

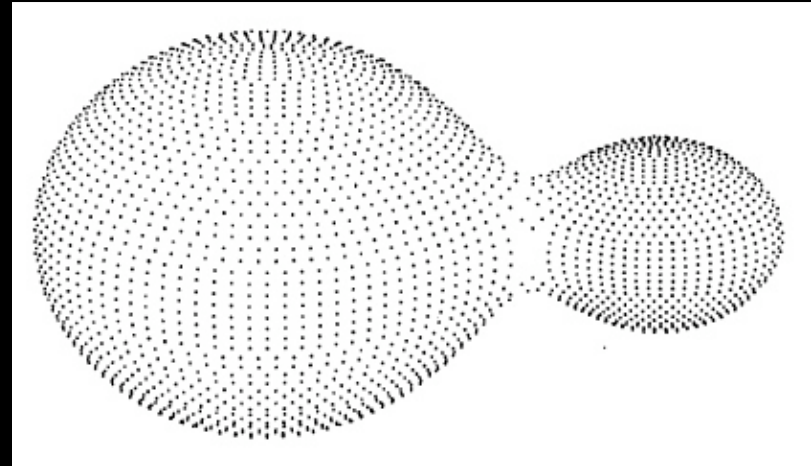
Multi-color survey of W UMa binaries

by Andy Howell

Nov 7, 2009

Color survey was begun in 2003 to observe W UMa binary systems in BVR_cI_c colors

- BVR_cI_c colors support structural modeling of W UMa binary systems.
- Dirk Terrell originally suggested the research.



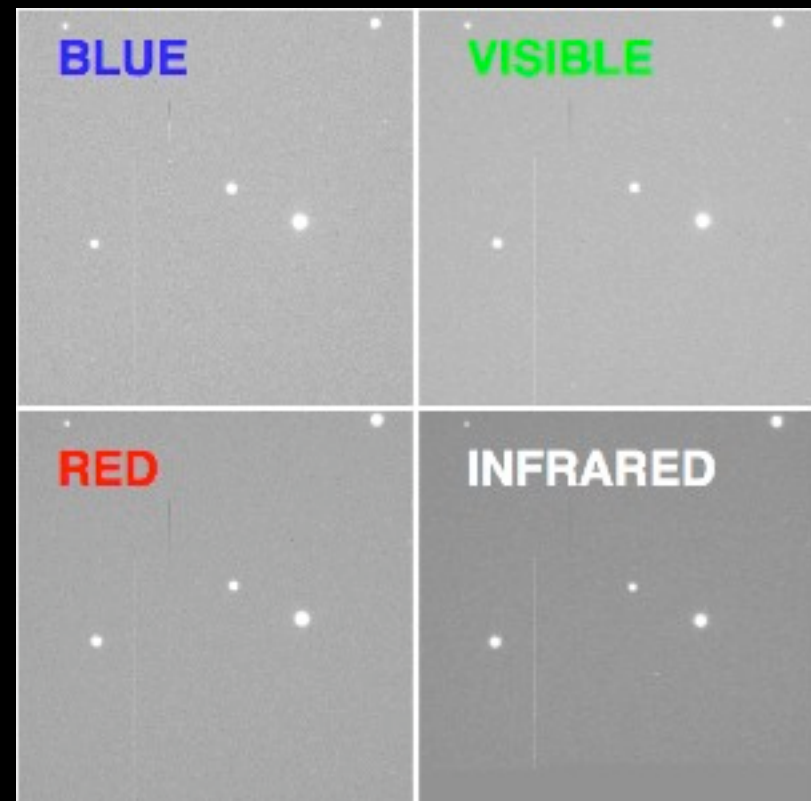
AAS Small Research Grant enabled purchase of $BVR_c I_c$ filters and filter wheel

- 11-inch SCT
- ST-9E camera
- $BVR_c I_c$ filters
- ST-8 filter wheel
- 1 willing observer



35 binary systems and 14 Landolt standards observed, Nov - Dec 2003

- 379 tracks on nine nights
- 1,516 total CCD frames
- Exposures ranged from 5 to 30 seconds
- Used Alt-Az mode for tracking.
- All-Sky photometry



Four frames = 1 track

Having the right tools saves time, makes for fun, and improves scientific value

Task	Tool
Image Acquisition	Maxim DL
Photometric Reduction	Mira AL
Airmass calculation	AAVSO Airmass Calculator
Data Storage and Retrieval	FileMaker Pro
Statistical Analysis	Minitab

AAVSO airmass calculator is a useful tool in the observer's toolkit

Date of Observation	<input type="text" value="2452958.54225"/>	JD or yyyy/mm/dd/hh/mm/ss (UT)
Observer Latitude	<input type="text" value="29.6691"/>	dd.ddd. North is positive, South is negative
Observer Longitude	<input type="text" value="-82.3752"/>	dd.ddd or dd mm ss. West is - or W, East is + or E (12.123E or +12.123)
Target RA	<input type="text" value="310.647859"/>	degrees or hh:mm:ss or hh mm ss
Target Dec.	<input type="text" value="0.459361"/>	degrees or dd:mm:ss or dd mm ss
Aperture	<input type="text"/>	cm (optional - only required for scintillation)
Integration Time	<input type="text"/>	seconds (optional - only required for scintillation)

Build a URL text string to trigger the AAVSO air mass calculator

<http://www.aavso.org/cgi-bin/airmass.pl?&>

[jd=2452958.542257&](#)

JULIAN DATE

[lat=29.6691&long=-82.3752&](#)

LAT & LONG

[ra=310.647859&dec=0.459361](#)

RA & DEC

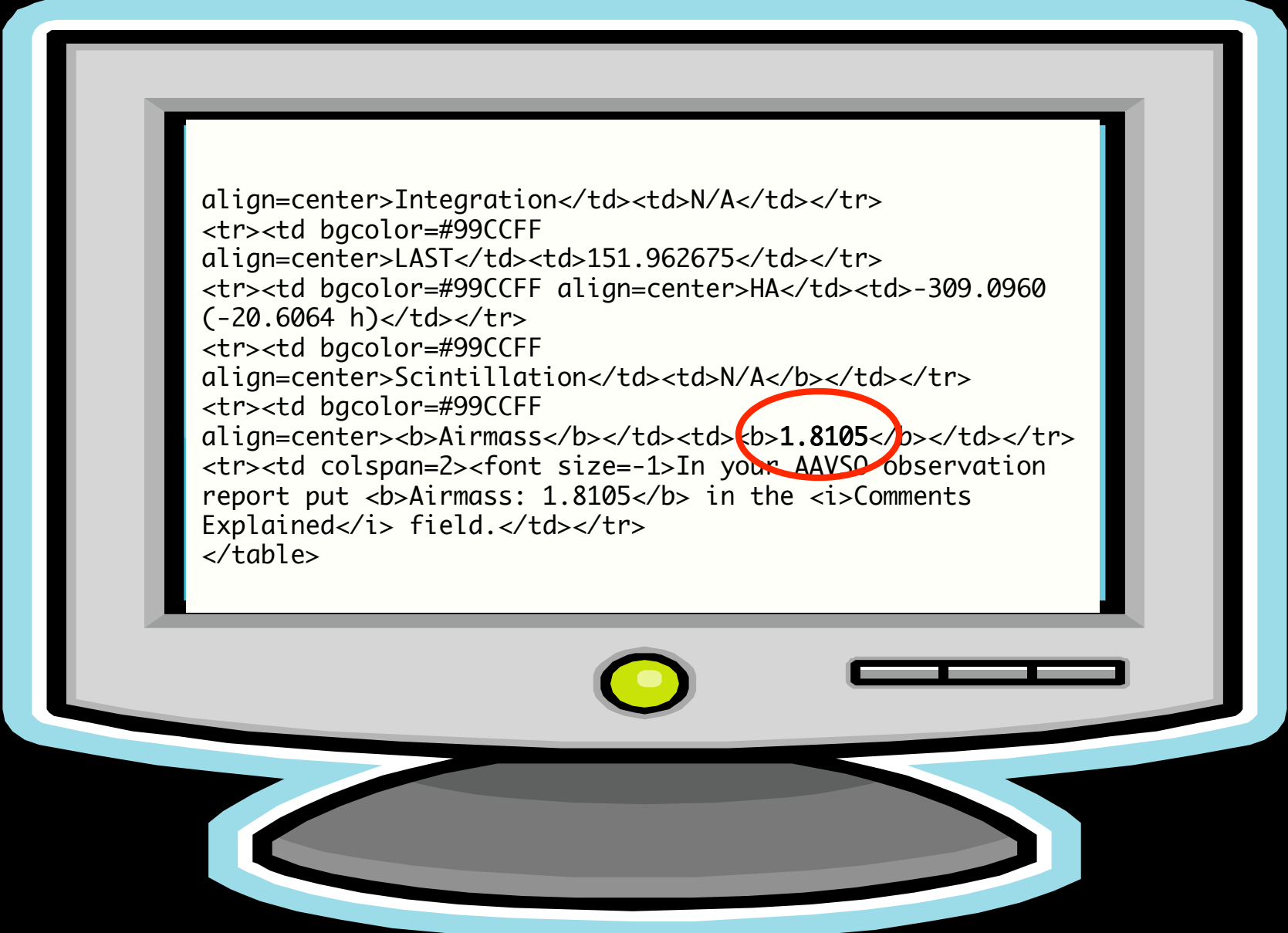
Pasting the URL text string into a browser triggers the AAVSO airmass calculator

RA	310.647859
Dec.	0.459361
Lat.	29.6691
Long.	-82.3752
Date	2452958.542257
Aperture	N/A
Integration	N/A
LAST	151.962675
HA	-309.0960 (-20.6064 h)
Scintillation	N/A
Airmass	1.8105

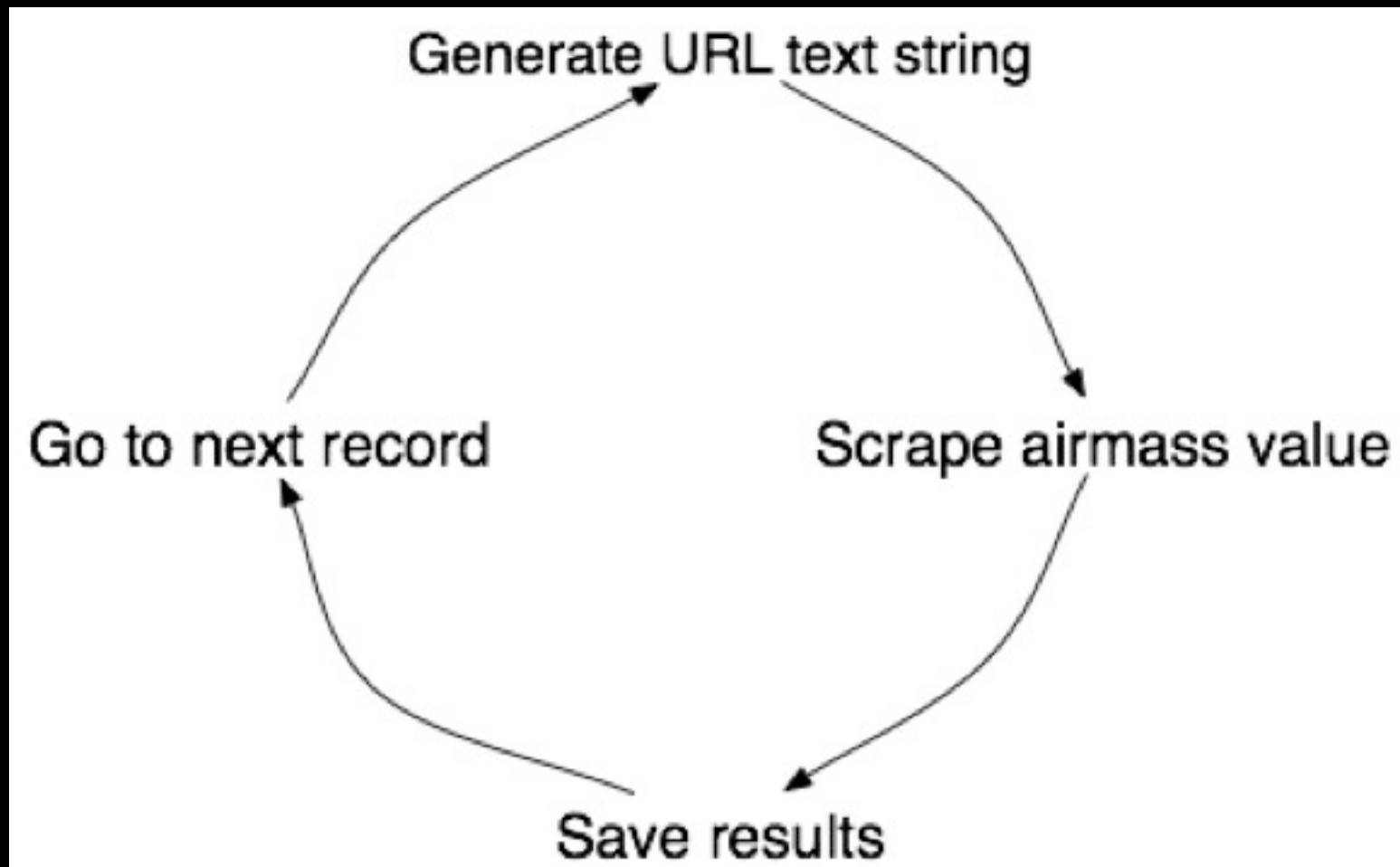
In your AAVSO observation report put **Airmass: 1.8105** in the *Comments Explained* field.

“Scrape” the airmass value from the screen

```
align=center>Integration</td><td>N/A</td></tr>
<tr><td bgcolor=#99CCFF
align=center>LAST</td><td>151.962675</td></tr>
<tr><td bgcolor=#99CCFF align=center>HA</td><td>-309.0960
(-20.6064 h)</td></tr>
<tr><td bgcolor=#99CCFF
align=center>Scintillation</td><td>N/A</b></td></tr>
<tr><td bgcolor=#99CCFF
align=center><b>Airmass</b></td><td><b>1.8105</b></td></tr>
<tr><td colspan=2><font size=-1>In your AAVSO observation
report put <b>Airmass: 1.8105</b> in the <i>Comments
Explained</i> field.</td></tr>
</table>
```



1,516 air mass values were scraped from AAVSO web site using FileMaker macro



Transform instrumental colors to standard colors using regression modeling

$$CI = f(\text{instrumental color}, \text{airmass}, \text{night}) + \text{error}$$

Standard Color



Observational Data

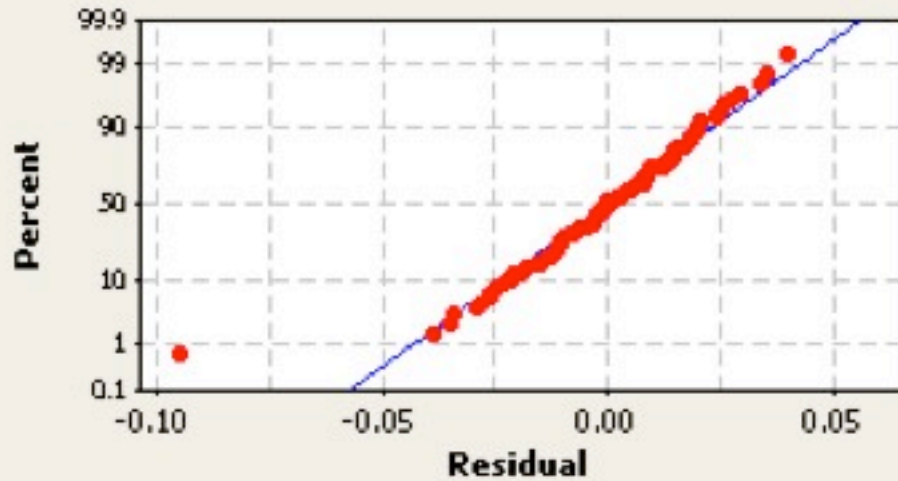
Residual error

Data were analyzed *en masse* to get a global solution for transformation coefficient, extinction coefficient, and zero pts.

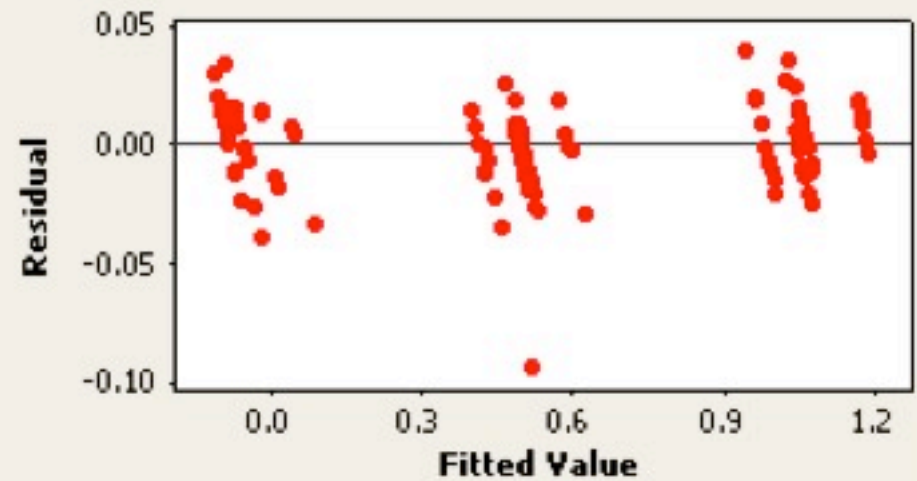
Analyze residuals to diagnose model fit

Residual Plots for B-V

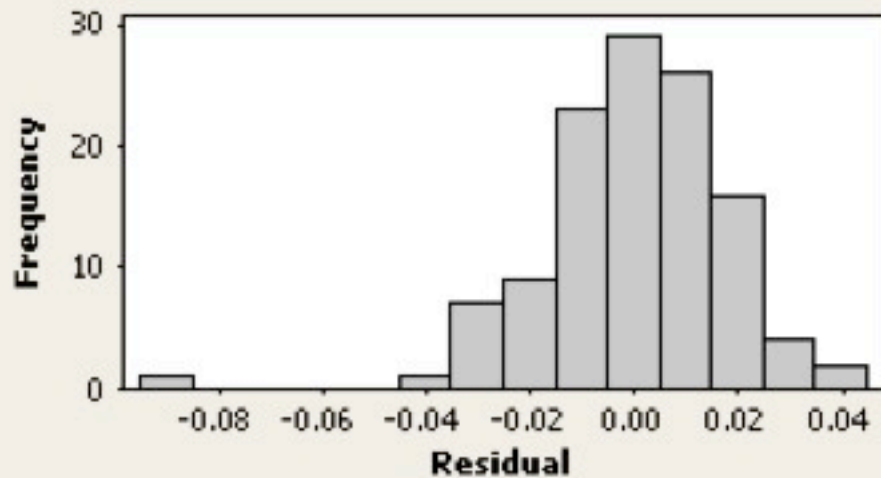
Normal Probability Plot of the Residuals



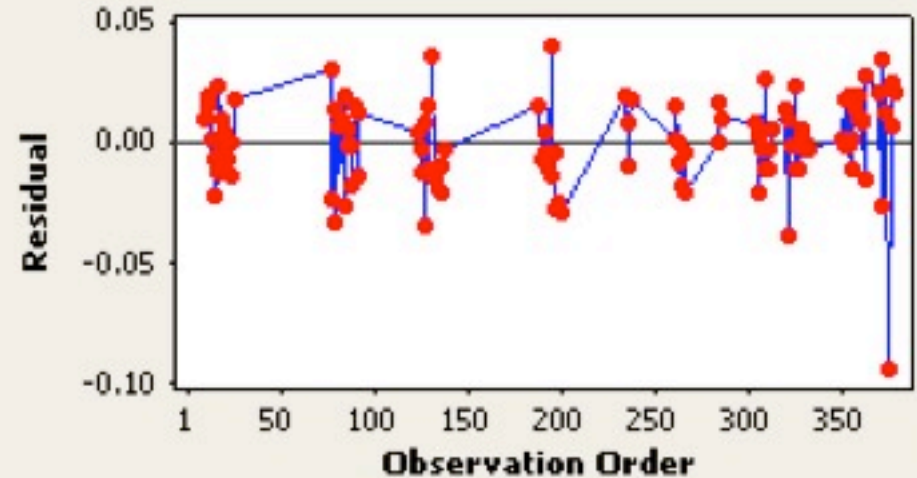
Residuals Versus the Fitted Values



Histogram of the Residuals

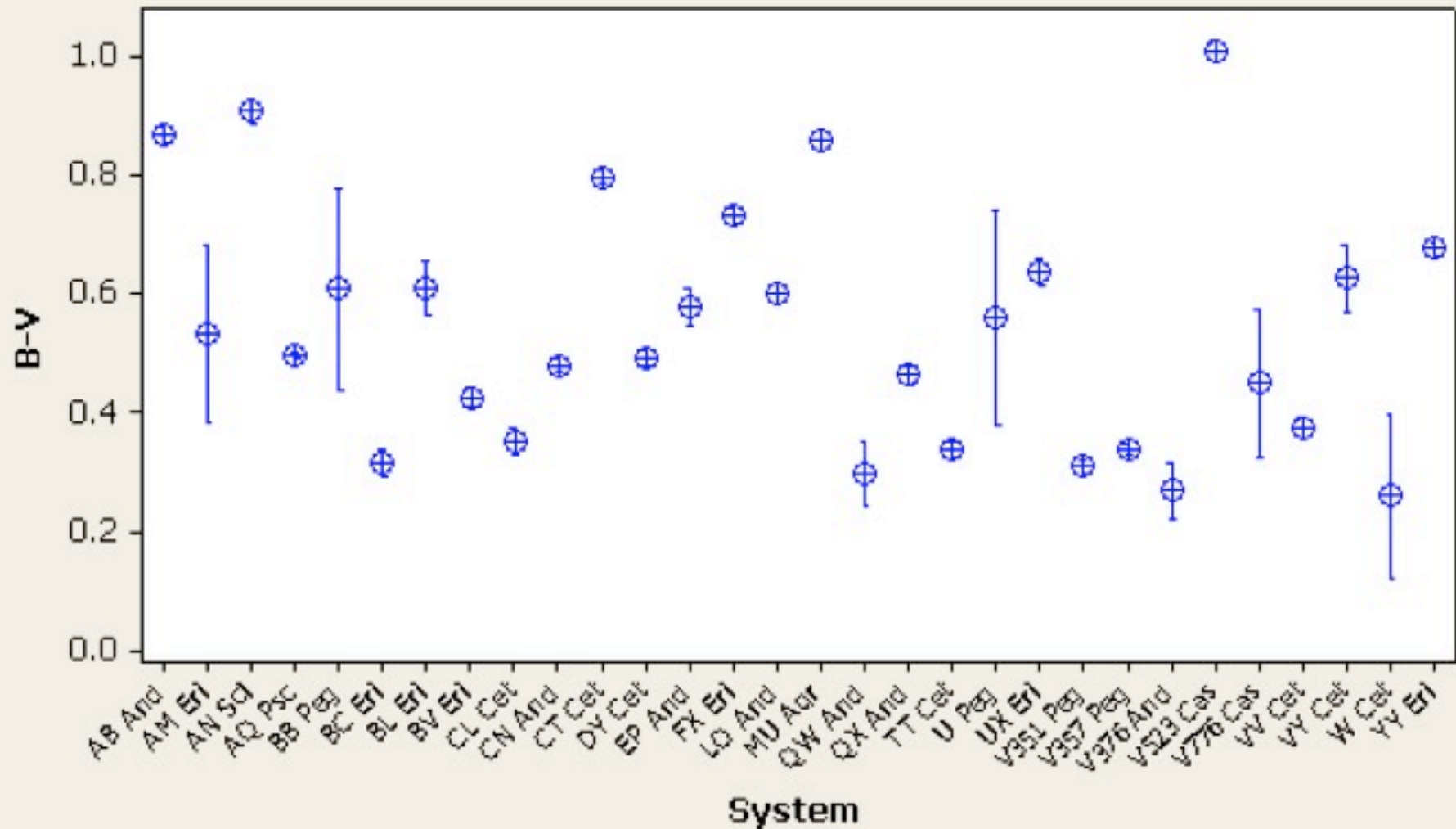


Residuals Versus the Order of the Data



Calculate 95% C.I.'s of B-V for the program stars

Interval Plot of B-V vs W UMa Binary System
95% CI for the Mean



If I were to do this again, I would . . .

- Avoid objects that are optical doubles.
- Focus on systems brighter than 12th magnitude.
- Figure out how to capture air mass and filter in the FITS header.
- Don't wait six years to reduce the data.



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Questions?