the shorter separation of 28 arcs-seconds compared to the separation of 34.7, 40.6, and 57 arcs-seconds in the others. The smaller the separation, the harder it is to align the double stars on the linear scale prior to determining the position angle. A false alignment can lead to an incorrect drift direction. 61 Cygni was also at the zenith when the measurement was made, making it difficult to move the telescope into the proper orientation for an accurate series of drifts.

Acknowledgments

The authors would like to thank Norma Frey, Jolyon Johnson, and Russell Genet, for their constructive suggestions regarding this paper.

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Table 2: Position Angle of Four Double Stars Obtained from Conversion Formula

Double Star	β-Cygni	61-Cygni	δ-Cephei	35-Cass
Mean ISV	214	117	80	289
Outer Scale	326	63	100	251
Position Angle	**56**	**153**	**190**	**341**
PA(WDS)	**56**	**151**	**191**	**342**
Epoch	2008	2008	2008	2001
DPA	0	+2	-1	-1

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