

# A Simple Method for Reproducing Orbital Plots for Illustration Using Microsoft Paint and Microsoft Excel

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**Abstract:** Papers published in the astronomical community, particularly in the field of double star research, often contain plots that display the positions of the component stars relative to each other on a Cartesian coordinate plane. Due to the complexities of plotting a three-dimensional orbit into a two-dimensional image, it is often difficult to include an accurate reproduction of the orbit for comparison purposes. Methods to circumvent this obstacle do exist; however, many of these protocols result in low-quality blurred images or require specific and often expensive software. Here, a method is reported using Microsoft Paint and Microsoft Excel to produce high-quality images with an accurate reproduction of a partial orbit.

## Introduction

Accurate orbital reproductions are often difficult and time-consuming requiring advanced software coupled with a thorough knowledge of the program. Many of these methods do not translate well into Microsoft Excel graphs and attempts often result in low-quality images instead of high-quality plots. To this end, a method was developed that allows for high-quality reproductions to be made in Microsoft Excel using data extracted from images with Microsoft Paint. For purposes of illustration, recent work published on the binary star WDS 15559-0210 will be reproduced.

## Methods

An orbital plot and the represented data points were obtained from the Washington Double Star Catalog (WDS) maintained by the United States Naval Observatory (ref: Washington Double Star Catalog). The data points were filtered (Musegades et al 2017) and plotted in MS Excel (Figure 1). The orbital plot was opened in MS Paint and the image was cropped to only include the third (lower left) quadrant. This placed the origin of the plot in the upper right corner of the image corresponding to pixel (230,0) as read in the cursor position readout at the bottom left corner of the MS Paint screen (Figure 2). Using the cursor position, 0 arcseconds (") corresponded with 0-pixels and -5" with 160 pixels. This means that, for this image, 1" is equivalent to 32 pixels. This was an important conversion factor needed for plotting the orbit in MS Excel.

Next, using the cursor position readout, five points were collected from the orbit itself and the corresponding pixels recorded in MS Excel. Two additional points were collected for the endpoints of the orbit as determined by the window range desired for the graph. Each of the points was subtracted from the identified origin so that the new coordinate was in terms of distance from the origin. These values were made negative in order to correspond with the third quadrant. The points were converted to arcseconds with the conversion factor mentioned above.

For this equation, Q is the quadrant multiplier (-1

$$(x_{excel}, y_{excel}) = (Q_x * C.F. * |x_{origin} - x_n|, Q_y * C.F. * |y_{origin} - y_n|)$$

for both x and y in Quadrant Three), C.F. is the conversion factor (1/32 for this example), and includes the pixel coordinates for the origin (230, 0)

These points, now in arcseconds from the origin,

$$(x_{excel}, y_{excel}) = \left( -\frac{1}{32} * |230 - x_n|, -\frac{1}{32} * |0 - y_n| \right)$$

were added to the MS Excel graph (Figure 3). Finally, as shown in Figure 4, a polynomial trend line of the extracted data points was added and the points were rendered invisible (Format Data Series – Marker Option – None).

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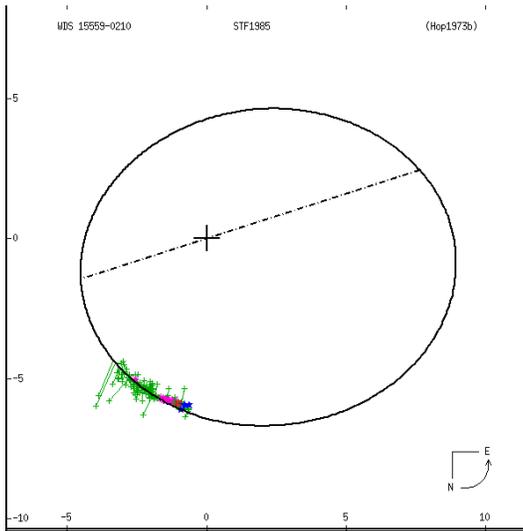


Figure 1. Two-dimensional orbital plot of WDS 15559-0210 (left) with the data points provided by the WDS plotted in Microsoft Excel (below).

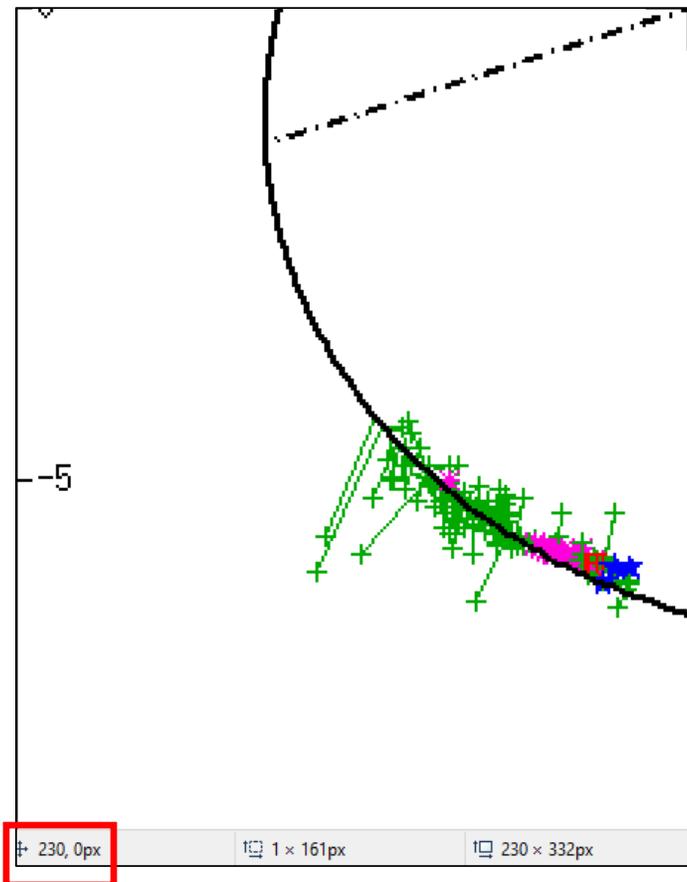
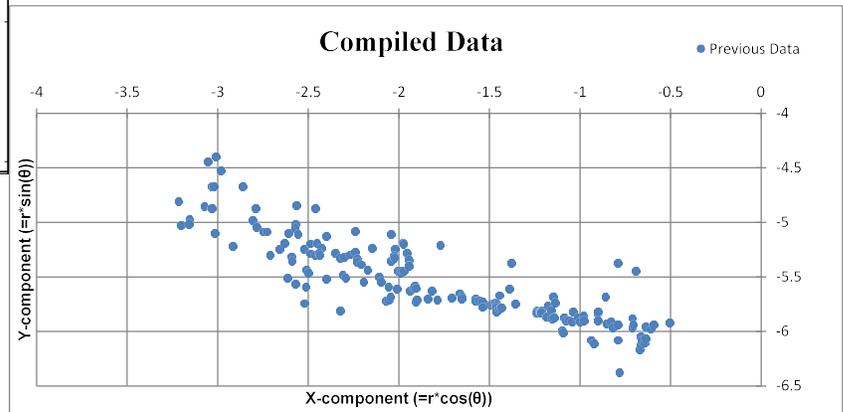


Figure 2. The orbital plot cropped to only include *Quadrant Three*. This places the origin of the orbit at pixel (230, 0) in the MS Paint Screen. Cursor position is shown in the bottom left corner of the screen and is highlighted in the figure with a red box.

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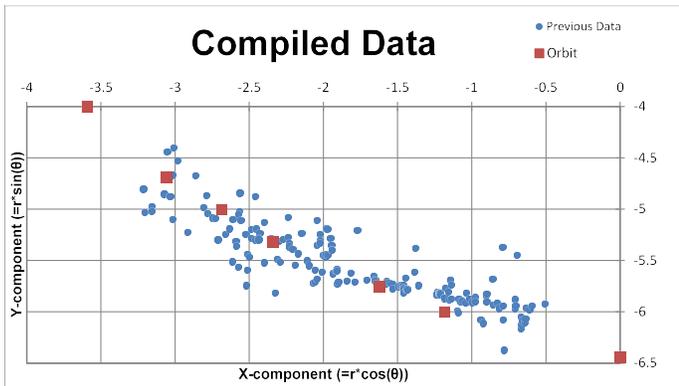


Figure 3. The points extracted from the published orbit (in pixels) were converted to arcseconds and plotted with the previous data points.

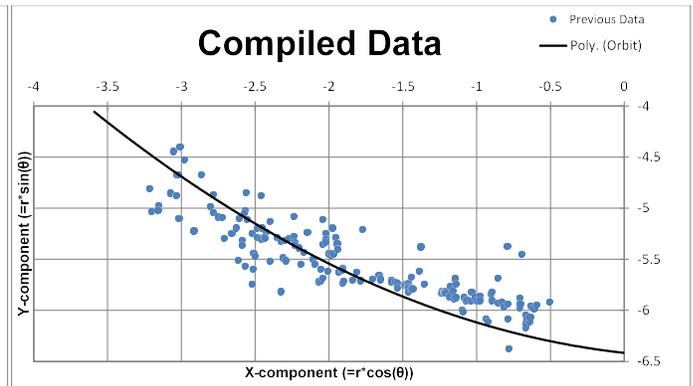


Figure 4. The “final product” where a reproduced orbit using the trend line feature is included with the previous data points for comparison.

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**Discussion**

This method has many advantages but is not without limitation. The advantages include the low price, accessibility, and ease of use of the MS Paint software and MS Excel. The resultant plot is not completely accurate, but it does serve as a good approximation sufficient for illustrating small arcs of an orbit. As seen in Figure 5, the 2<sup>nd</sup>- through 5<sup>th</sup>-order polynomial trend lines quickly lose fidelity to the orbit once the domains of the functions move beyond the preselected data points. Within the scope of the selected data, however, the trend lines and published orbit overlap together nearly identically.

**Acknowledgements**

It is a pleasure to thank Brian Mason from the United States Naval Observatory for supplying the historic data collected in the Washington Double Star Catalog. Thanks are also due to Richard Harshaw, John Kenney, and Vera Wallen for their services as external reviewers.

**References**

Musegades, L., Niebuhr, C., Graham M., Poore, A., Freed, R., Kenney J., Genet, R., 2017, “An Astrometric Observation of Binary Star System WDS 15559-0210 at the Great Basin Observatory”, *Journal of Double Star Observations*, 14(2), 197 (this issue).

The Washington Double Star Catalog, 2012, Retrieved July 06, 2017, from <http://www.usno.navy.mil/USNO/astrometry/optical-IR-prod/wds/WDS>

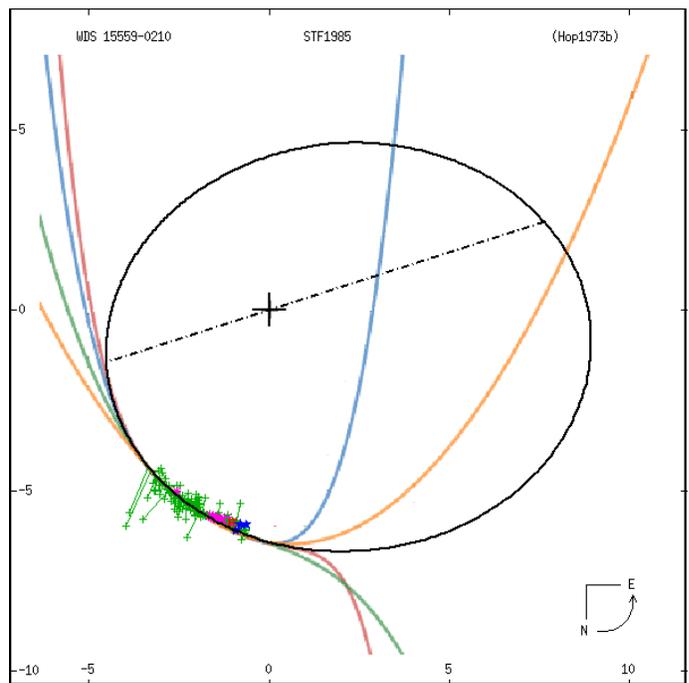


Figure 5. MS Excel trend lines plotted for comparison with the published orbit (black). The plots includes 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> order polynomial trend lines (colored). The graphs were produced with the Desmos software and MS Paint was used to paste the graphs onto the orbital plot by aligning the origin of the two images.