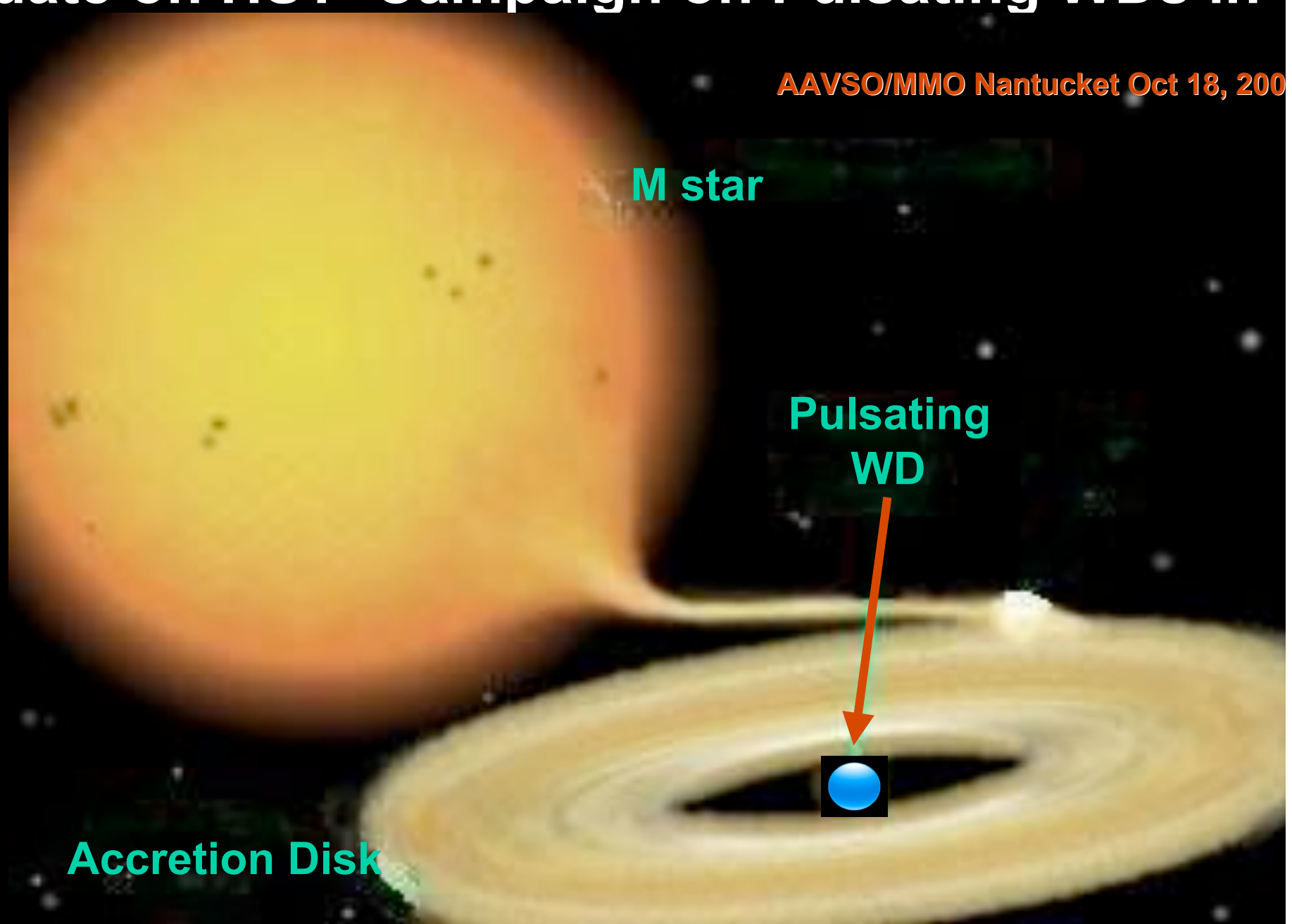


# Update on HST Campaign on Pulsating WDs in C

AAVSO/MMO Nantucket Oct 18, 200



Paula Szkody, Anjum Mukadam, Boris Gaensicke, Arne Henden + AAVSO, Atsuko Nitta, Ed Sion

# Why study accreting WD pulsators

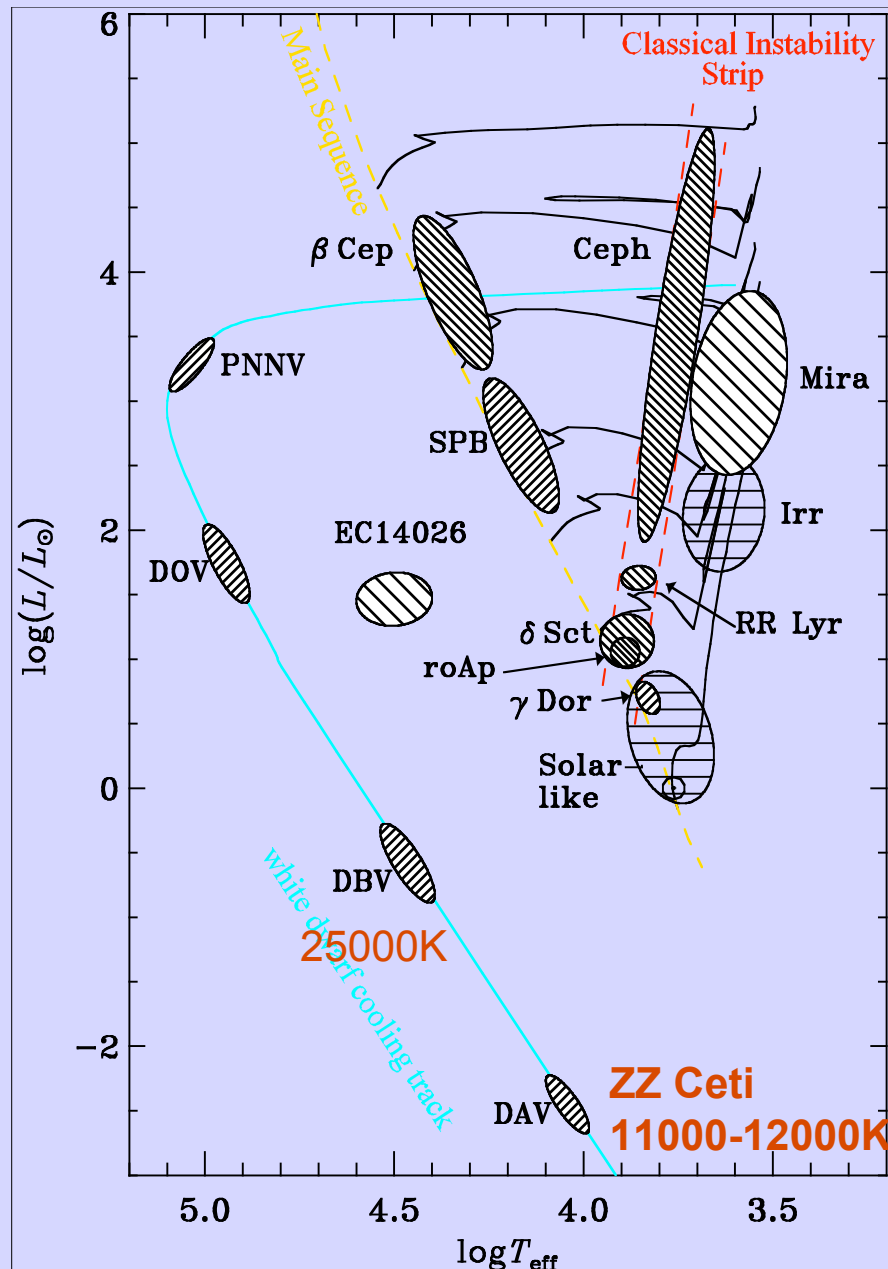
## Pulsations probe inner stellar structure

uniform density; pulsations penetrate the inner 99% of white dwarf

## Effects of accretion on pulsations ?

- Heating due to accretion
- Increase in angular momentum
- Changing surface composition
- Changing stellar mass

# Instability Strips for **Non-Interacting** White Dwarf Pulsators



**Our question  
where is the  
instability strip  
for accreting  
pulsators?**

# HST Programs 2002/2008

## UV time-series spectroscopy

Space Telescope Imaging Spectrograph (STIS)  
1150-1750Å with 1Å resolution

HST Advanced Camera for Surveys (ACS)

Solar Blind Channel (SBC) 1200-1900Å

lower resolution time-series spectroscopy



**Co-added Spectrum & Light Curve**

12 known accreting pulsators so far

# Ground data is necessary:

We need to know the optical state (outburst or quiescence or high/low) since:

CVs are always changing in some way

Pulsations can change

Accretion glitches can occur

And we need to make sure the HST detector is not harmed!

# Known Outbursts of Accreting Pulsators:

- PQ And (1938, 1967, 1988)
- GW Lib (1983, **2007**)
- V455 And (**2007**)
- REJ1255+26 (1994)
- SDSS0745+45 (**2006**)

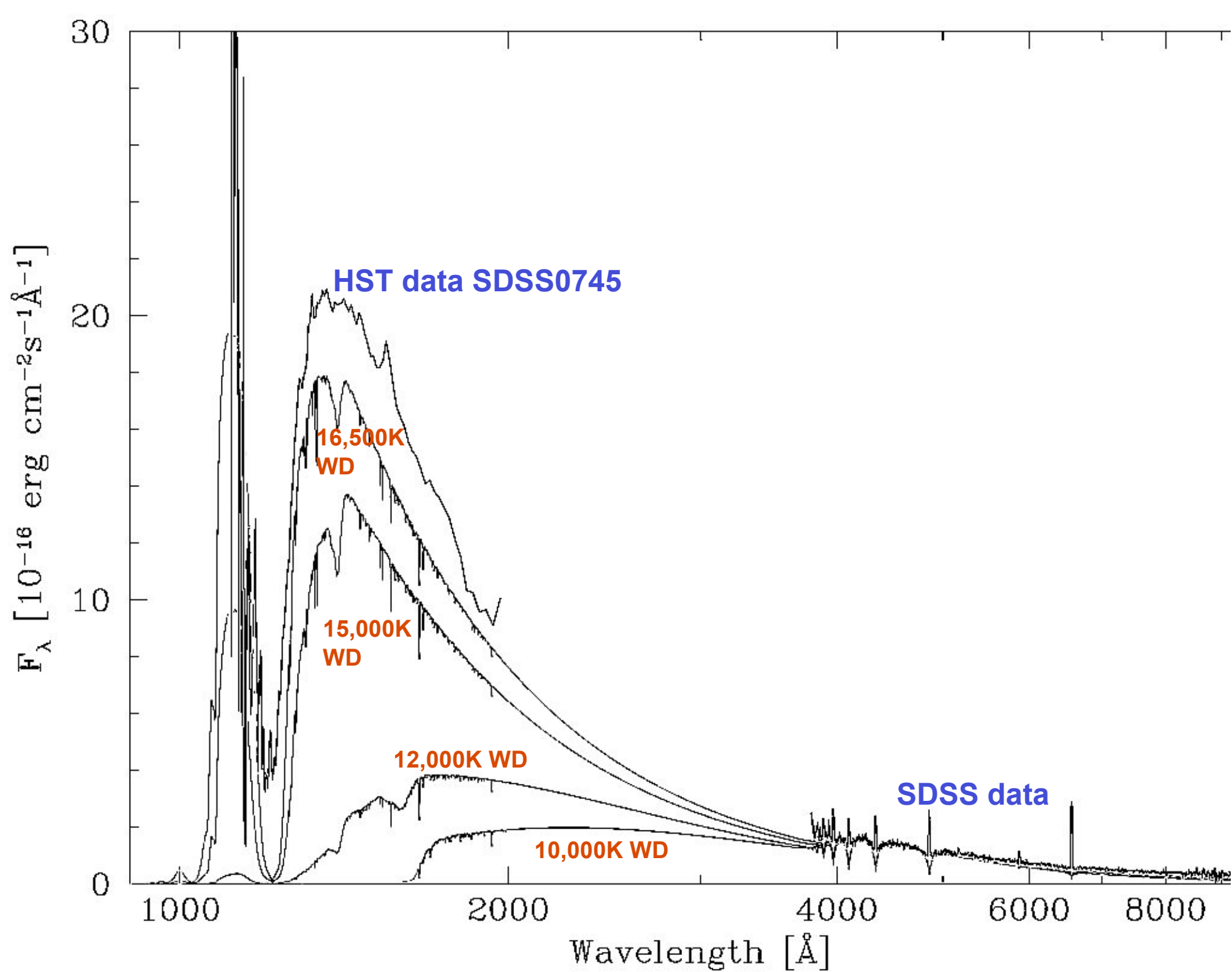
**Bill Dillon**

**'Round the World observing with GRAS** (Global Rent-a-Scope)

**US, Australia, Israel same day !**

**+ Arne, Gary Walker and many others from AAVSO  
contributing observations**







# Temperatures from HST UV spectroscopy

Spectral Fits by Boris Gaensicke (U. Warwick)

Uncertainties ~ 1000K

Object	Date	Instrument	Temp (K)
GW Lib	Jan17, 2002	STIS	15,400
V455 And	Oct 24, 2002	STIS (snap)	<b>10,500</b>
SDSS2205+11	May 23,2005	SBC	15,000
SDSS0131-09	Jun 18, 2005	SBC	14,500
SDSS1610-01	Jun 30, 2005	SBC	14,500
PQ And	Sep 13, 2007	SBC	<b>12,000</b>
SDSS0745+45	Nov 1, 2007	SBC	16,500
SDSS0919+08	Nov 14, 2007	SBC	13,500
SDSS1339+48	Jan 25, 2008	SBC	<b>12,500</b>

# Possible Explanation for the Different Instability Strip for Accreting Pulsators

(Arras, Townsley & Bildsten (2006, ApJ, 643, L119))

**Helium Abundance  $< 0.38$**

Instability Strip like ZZ Ceti stars @ 11000-12000K

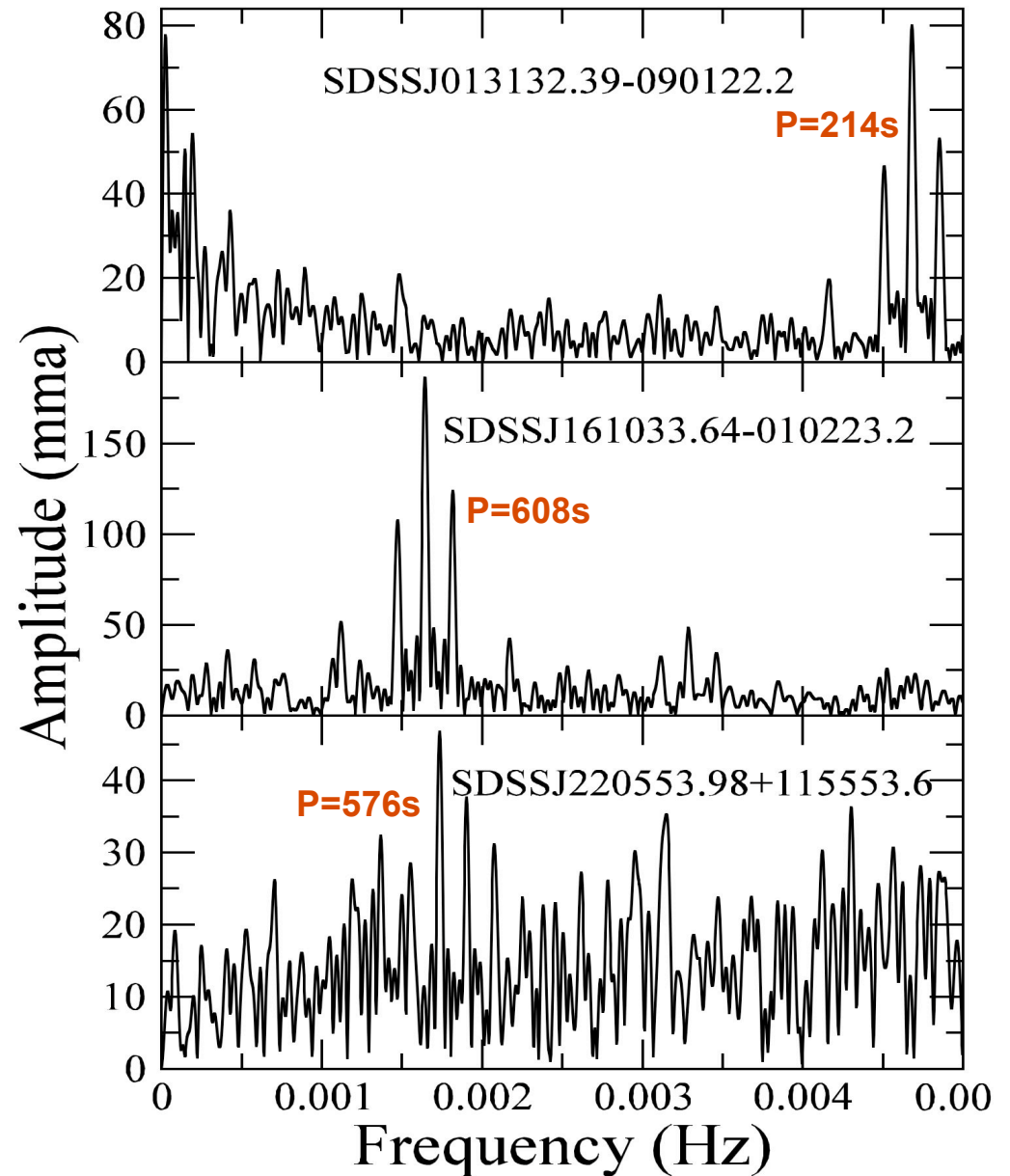
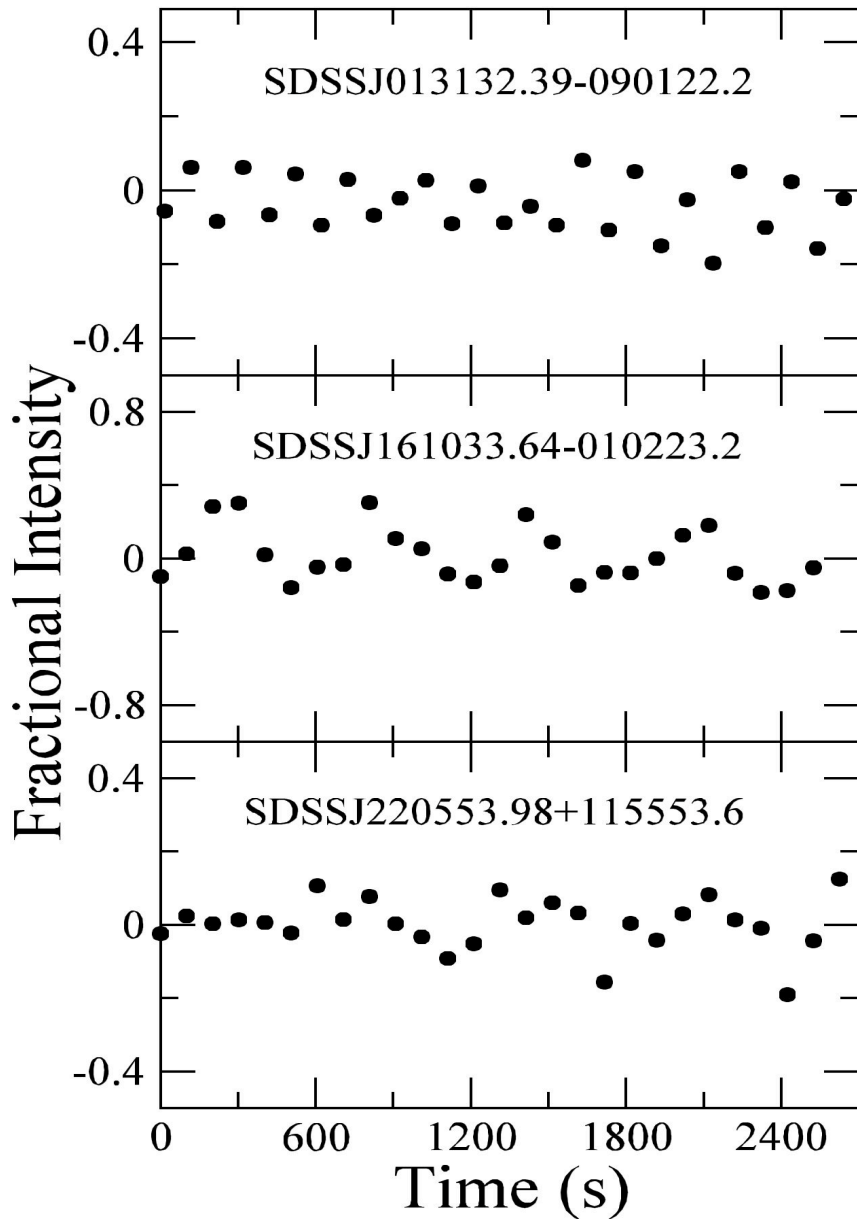
**Helium abundance  $> 0.38$**

Additional instability strip @ 15000K

Is the difference based on mass and evolution?

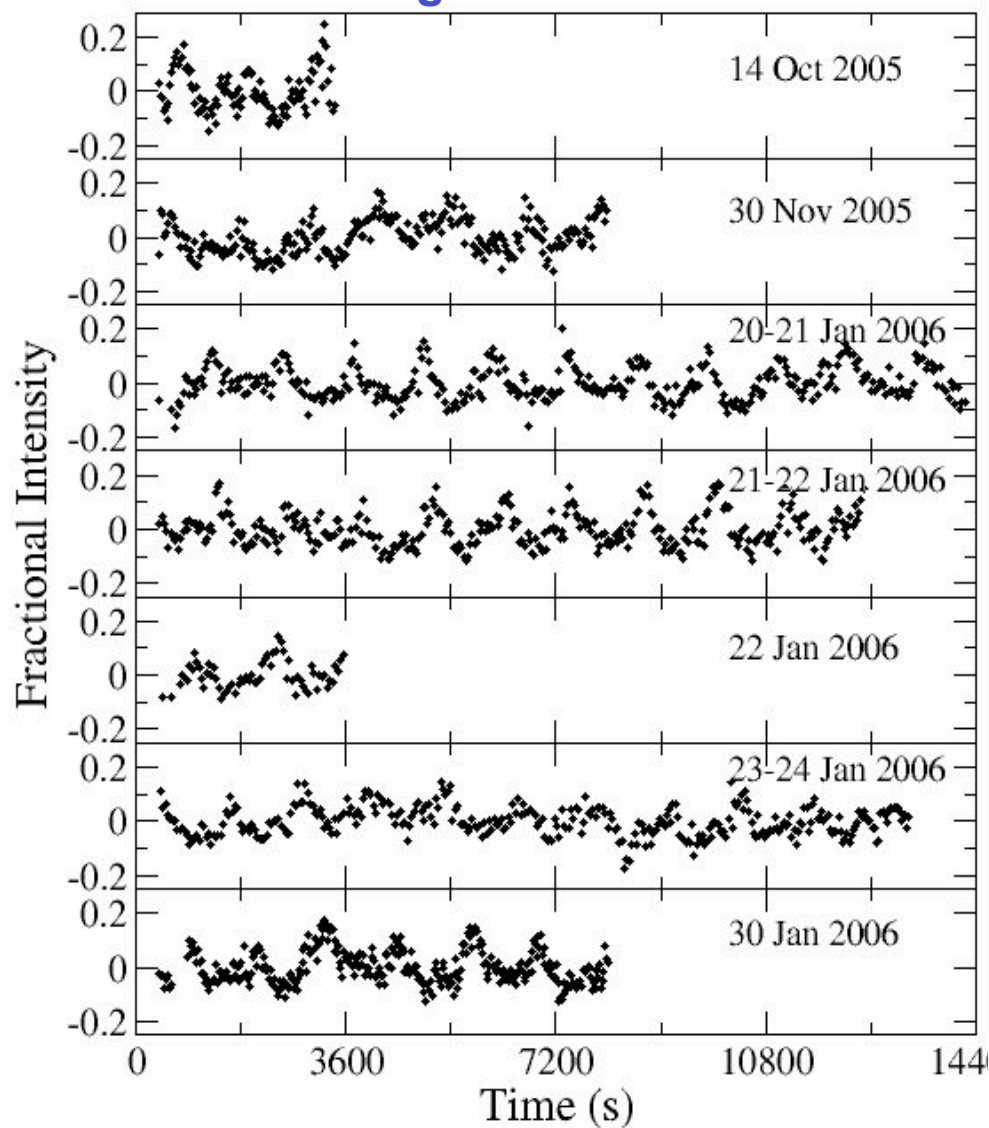
# HST observations of accreting ZZ Ceti stars in 2005

UV Time Resolved Spectroscopy using ACS SBC

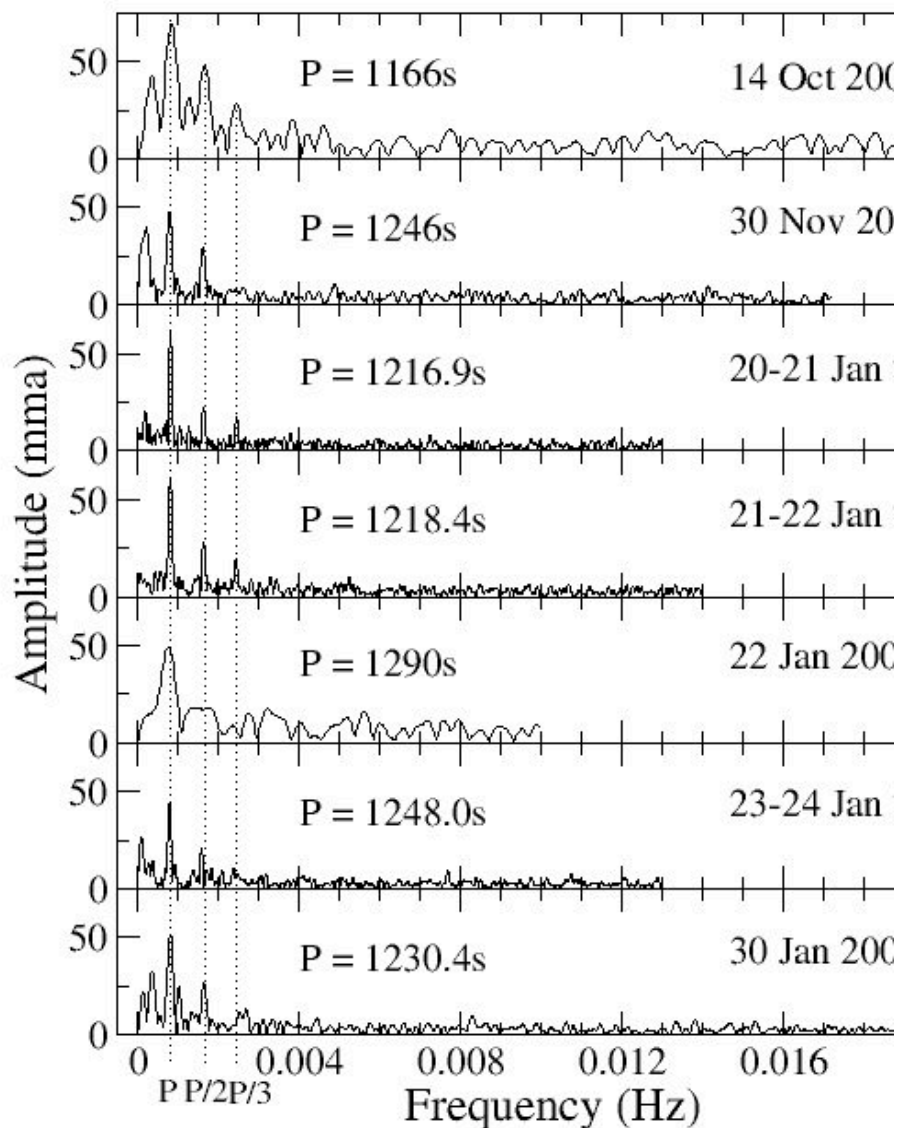


# Optical Data prior to HST on Long Period Pulsator SDSS0745+4538

## Light curves

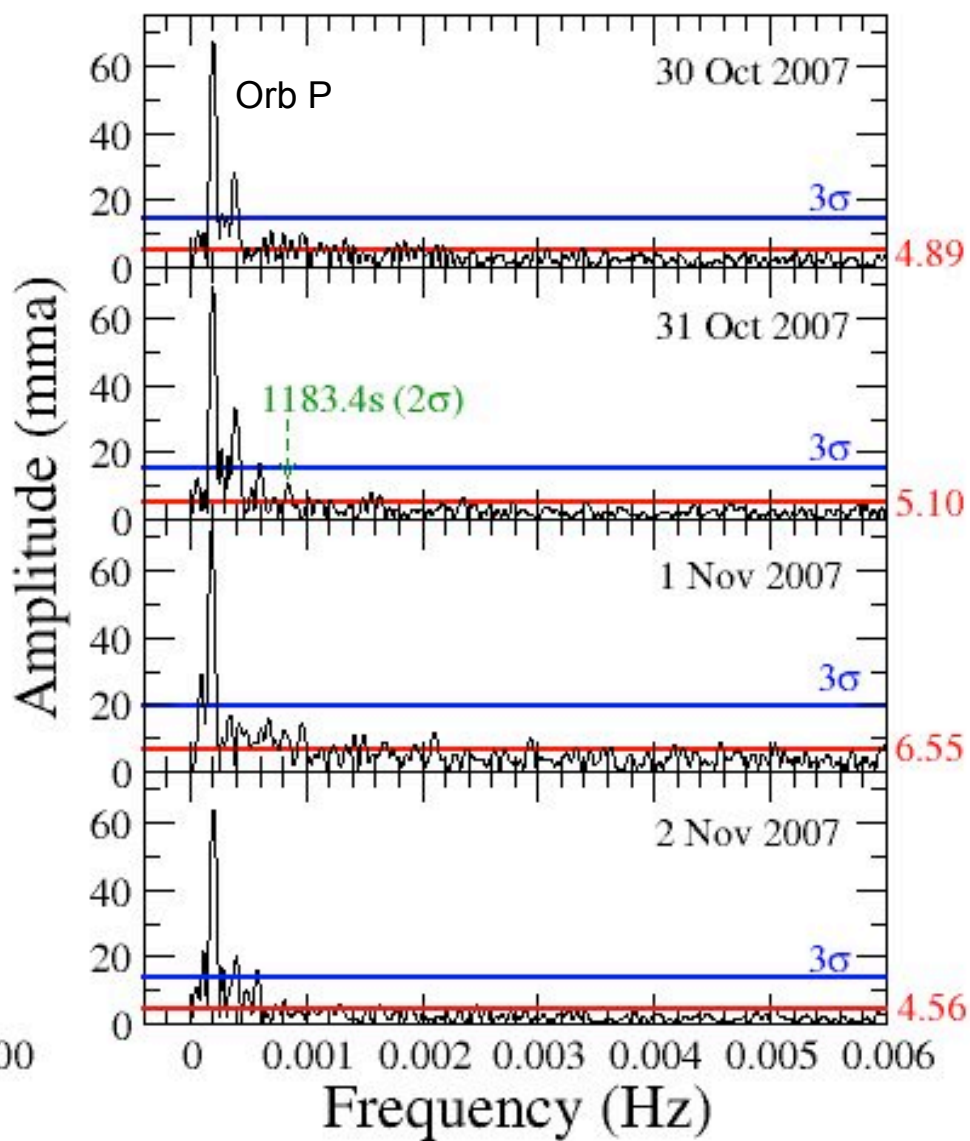
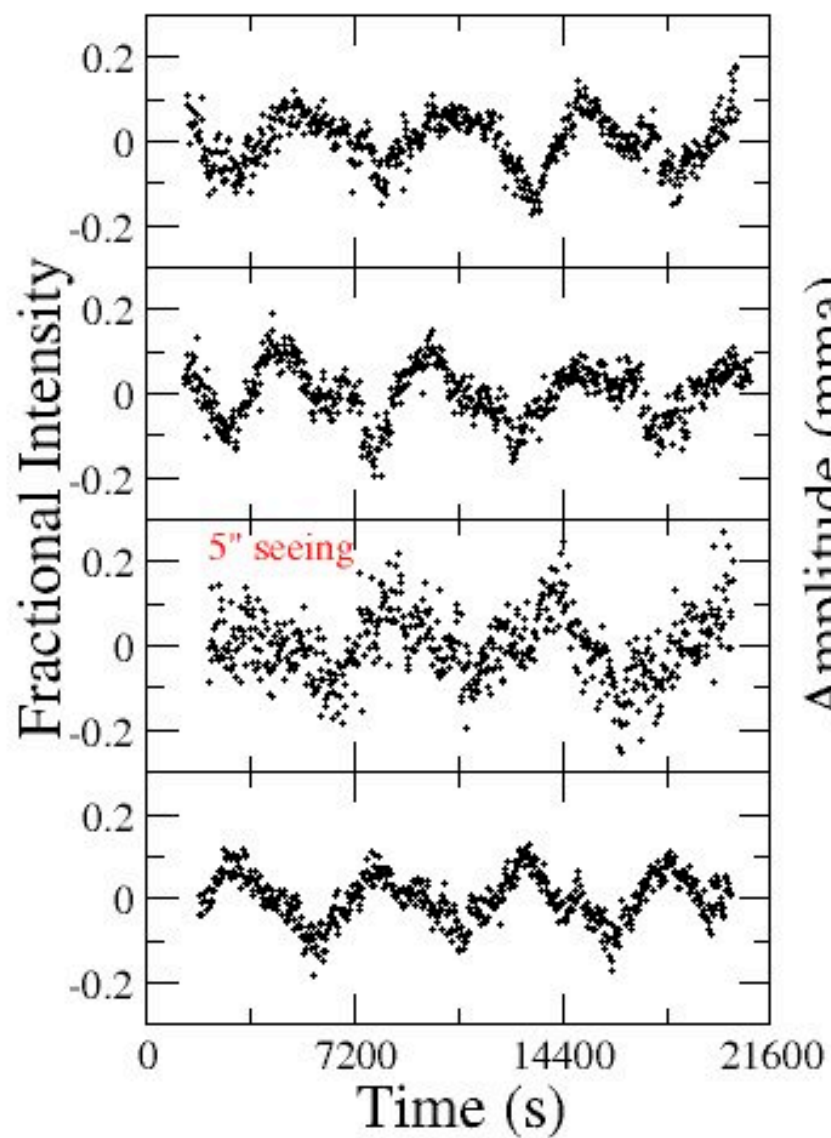


## Fourier transforms



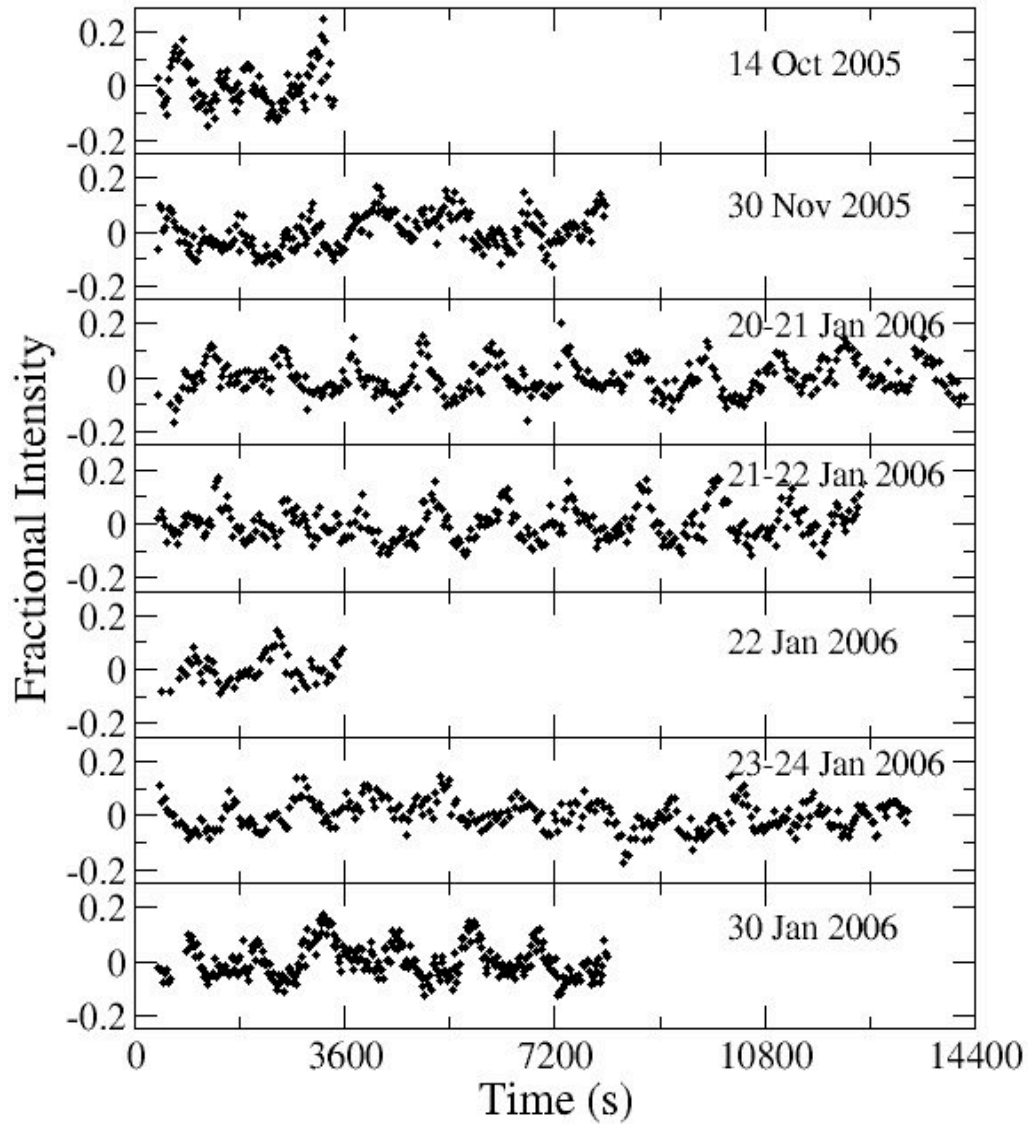
But in 2007:

SDSS0745+4538 (Optical Data from Argos on the McDonald 2.1m)



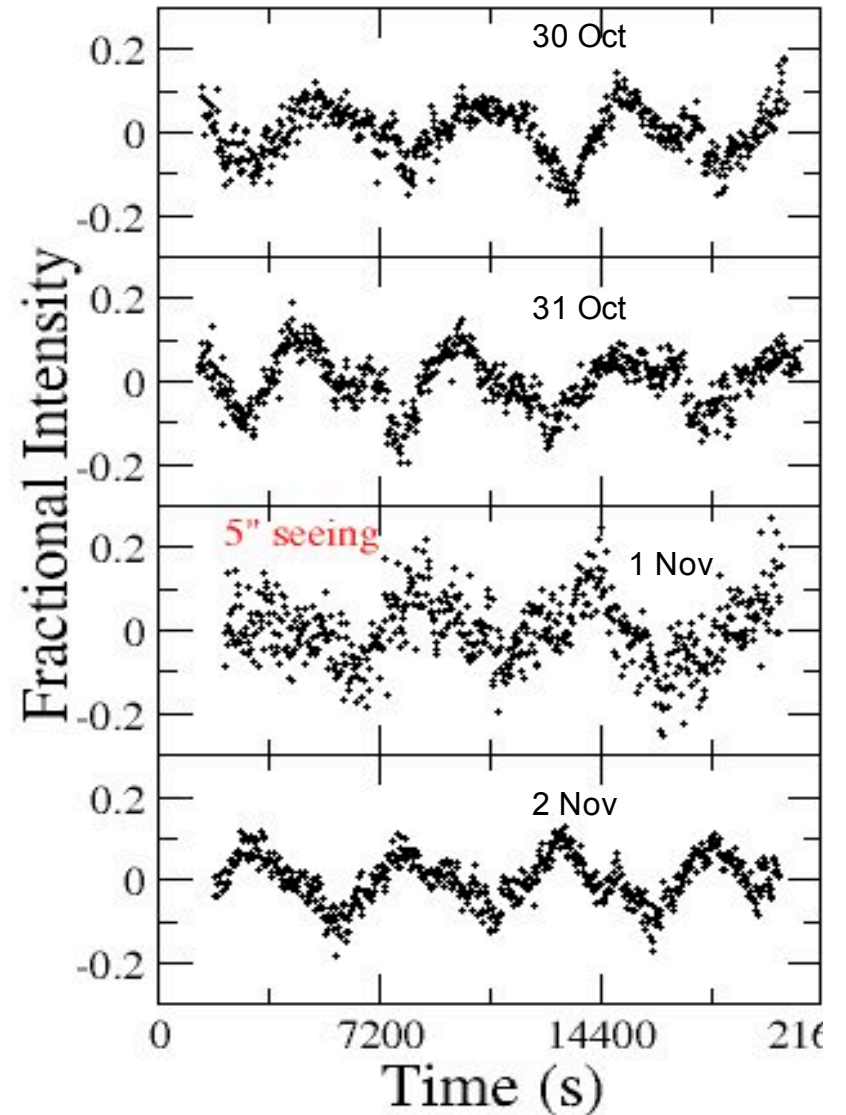
# SDSS0745+4538

2005-2006



6 peaks/ 7200 sec = pulsation

2007



1.5 peaks/ 7200s = orbital

**This accreting pulsator stopped pulsating between 2006 -2007!**

**No respectable ZZ Ceti stops pulsating!**

**BUT**

**The Catalina Sky Survey detected an outburst of SDSS0745+45 in Oct 2006 - did this matter?**

# Summary of Pulsations

Object	Opt Periods (s)	UV Periods (s)	UV/opt amp
GW Lib	650,370,230	650,370,230	6
SDSS0131	581,213,79	213	6
SDSS1610	608,221	608,221	6
SDSS2205	575,475,330	575	6
PQ And	1263	none	<1
SDSS0745	1166-1290	none	
SDSS0919	260	none	
SDSS1339	642	230,210	?
V455 And	419,336,310	No obs	
SDSS1514	571	none	
REJ1255+26	1344,1236, 654,582	none	<2



# Possible Reasons for non-detection of pulsations:

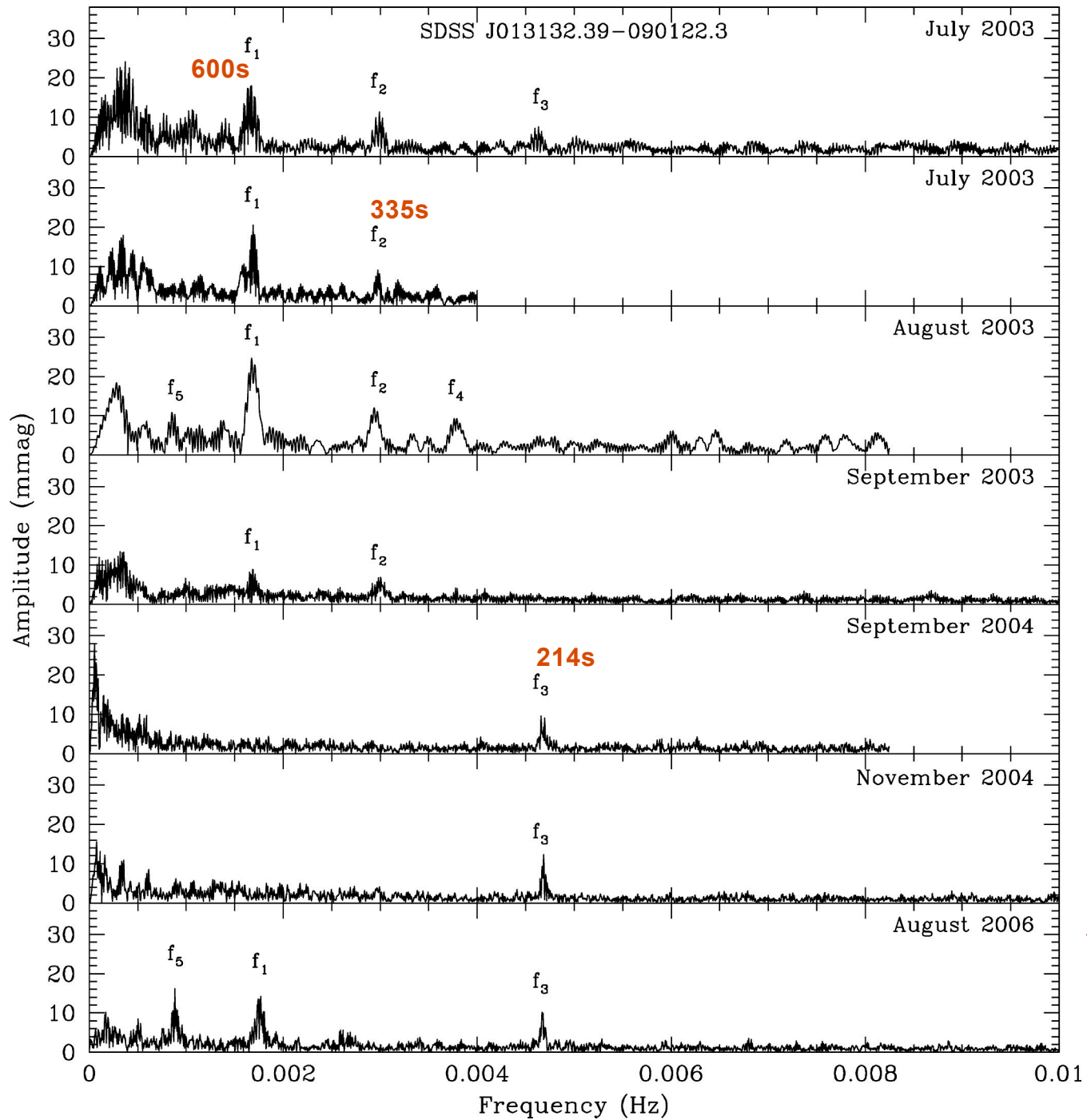
Unknown SOB occurred

or

Accreting pulsators have changing temperature, mass, angular momentum & surface composition

???

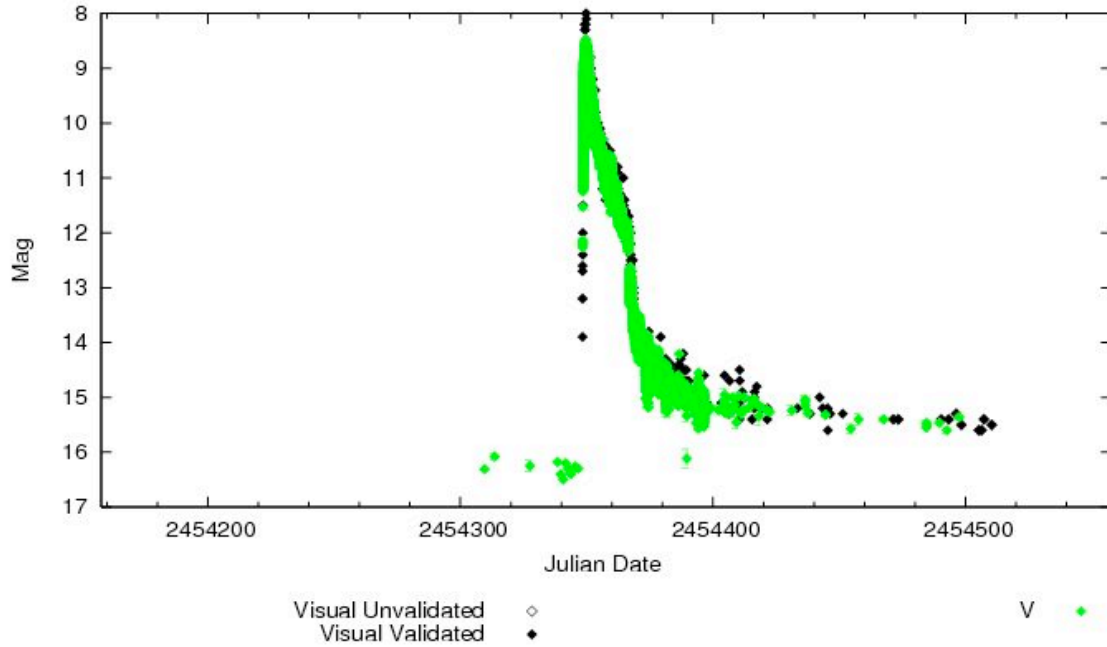
**We need long-term observations for each pulsator**



Patrick  
Woudt  
SAAO for  
term  
monitorin  
of pulsar  
SDSS013

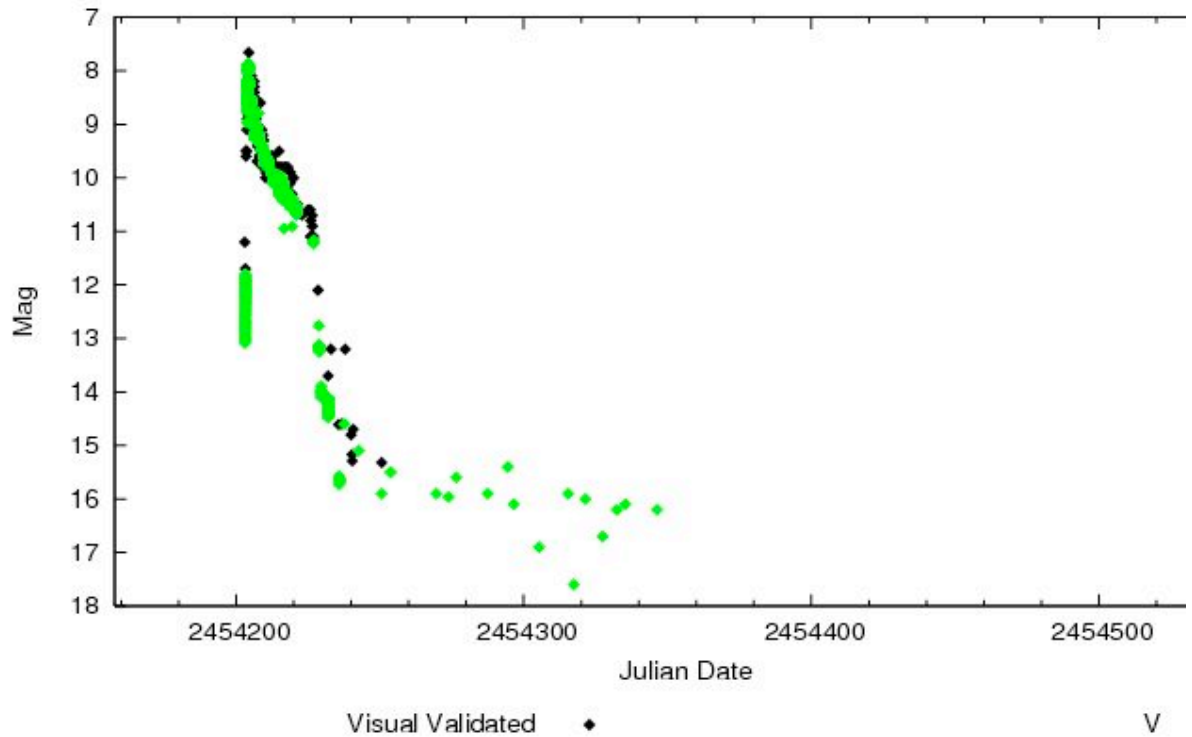
From Szkoc  
et al. ApJ 64  
1188, 2007

HST data June  
2005 showed  
P=214s



V455 And  
Sept 2007 outburst

**Known SOB's give  
a chance to study  
this effect**

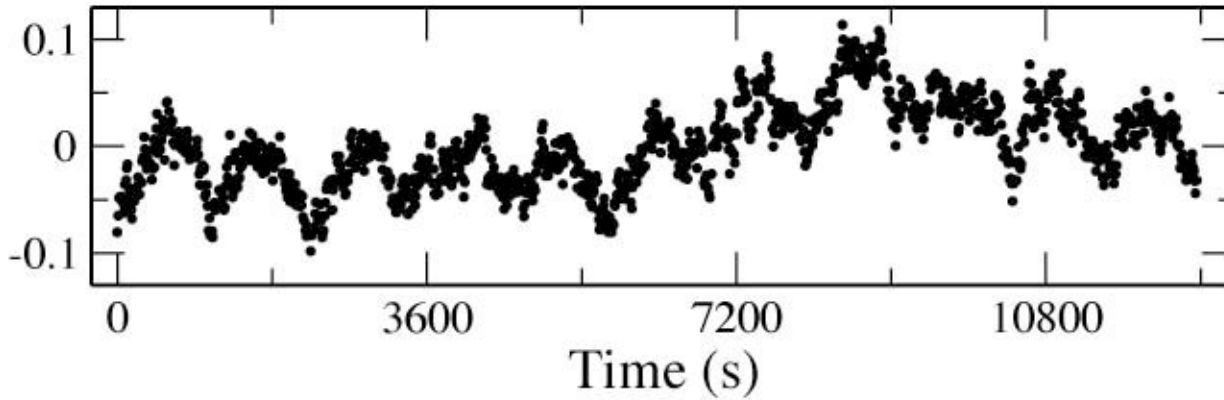


GW Lib  
April 2007 outburst

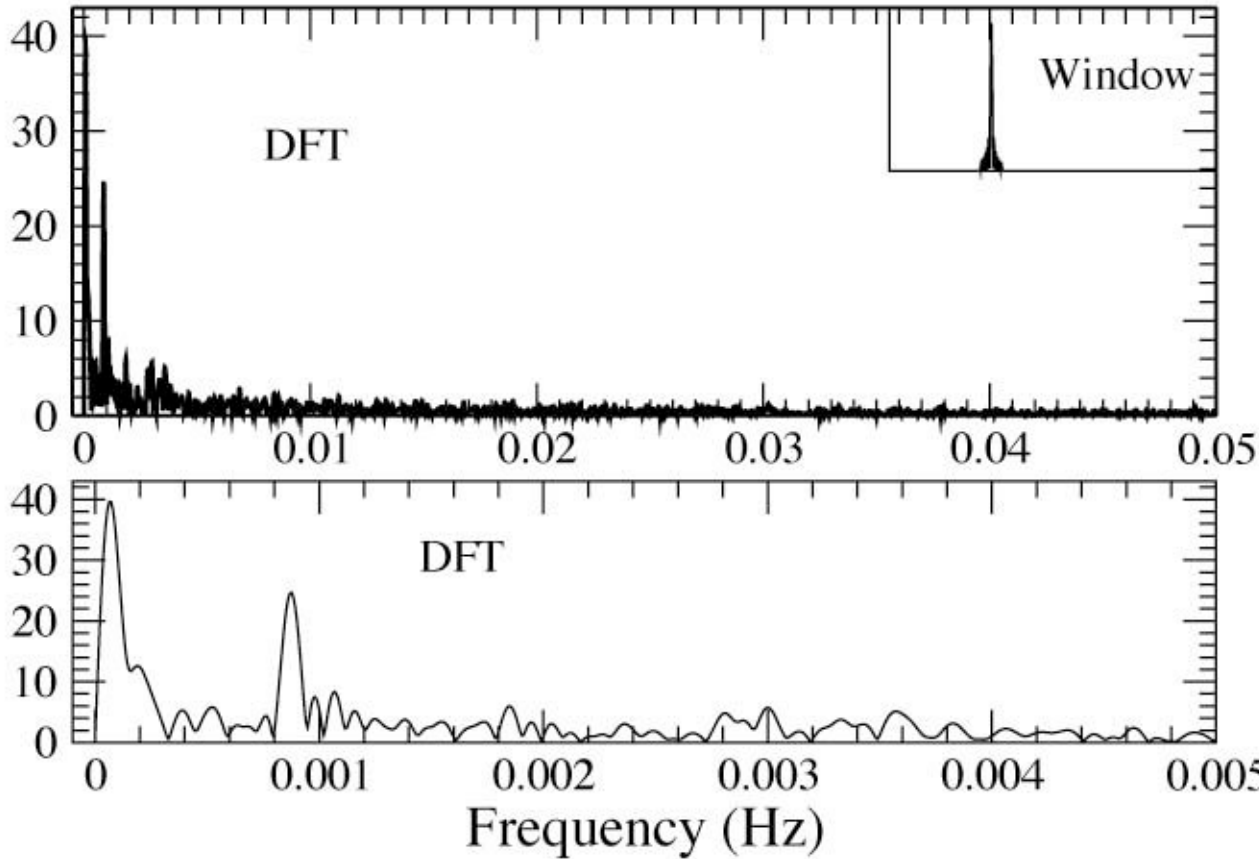
# GW Librae (29 March 2008)

APO 3.5m, Agile, 10s exp, BG40 filter, high airmass, 2.7" seeing

Fractional Intensity



Amplitude (mma)



**A new  
periodicity  
apparent  
after outburst**

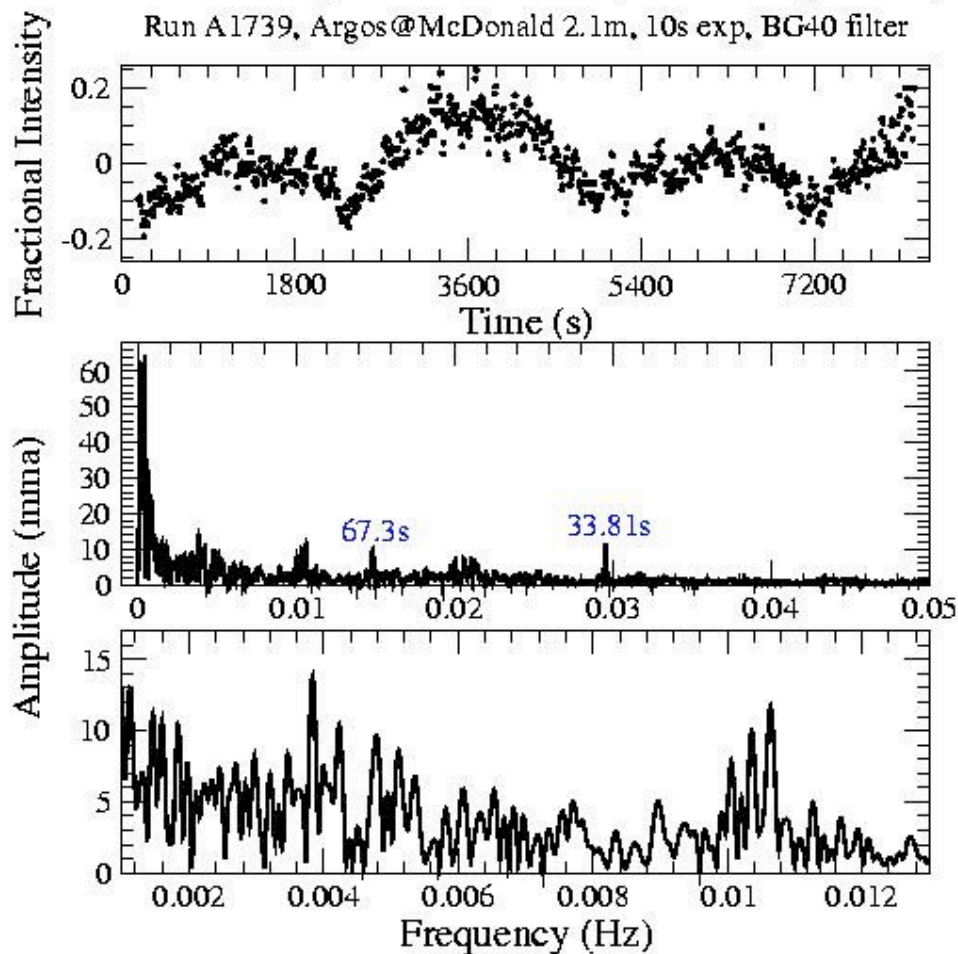
**but not seen  
in UV ???**

Before  
outburst:  
P=650s, 370s

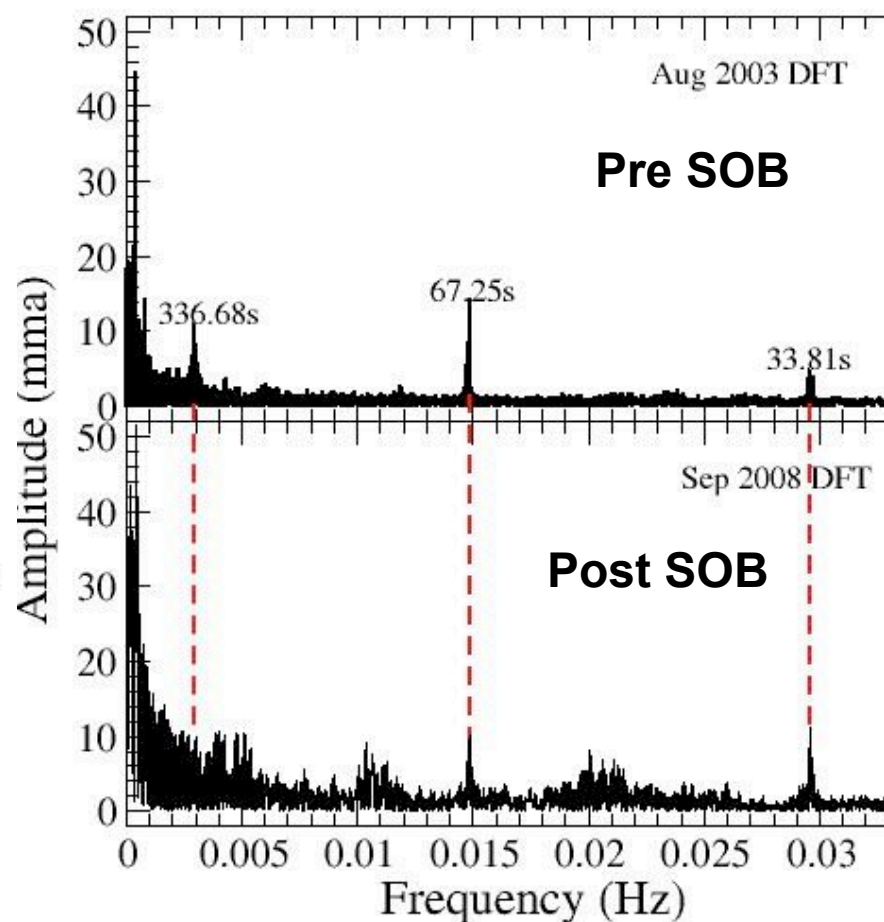
After  
outburst:  
P=1145s

### V455 And (HS2331+3905; 2008 Sep 7 UT)

Run A1739, Argos@McDonald 2.1m, 10s exp, BG40 filter



### V455 And (HS2331+3905)



**We still have a lot to learn but**

**Thanks to AAVSO  
observers for all the  
ground support!**

**Please keep an eye on the  
accreting pulsators!**