

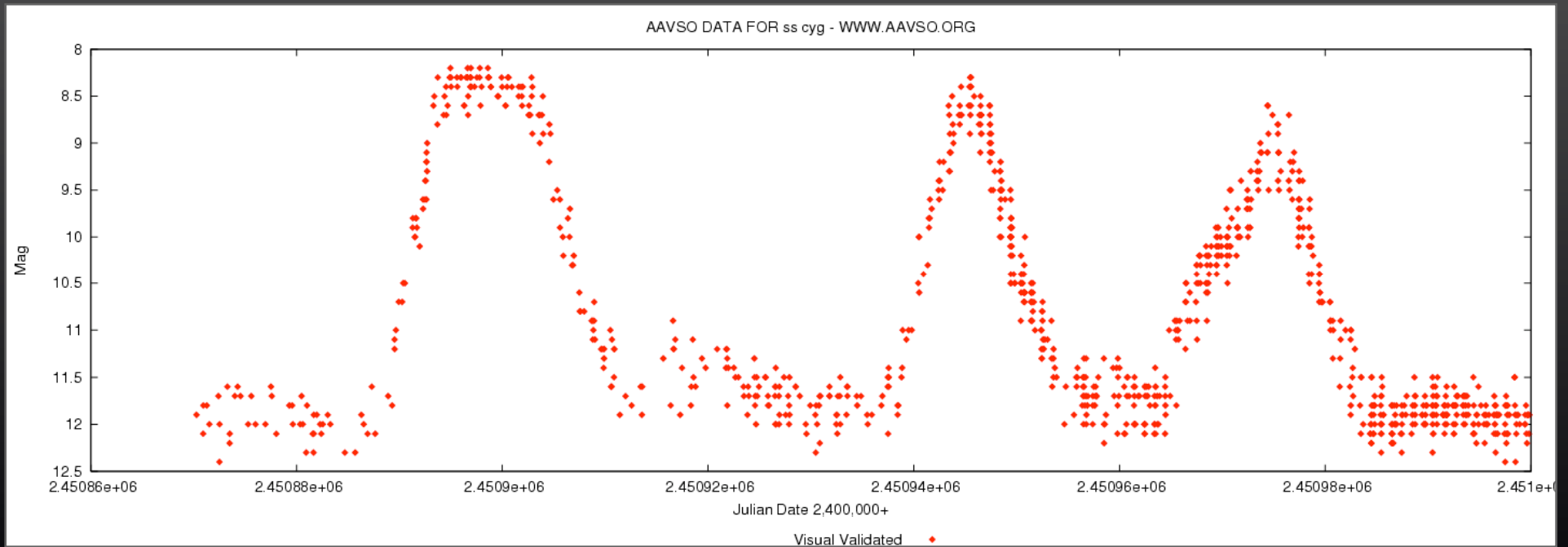
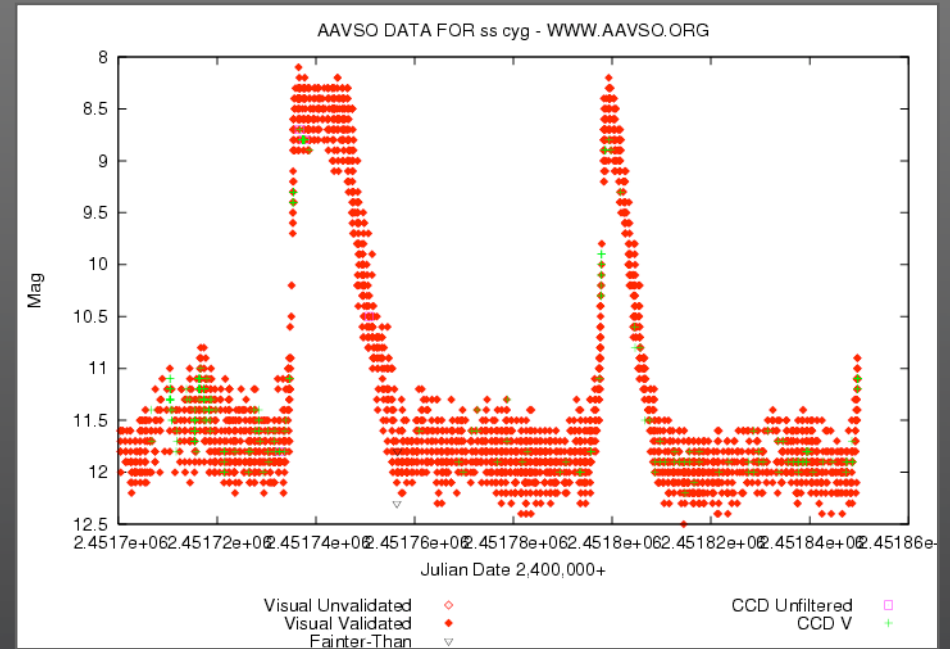
# A New Look At SS Cyg



Aaron Price, AAVSO  
95th Spring Meeting of the AAVSO  
Rockford, IL

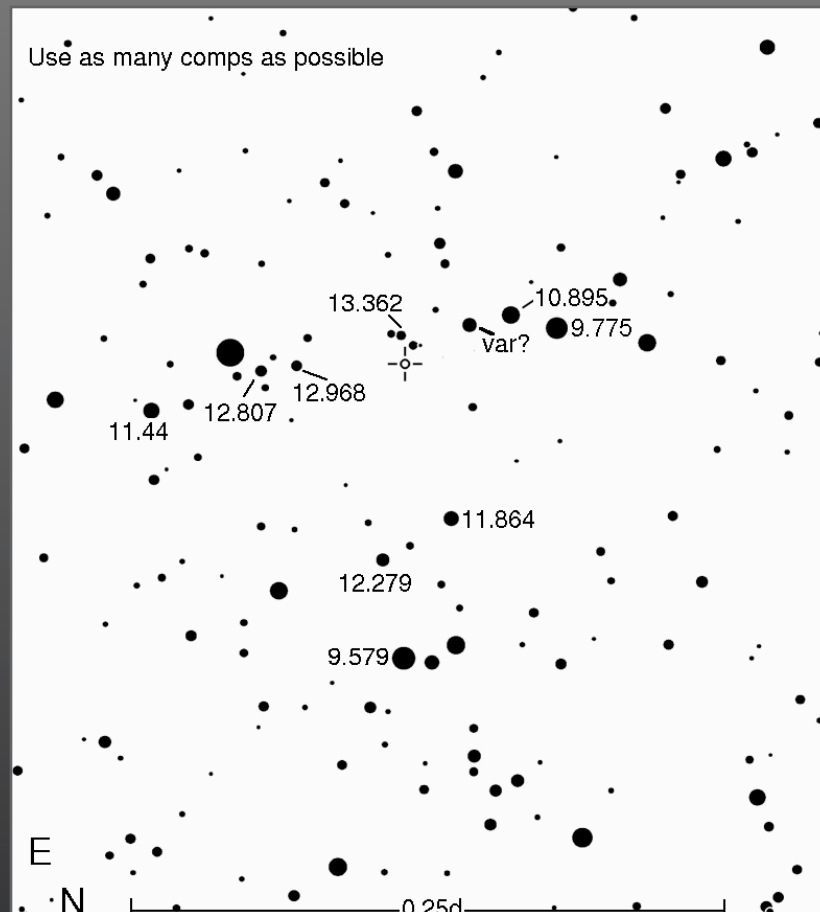
# SS Cyg Outbursts

- Long/Wide ( $>12$ d)
- Short/Narrow ( $<12$ d)
- Anomalous
- Cannizo & Mattei (1998)
- Fast (82%:  $\sim 2.3$  mags/day)
- Slow ( $\sim 0.5$  mags/day)
- The “Glitch”
- Sampling



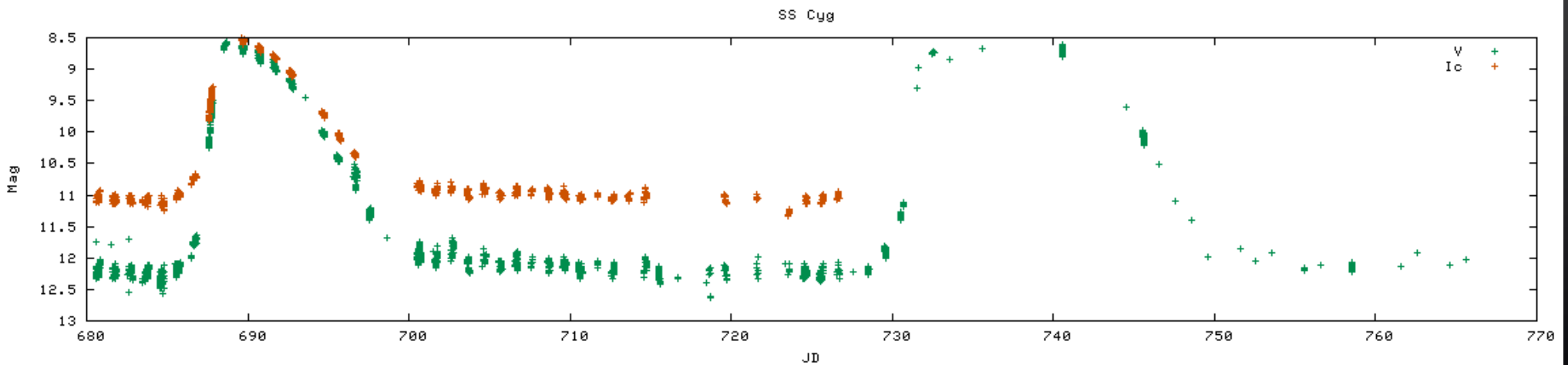
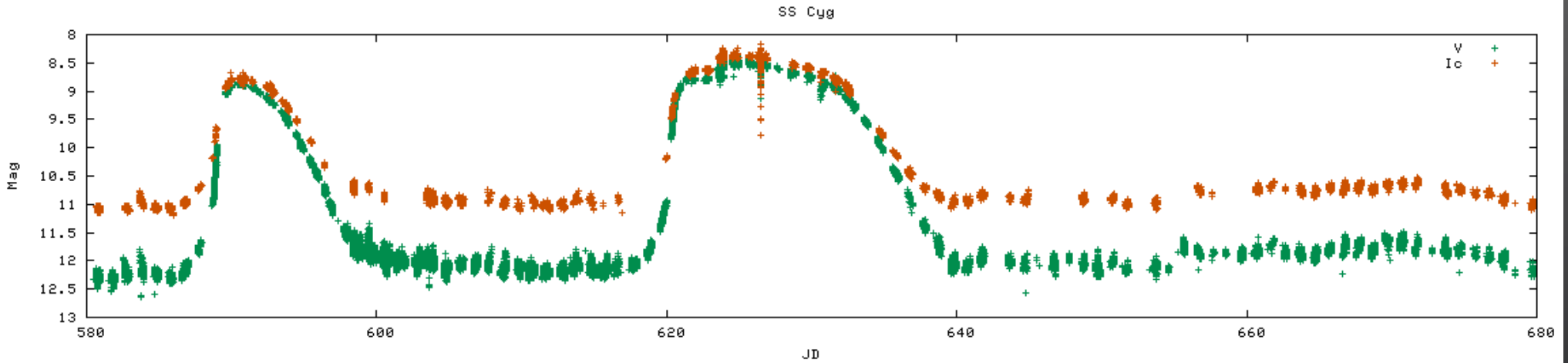
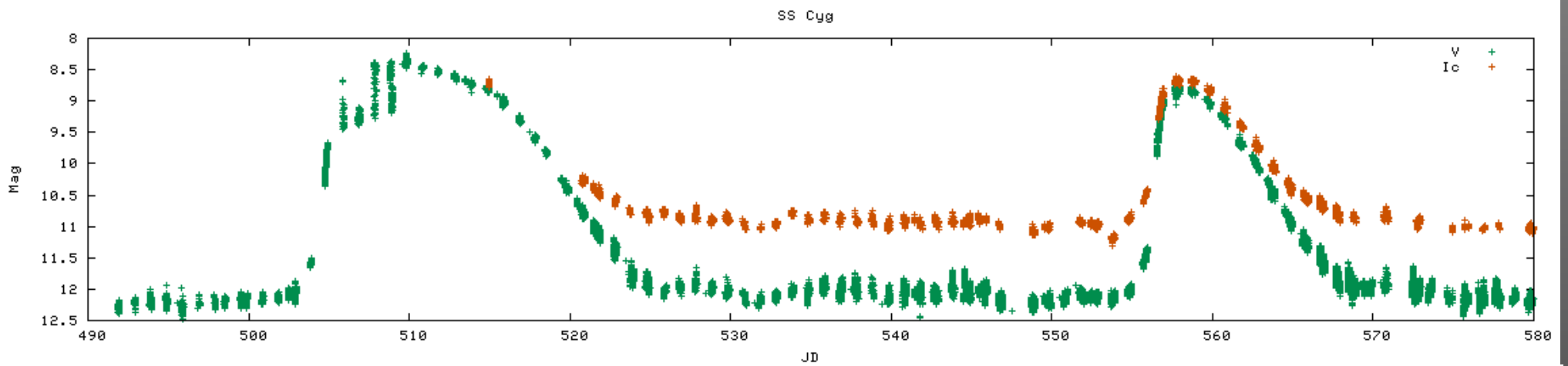
# At a Glance

- **Primary Goal:** Test for outburst precursors
- **Secondary Goals:** Search for the “glitch” and any other recurring behavior; Higher resolution tests of previously published results
- **Tertiary Goal:** Create a high-quality, intensive data set for use by professional researchers
- **Method:** High precision CCD data for as long as possible, each night.
- Preparation and practice in April, 2005
- Full campaign May 1 - Oct. 1, 2005
- Volunteer follow up Oct. 1 - Jan. 29, 2006
- Ic began May 29, 2005



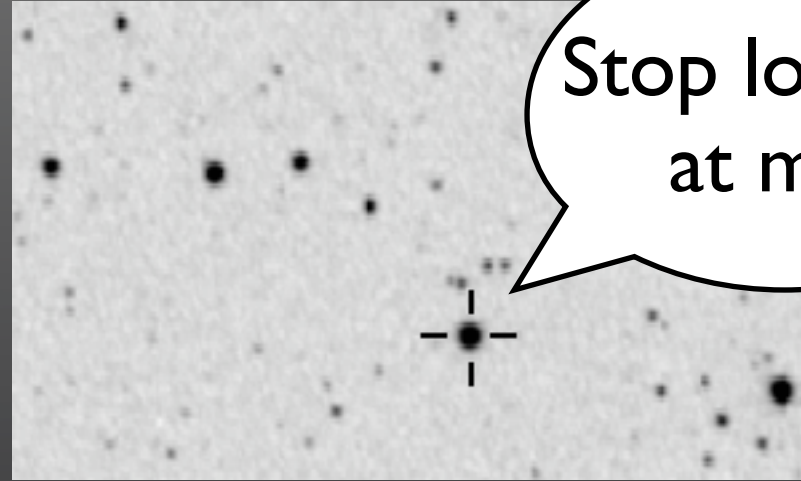
V	B-V	V-R	R-Ic
9.775	0.379	NA	NA
10.895	0.522	0.312	0.270
11.44	0.600	NA	NA
11.864	0.620	0.358	0.328

# Let there be photons...



# And it was good...

- 95,720 V Observations
- 11,467 Ic Observations
- 274 days of coverage
- *~134,496 minutes of observing time*
- 2,241.6 hours
- 93.4 days
- 3,672 cups o' joe
- 165 spousal permission units
- 13 bouquets of flowers
- 1 broken server/light curve generator
- $V = 85,392\text{m}/1,423.2\text{h}/59.3\text{d}$
- $Ic = 49,104\text{m}/818.4\text{h}/34.1\text{d}$



Stop looking  
at me!

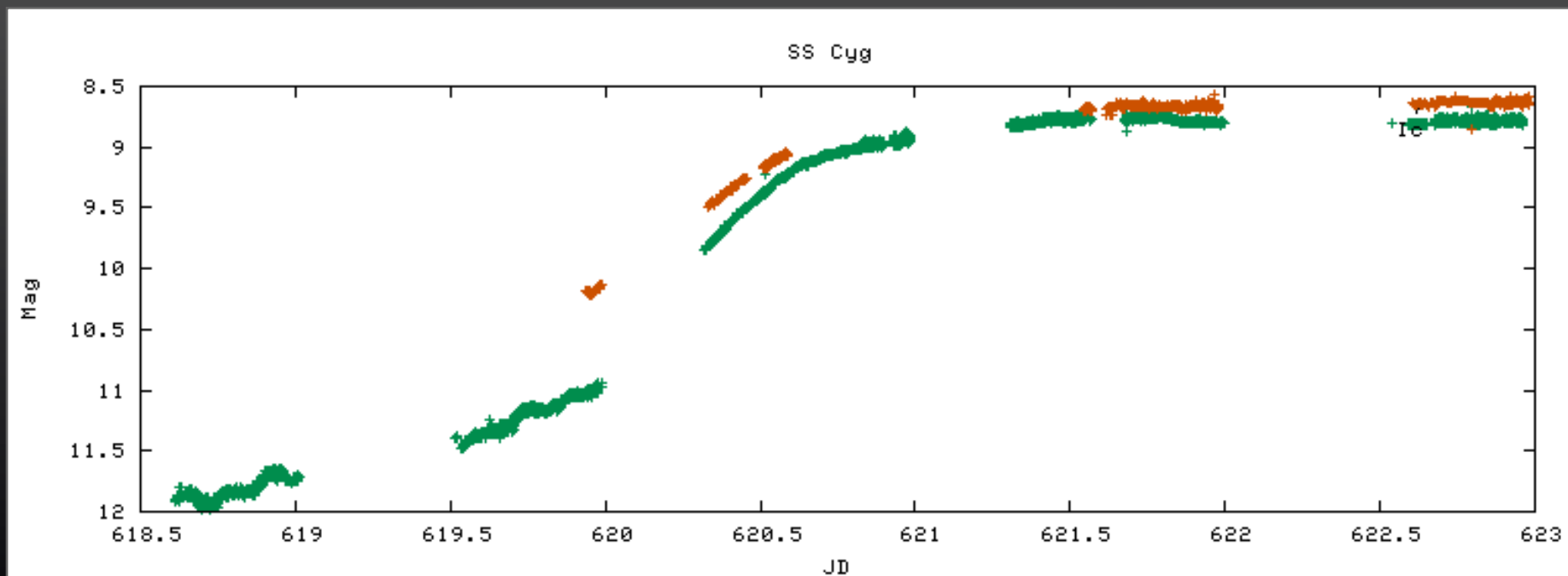
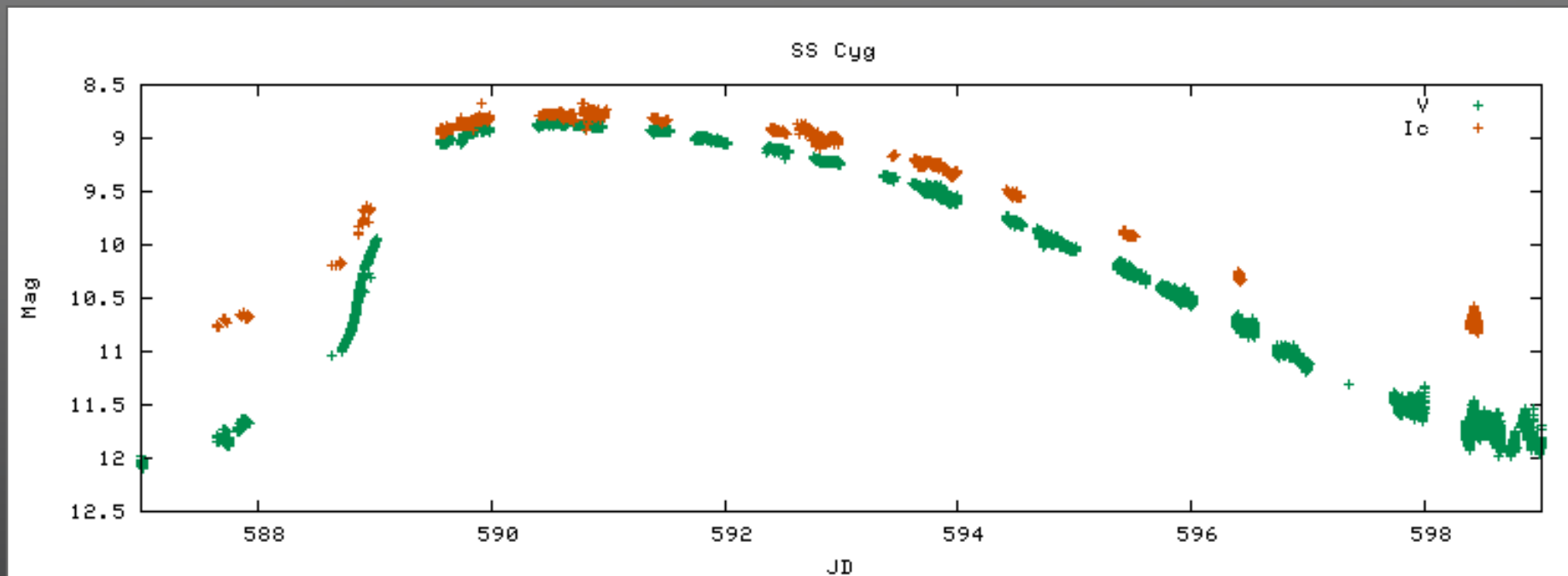


The  
2005  
SS Cyg  
Hall of  
Fame

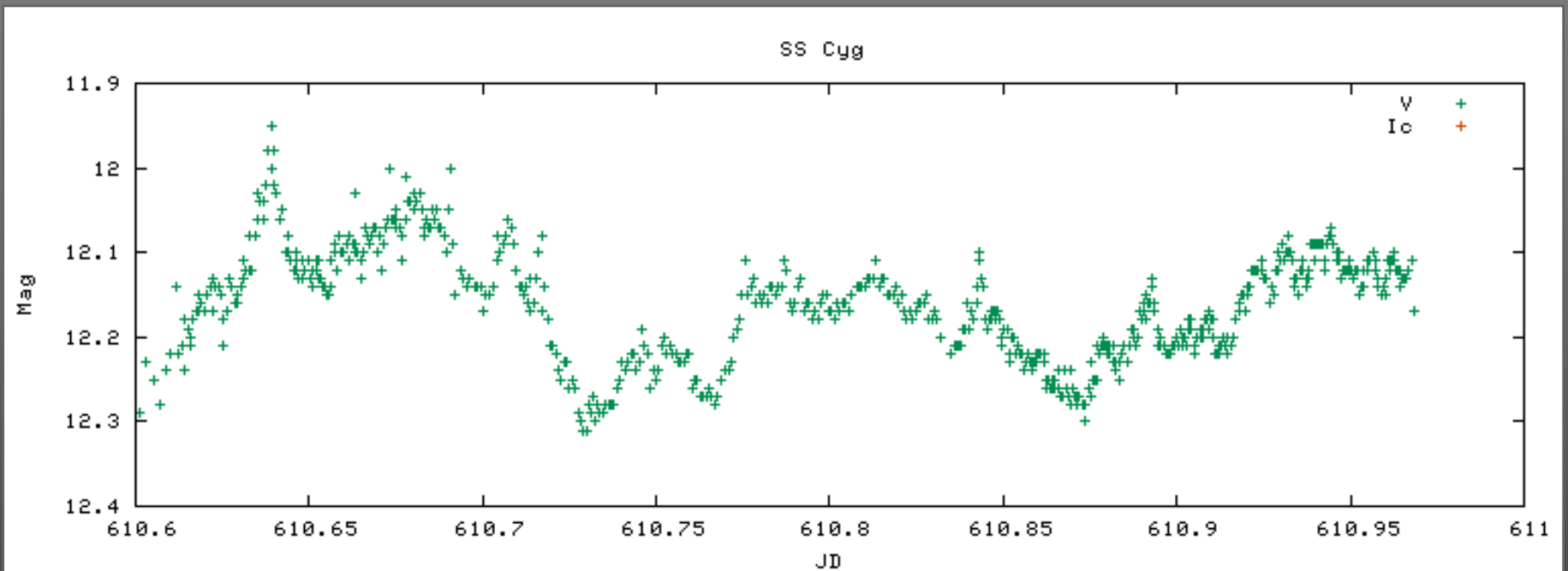
JM	Robert James
PVA	Vance Petriew
HUZ	Rick Huziak
SDB	Donn Starkey
MXL	Richard Miles
GFB	Bill Goff
VMT	Tonny Vanmunster
TDY	Dave Tandy
BKL	John Blackwell
BDG	David Boyd
WGR	Gary Walker
BXS	Steve Brady
KMP	Mike Koppelman
CTX	Tim Crawford
JJI	Jim Jones
PJT	Jennifer Petriew
SGRA	Graham Salmon
GBL	Bruce Gary

Canada, Belgium,  
England, United  
States

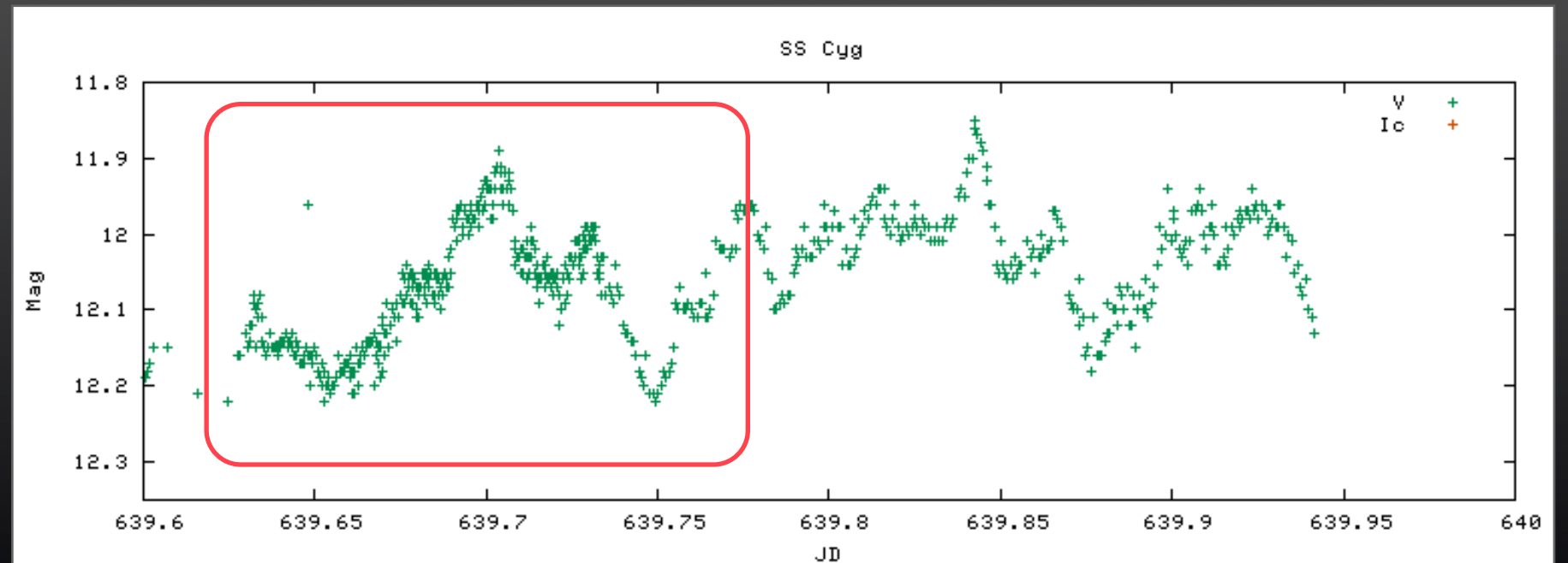
# Close Ups



# 4 Observers (V)

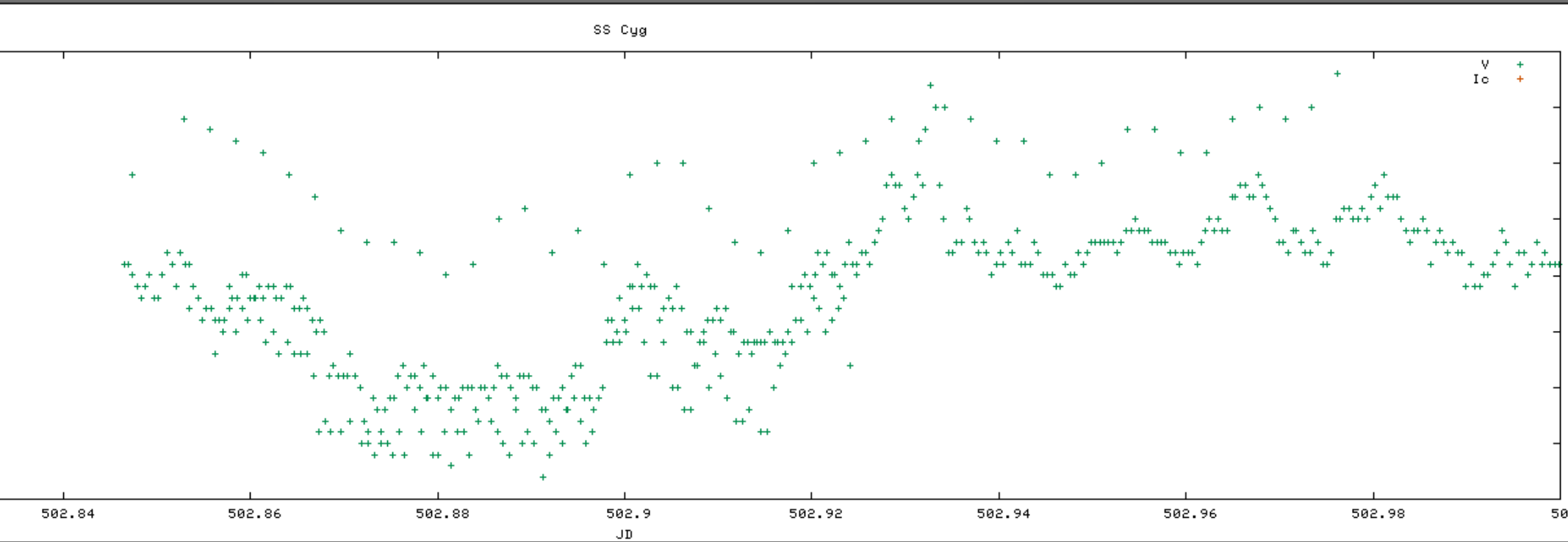


## Good overlap and detail (V)



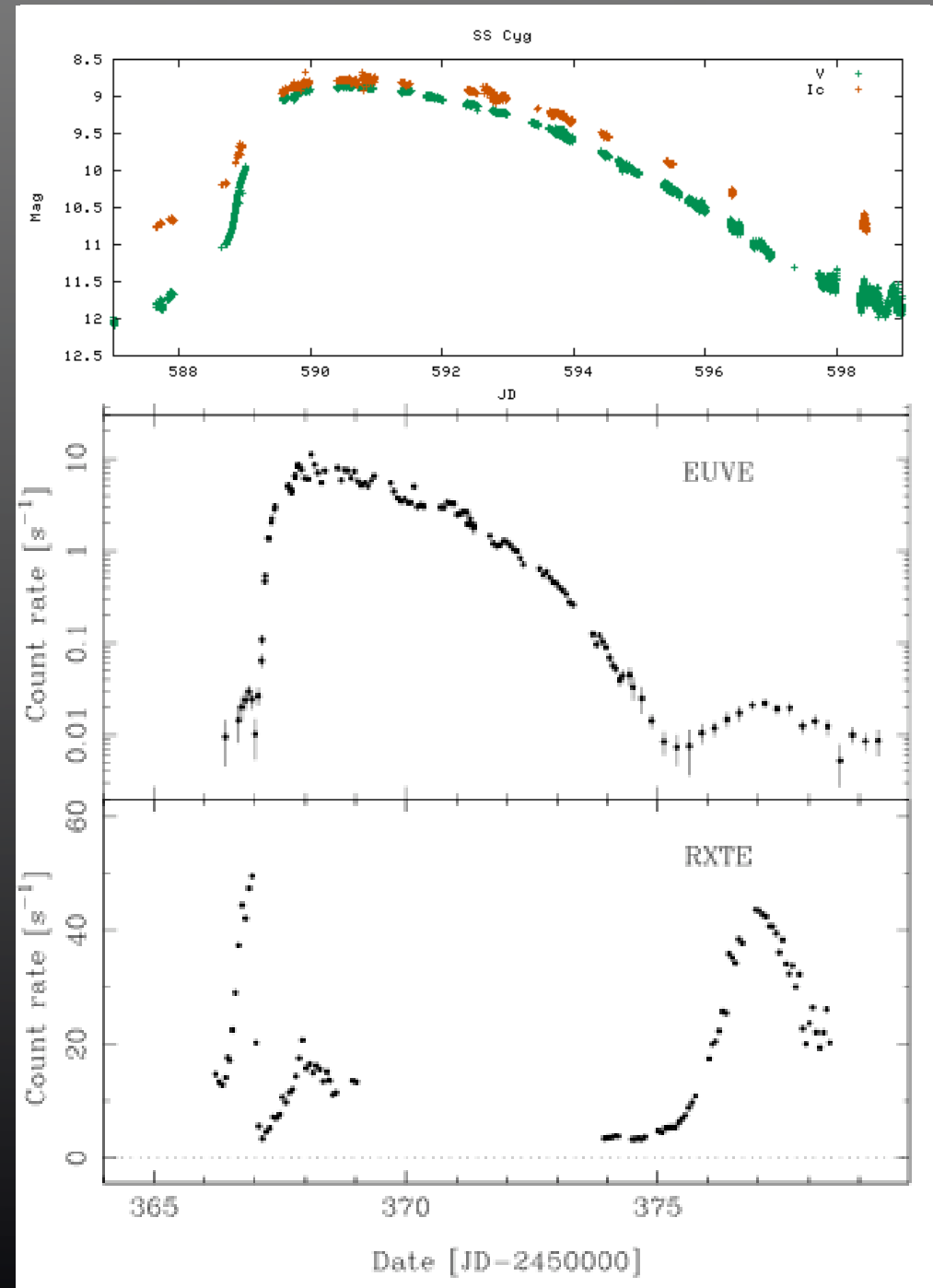


# Comp Star & Chart Problems



# Multiwavelength Comparison

Example of our new data



- “The X-ray and extreme ultraviolet flux evolution of SS Cygni throughout outburst.”  
Wheatley, Mauche, Mattei (2003)

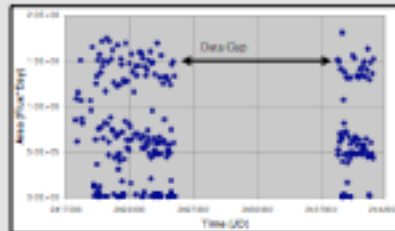
Robert L. Hill  
(Ball State), AAS  
205th meeting  
(2005)

# Outburst Energies and Precursors to Outbursts for SS Cyg from AAVSO Data

## Method: Outburst Energies

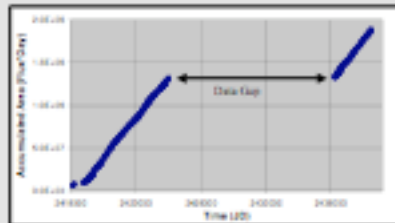
I obtained two data sets for SS Cyg. I was given the first data set by my adviser, Dr. Ron Kaitchuck. I downloaded the second data set from the AAVSO website.  
The magnitudes were converted to fluxes using  $F(L) = 10^{(2.4 - V \text{ magnitude}) - 8.2}$ .  
The area of each outburst on a flux vs. time graph was determined using the Trapezoidal rule. The outburst area should be proportional to the energy released during the outburst.

## Outburst Energies



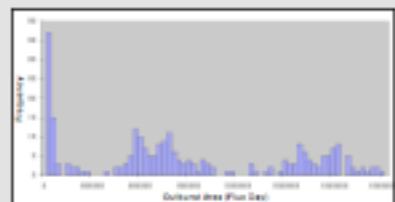
**Implication**  
Three types of outbursts occur. They do not occur in a very regular pattern.

## Accumulated Outburst Energies



**Implication**  
The accumulation of outburst energy is linear over time. This implies that the average mass transfer rate for a year is the same as the mass transfer rate for another year.

## Outburst Energy Histogram



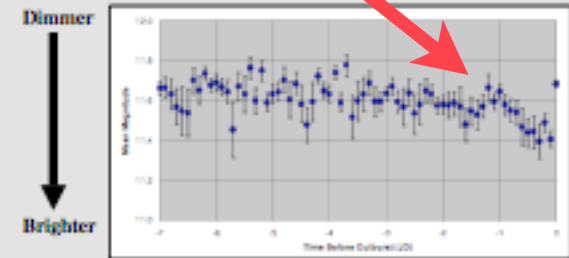
**Implication**  
Three types of outbursts occur. Two outburst types might be bimodal.

Author: Robert Hill (roberthill58@yahoo.com, rhill@bsu.edu)  
Department of Physics and Astronomy  
Ball State University  
Co-Author: E.O. Waggen  
AAVSO

## Method: Outburst Precursors

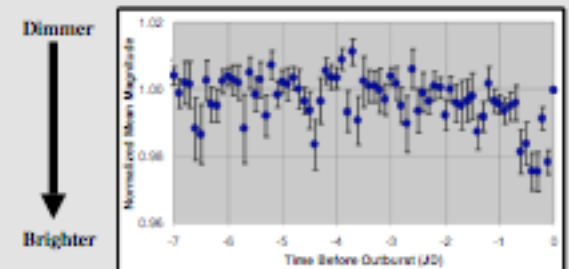
I obtained two data sets for SS Cyg. I was given the first data set by my adviser, Dr. Ron Kaitchuck. I downloaded the second data set from the AAVSO website.  
The beginning of each outburst was set to be  $t = 0$  days. The data points before each outburst were phased relative to this. For example, an observation that occurred 2.5 days before an outburst was given a time of  $t = -2.5$  days.  
The data was binned in increments of 0.1 days.  
The data was averaged according to the time before outburst.  
The data was normalized relative to the magnitude at the beginning of the outburst.

## Mean Magnitude Before Outburst



Dimmer  
↓  
Brighter

## Normalized Mean Magnitude Before Outburst



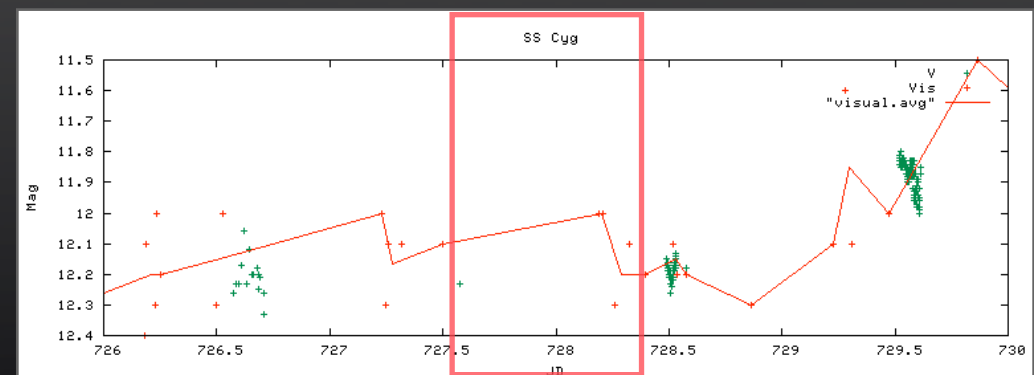
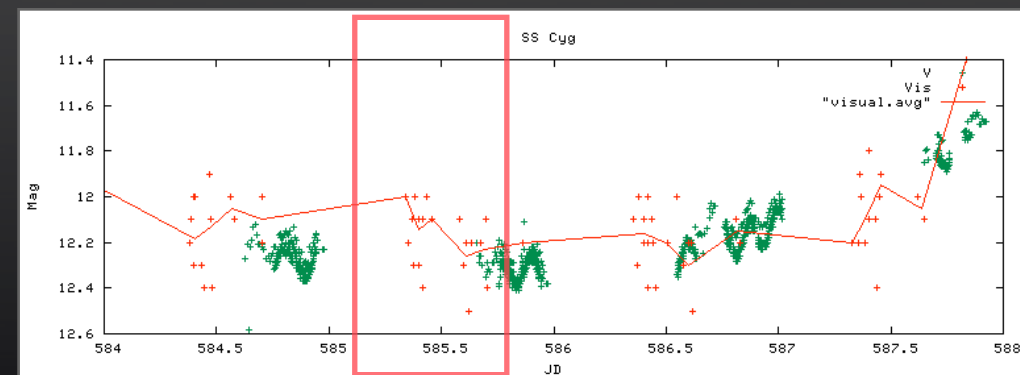
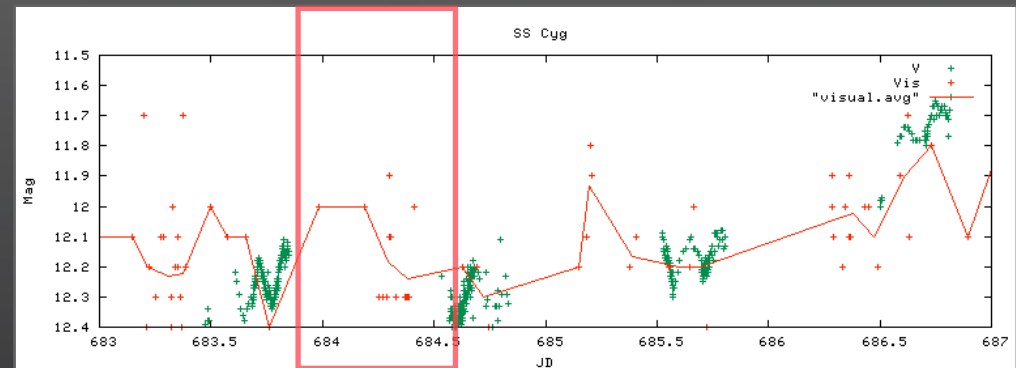
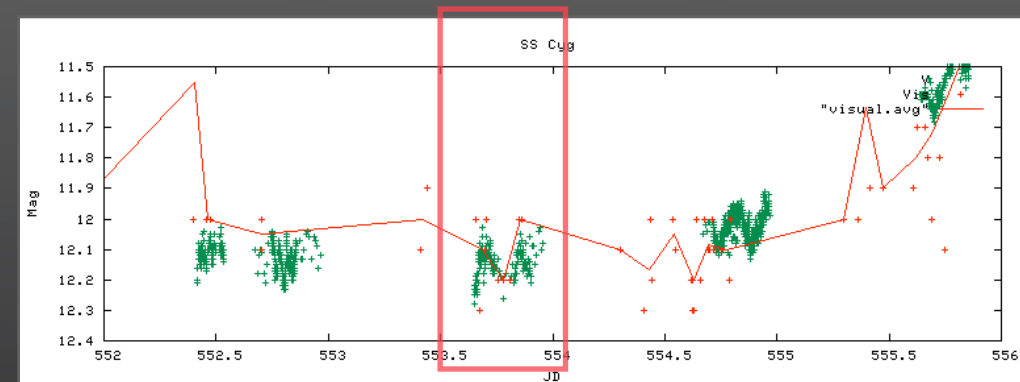
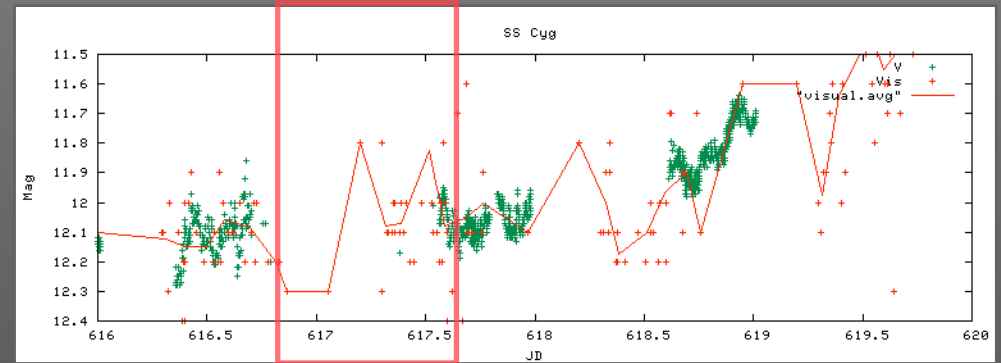
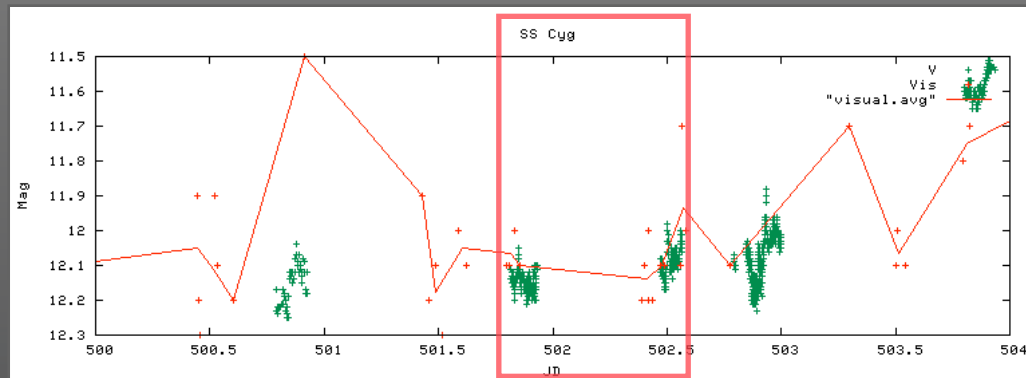
Dimmer  
↓  
Brighter

**Implication**  
SS Cyg appears to brighten around 2% on the average on the day before going into outburst.



- Subset of AAVSO visual data
- Flux converted, Binned, averaged, normalized to pre-outburst magnitude
- SS Cyg brightens by 2% 1 day before outburst

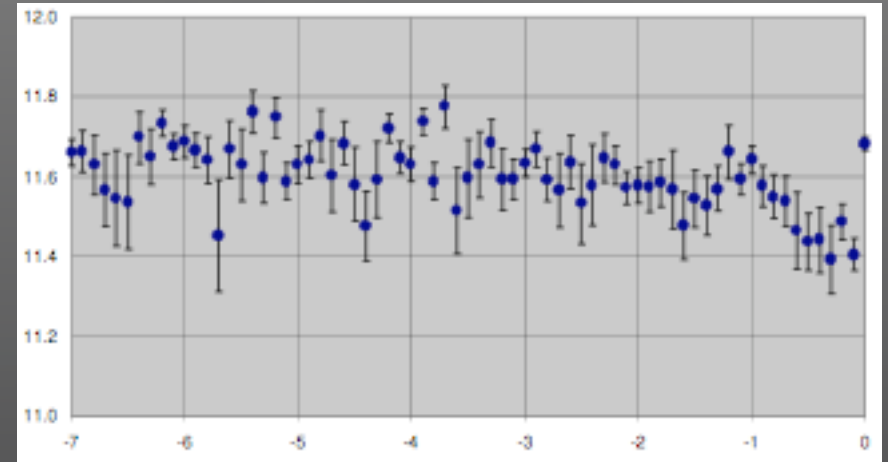
# 4 Days Around Outburst Onset



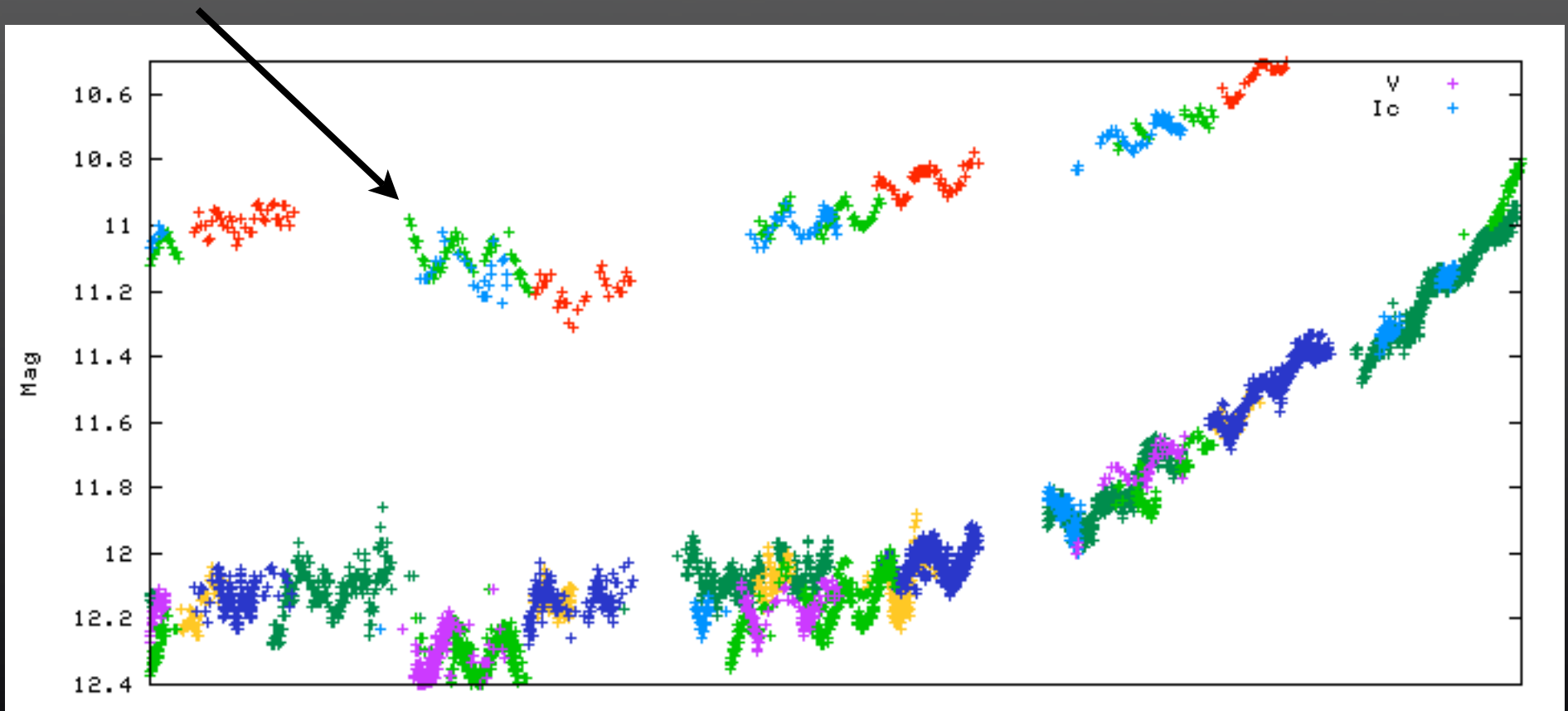
CCDV Visual+0.1 d avg

# Combined Data

- Flickering amplitude is too great to determine: need long term monitoring to average out
- Interesting feature in 2 data sets ~1-2 days before outburst onset
- Phasing of the light curve?

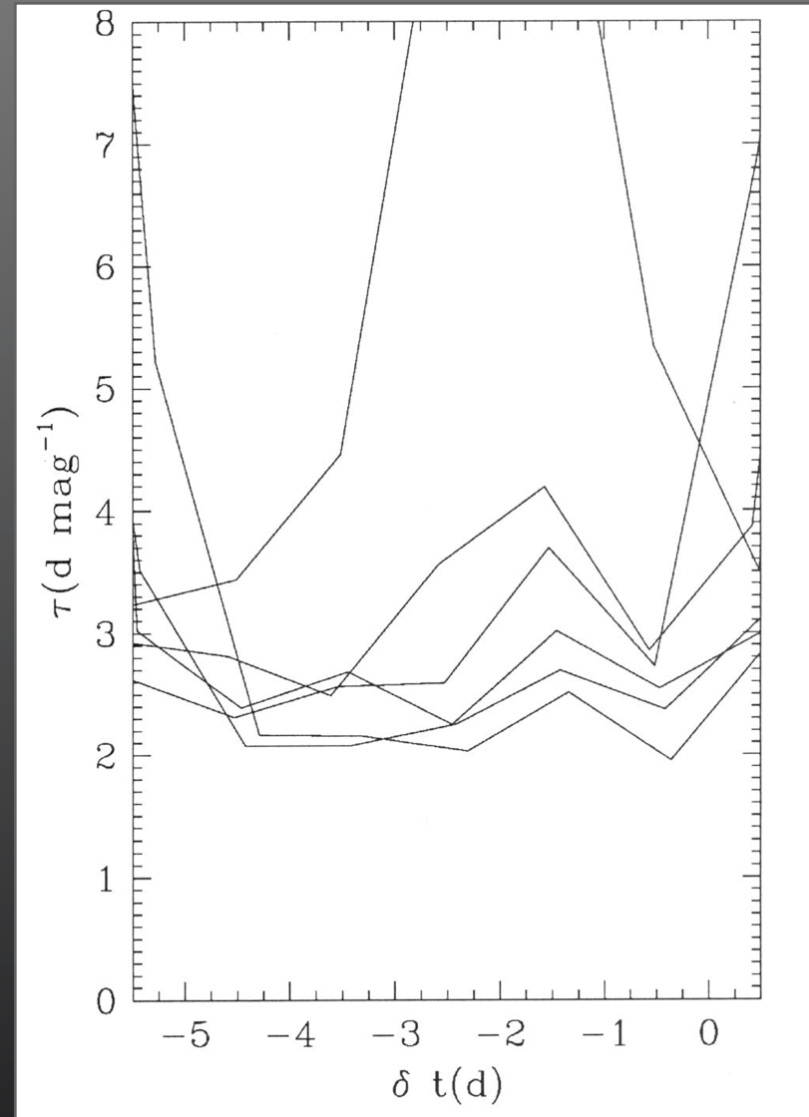


Not seen in Ic



# The Cannizo Glitch

- Decays are largely exponential
- Except for a “glitch” around 2/3 through (2 days before the end)
- The larger the time of decay, the larger the glitch
- 20% - 300% increase in  $t_{\text{decay}}$  for  $\sim 1$  day

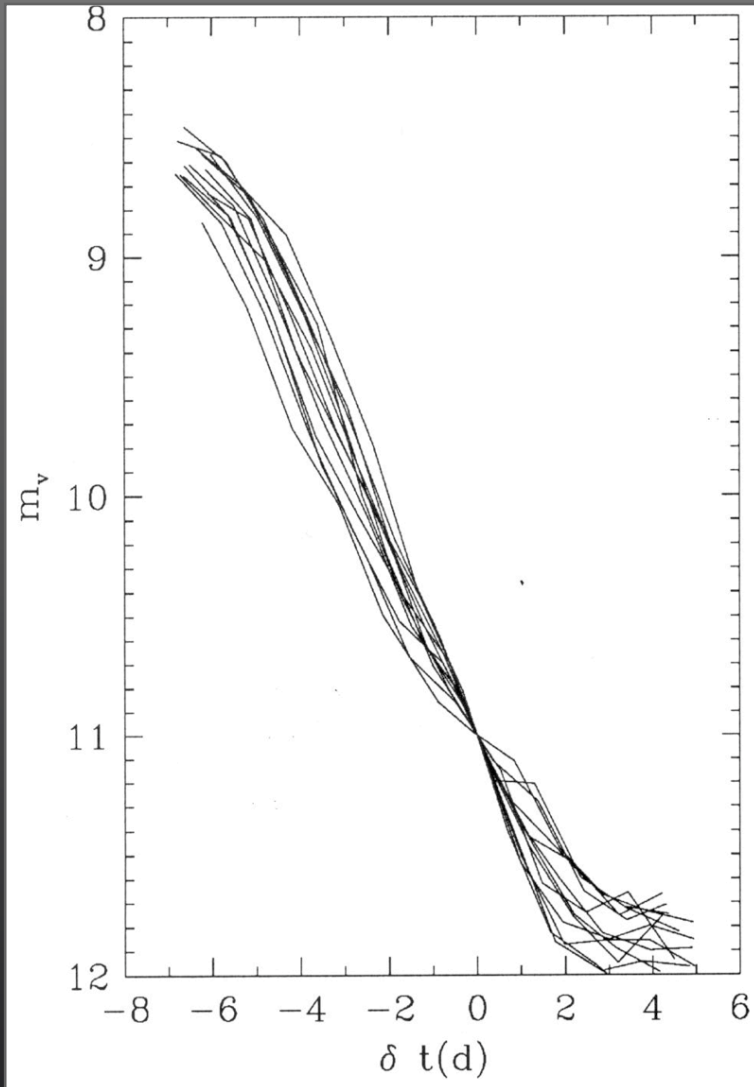


The Glitch

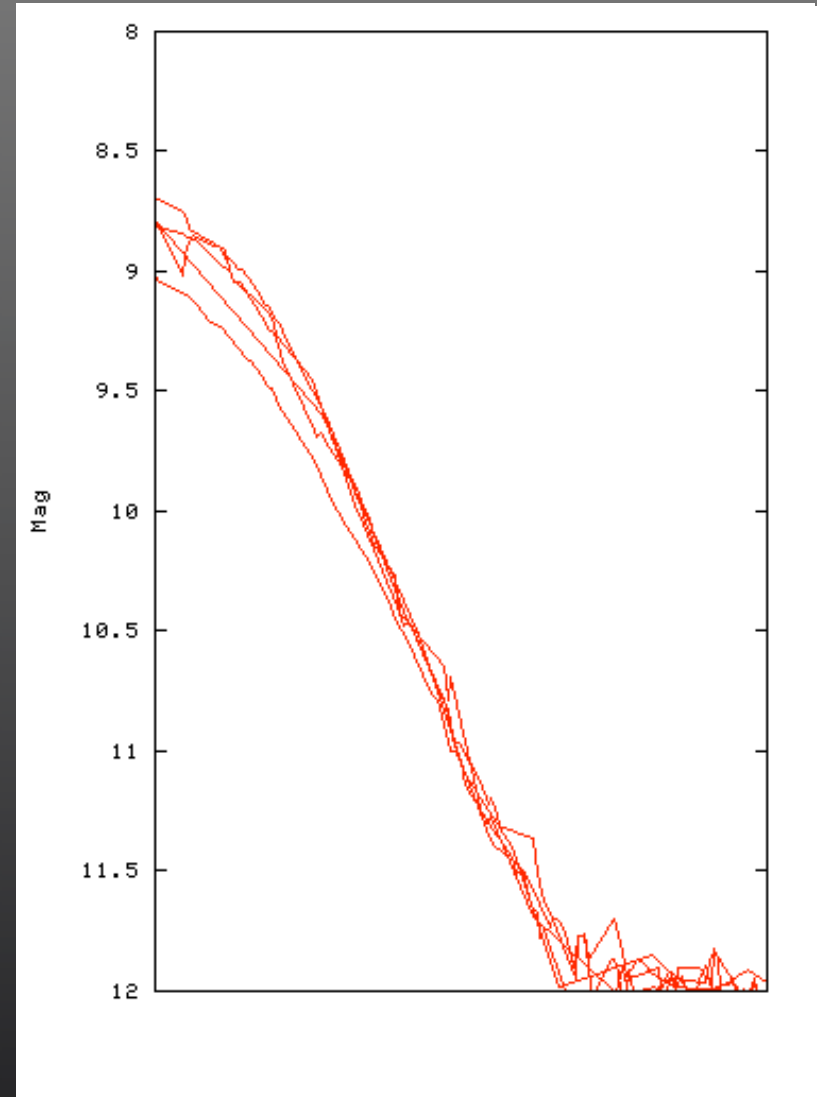
(Fig. 7 from Cannizo & Mattei (1998))



# Looking For the Glitch

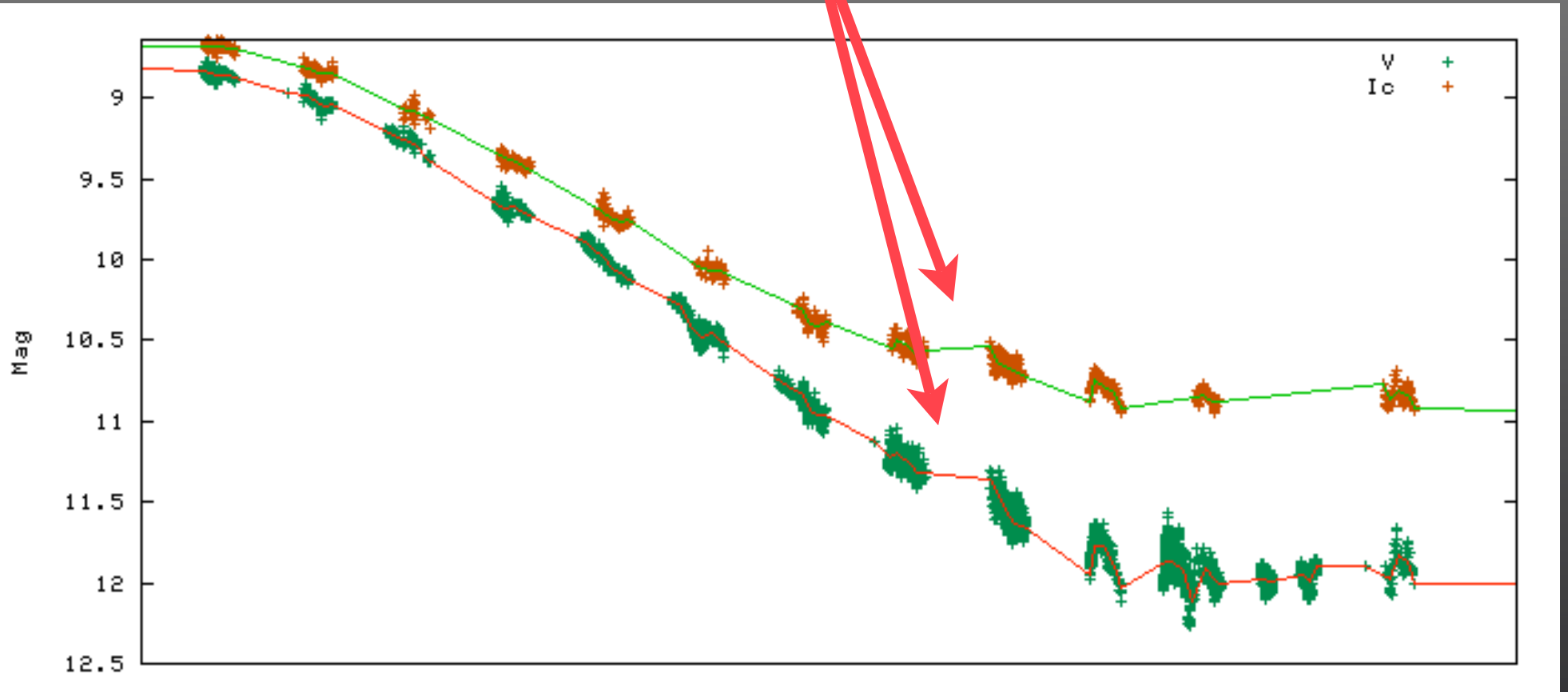


The Glitch, correlated at  $M_V=11$   
(Fig. 8 from Cannizo & Mattei (1998))

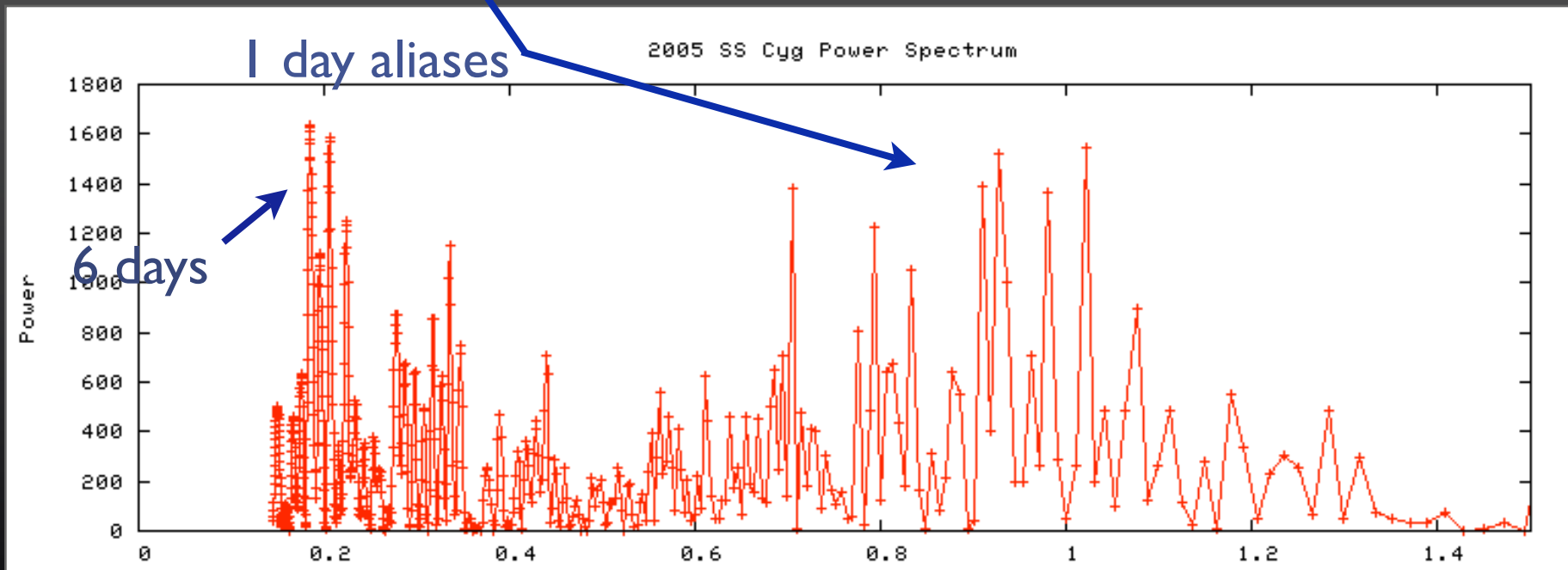
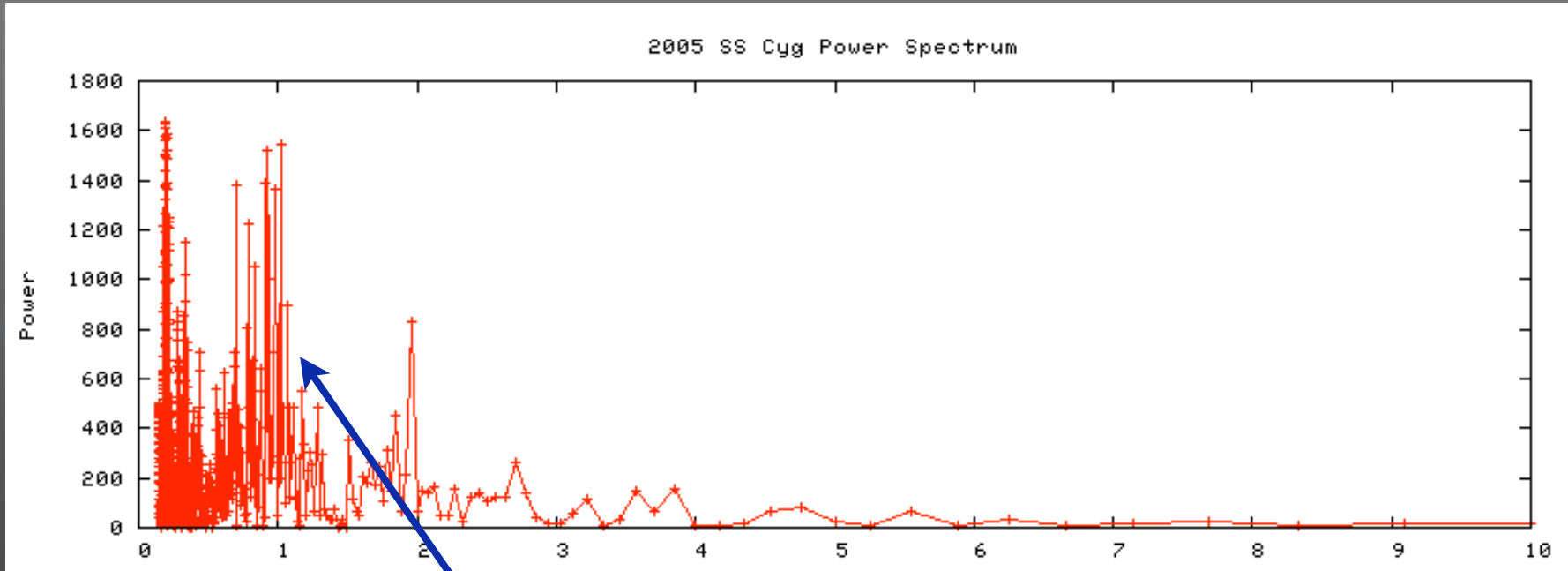


Our data + 1d means, correlated at  
 $M_V=11$

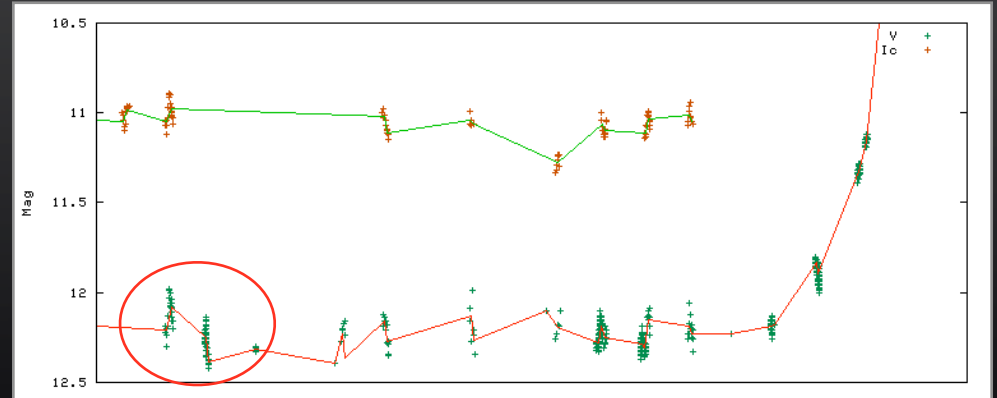
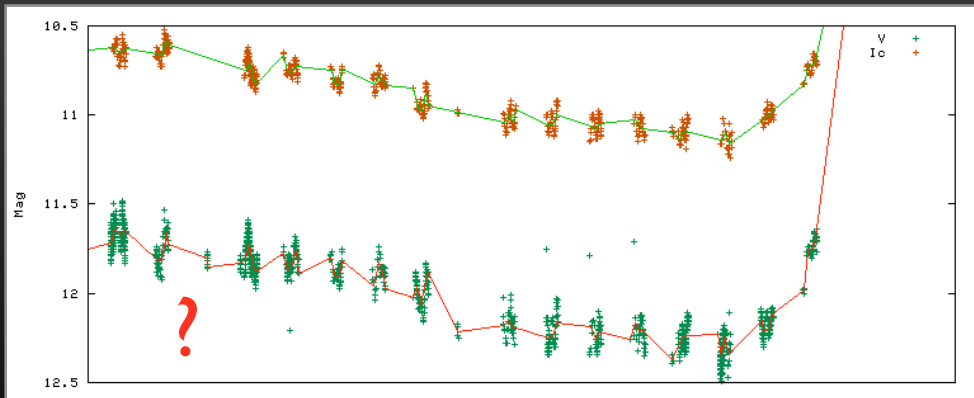
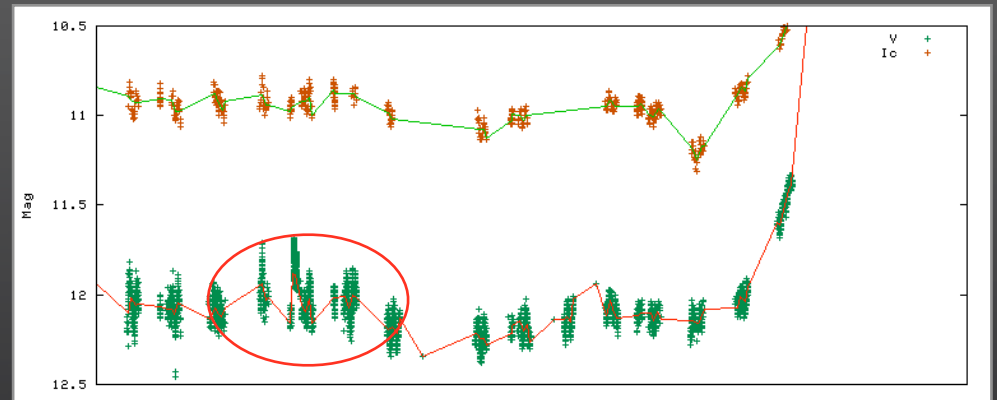
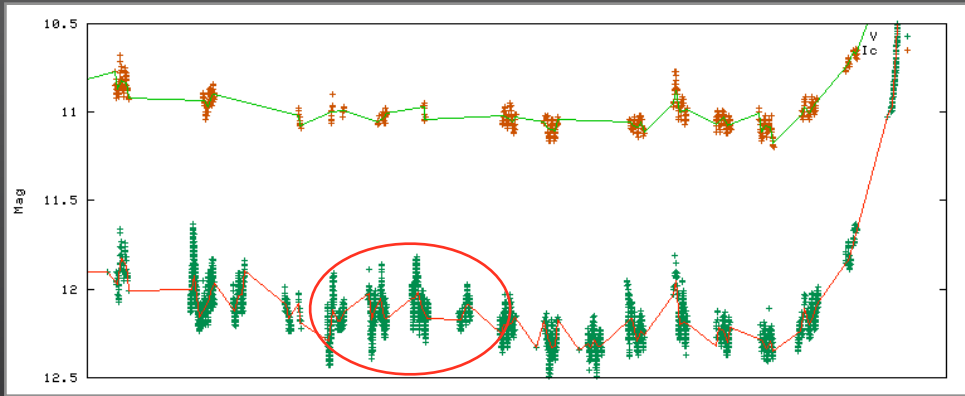
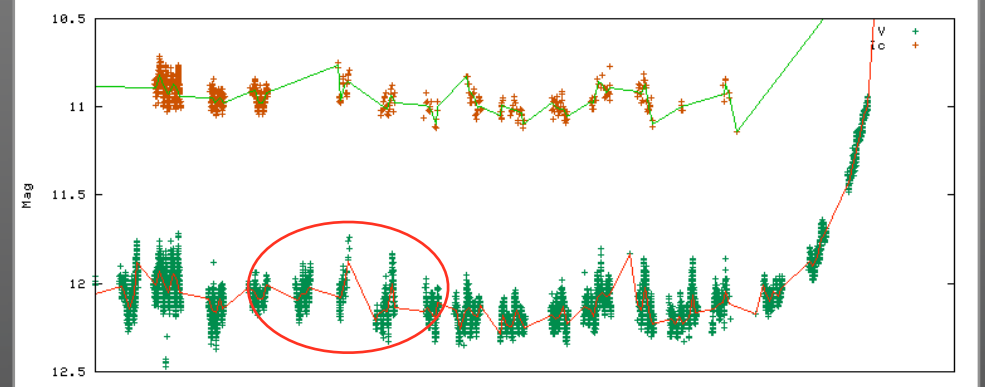
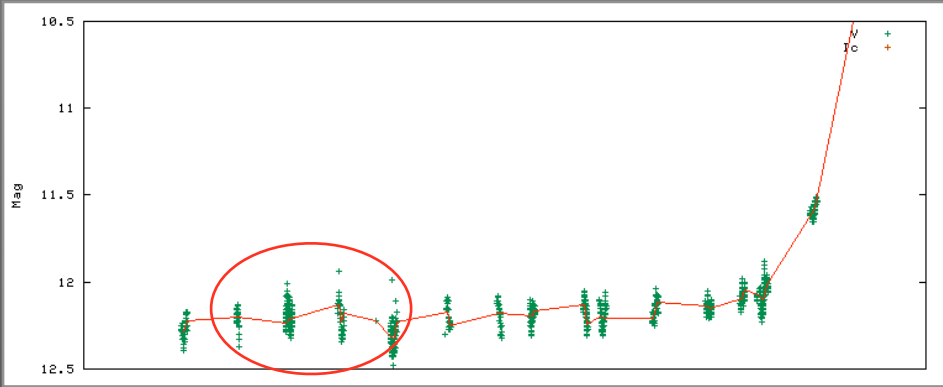
A glitch?



# Periodicity

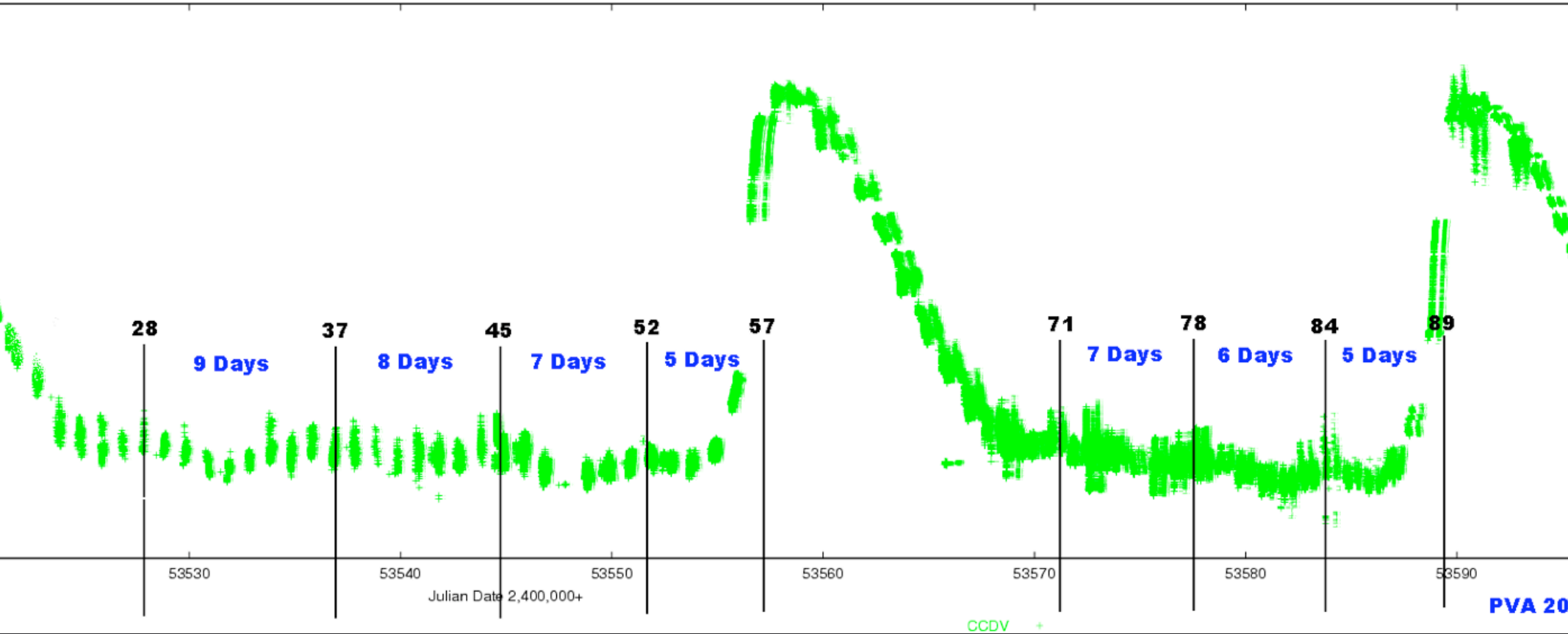


# Precursor Humps



# Quiescent Modulation

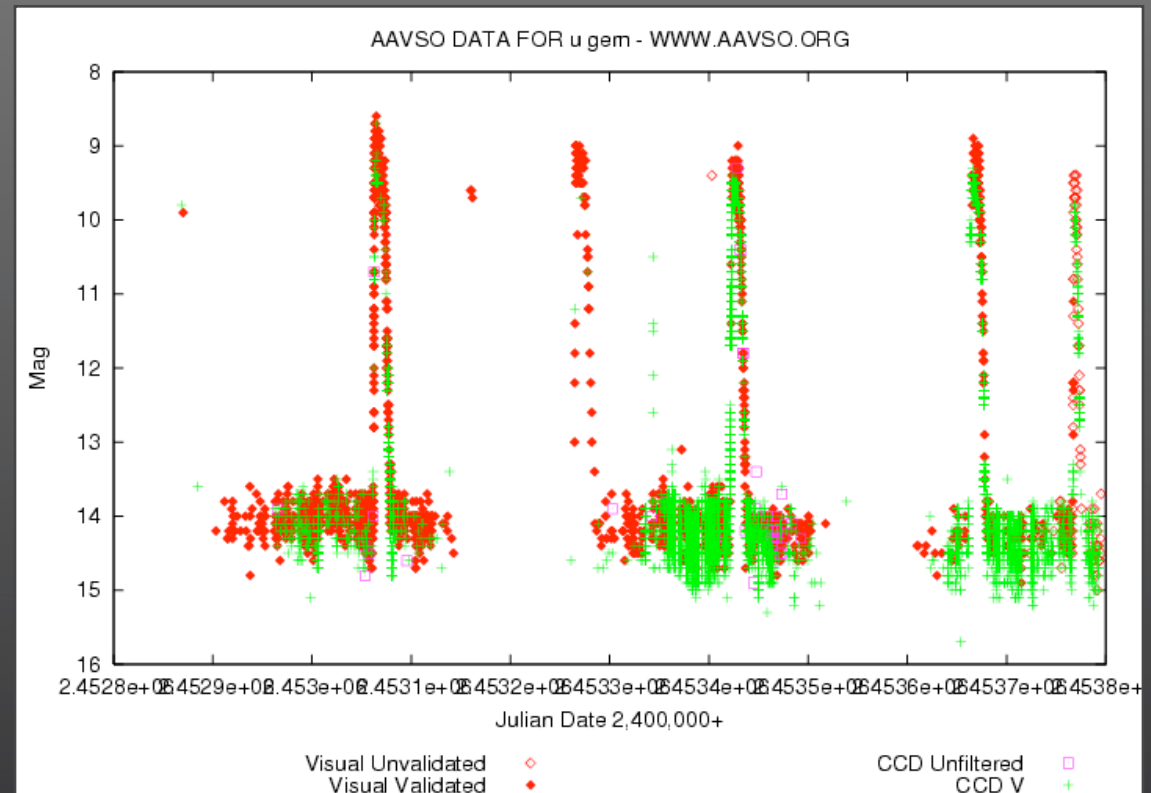
AAVSO UNVALIDATED DATA FOR SS CYG - WWW.AAVSO.ORG



Graph by Vance Petriew (PVA)

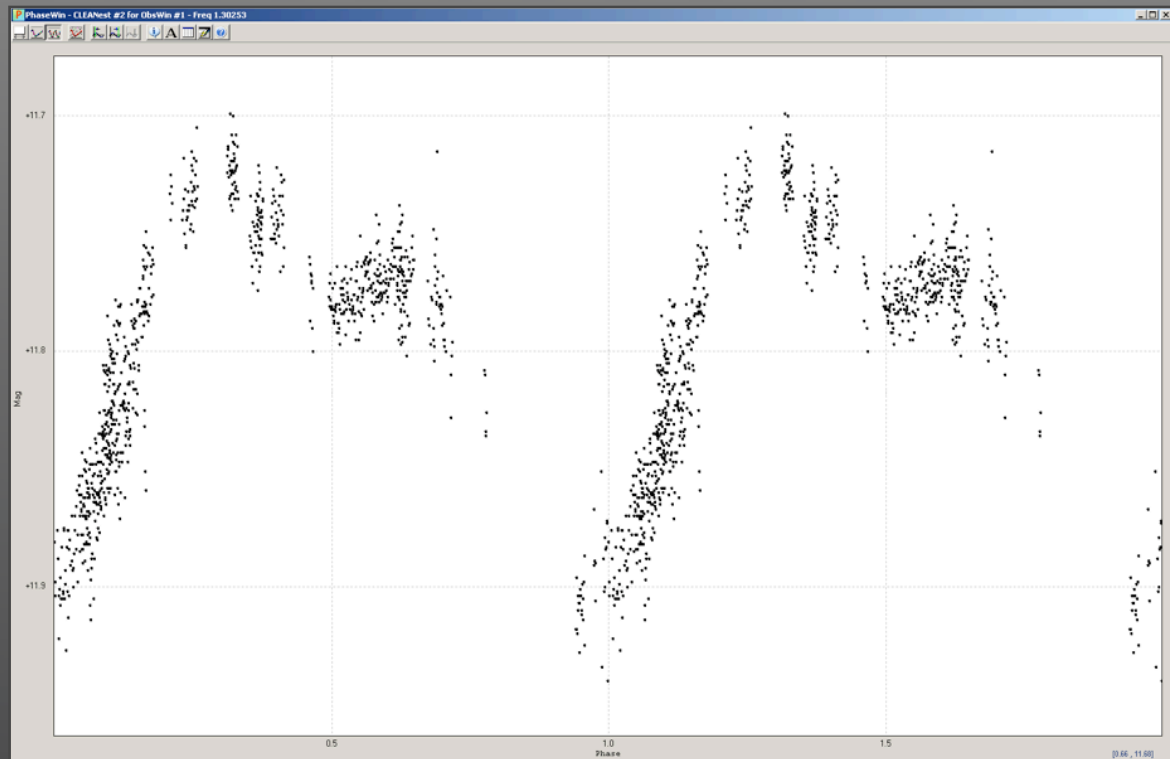
# Side Benefits

- HUZ and PVA are conducting searches for new field variables
- 1 confirmed suspected variable star (a comp star!)
- 1 newly discovered variable star (RRab)
- 3 suspected new variables
- Observer experience with time series
- Staff experience with large-scale data processing

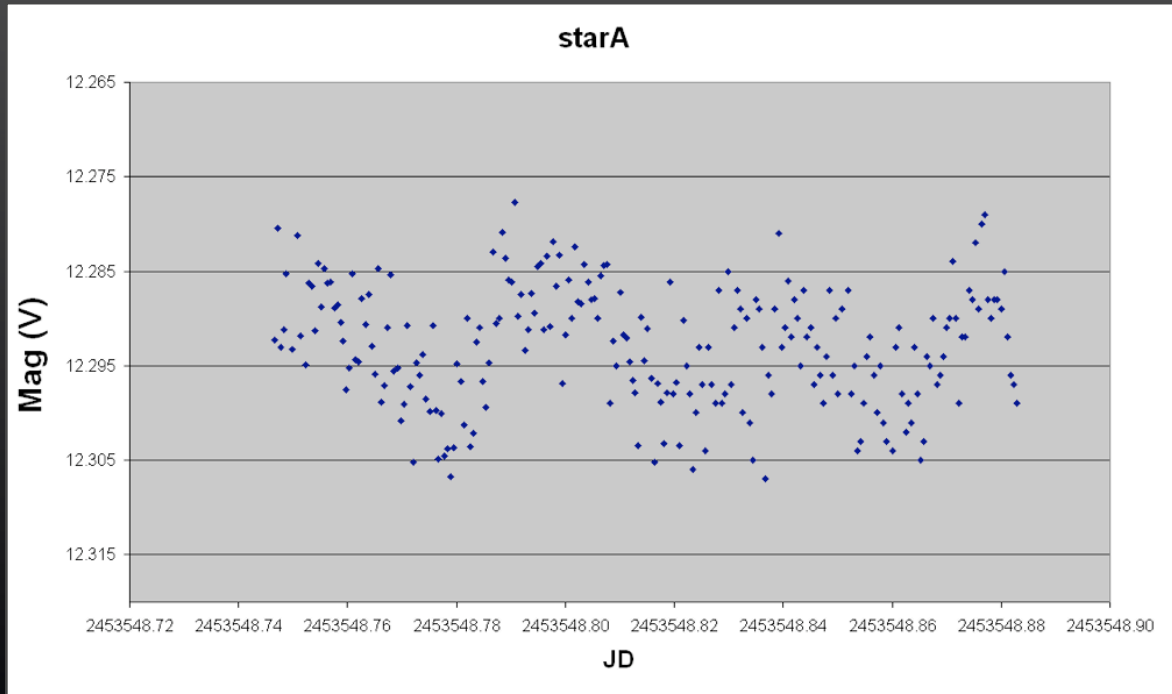


Robert James (JM) U Gem CCDV data





New variables courtesy Rick Huziak (HUZ)



# Now What?

- Rest!
- Archival visual data statistical analysis
- Paper in summer?
- SMOOTCH!
- U Gem in B and V?
- More SS Cyg: nightly snapshots indefinitely



*Some could care less about SS Cyg*

*fin.*

# CCD & Visual Animation by Vance Petriew From the Light Curve Generator

