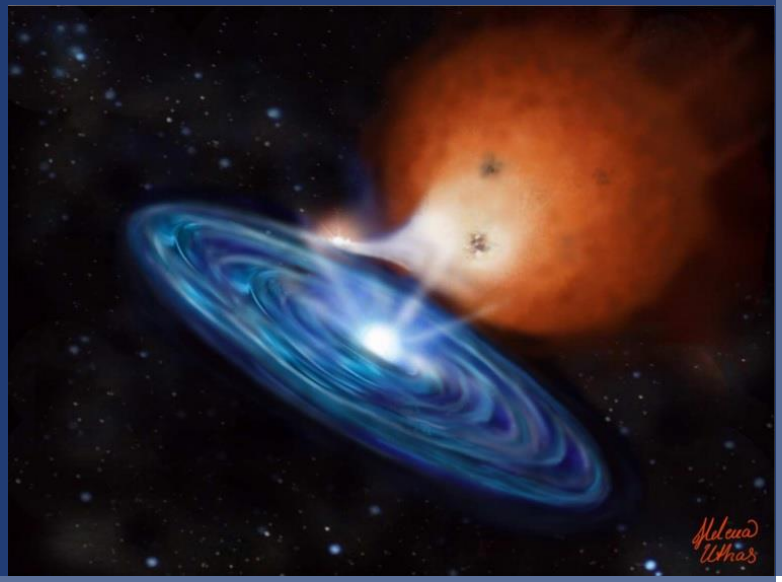
Far northerly cataclysmic variables from the Hamburg Quasar Survey

Jeremy Shears
Director, BAA Variable Star Section



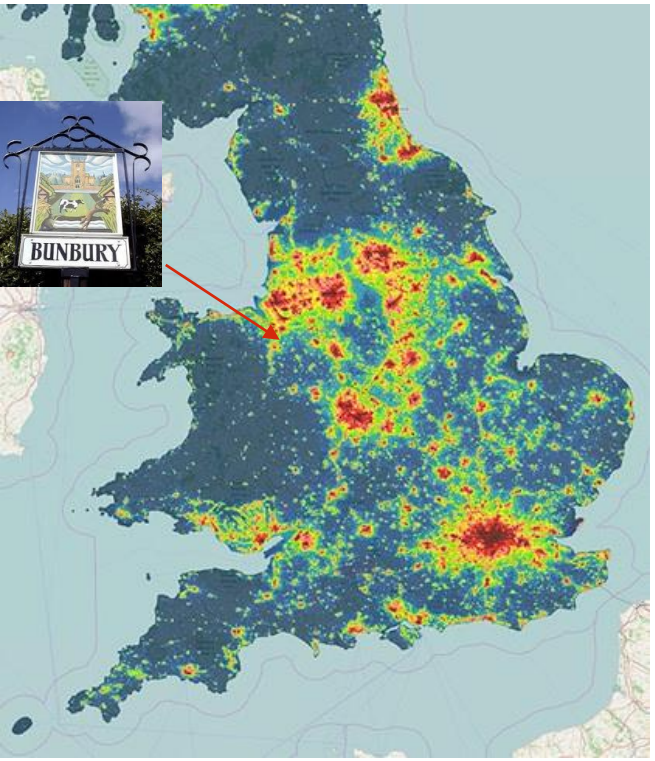
Helena Uthas

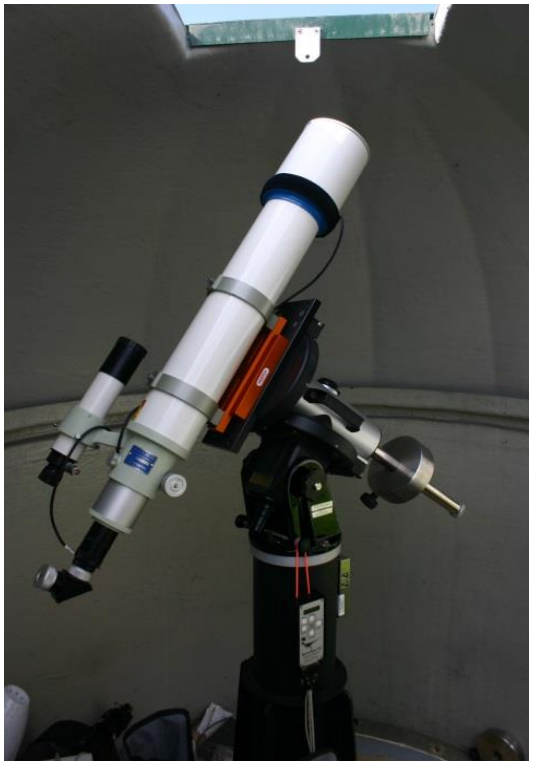
4th European VS meeting
2019 Sept 14

Félix de Roy (1889 – 1942)

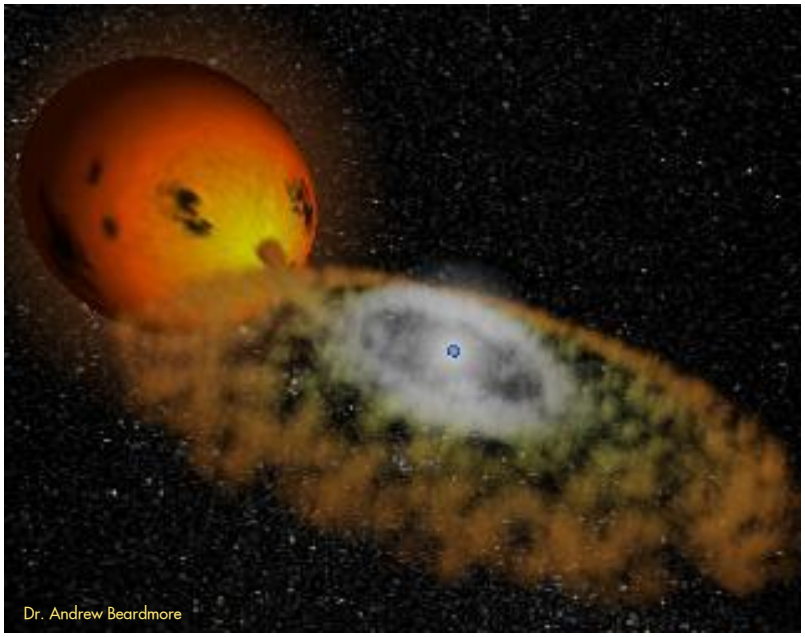
BAA Variable Star Section Director, 1922 -1939
Resident of Antwerpen/Anvers and Thornton Heath near London (1914-18)
Z Cam stars; issued first ever VSS Circular (1922)

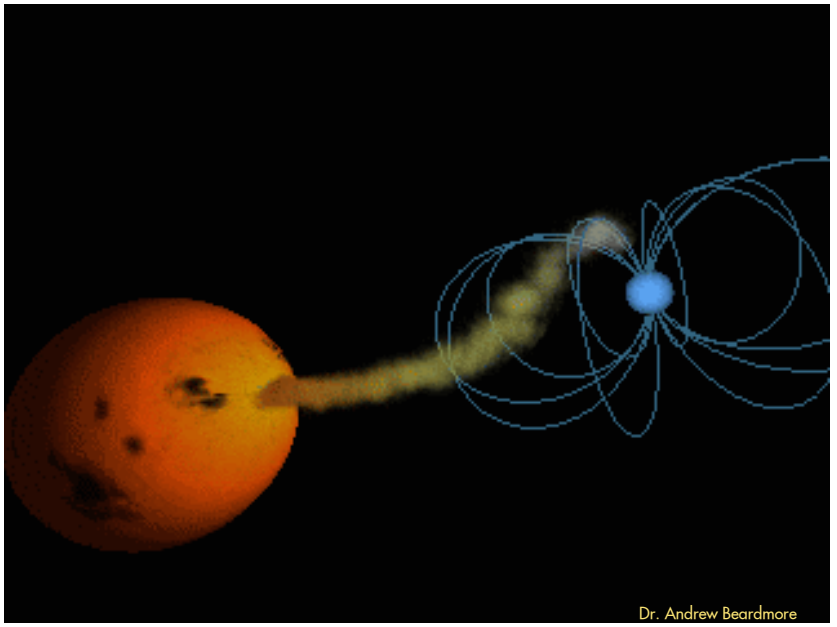
The Bunbury Observatory

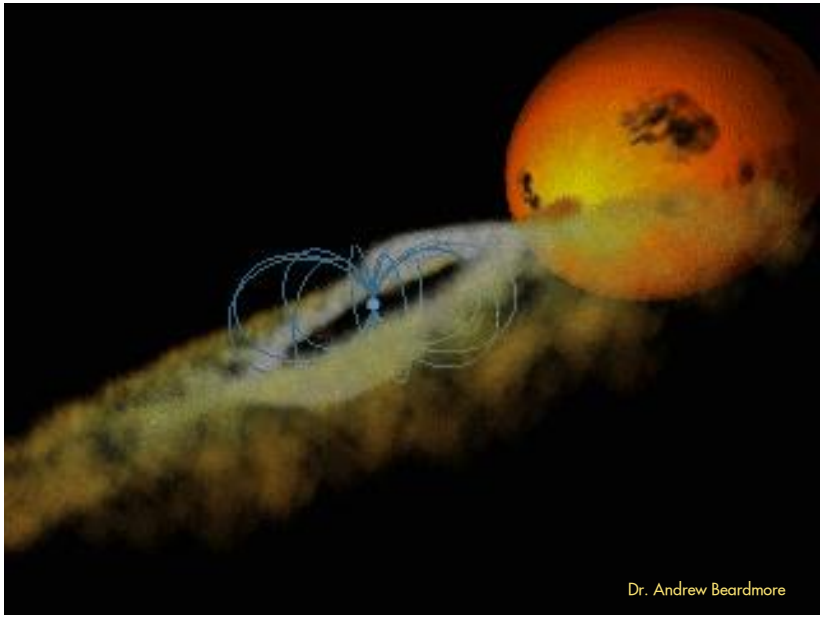




What are cataclysmic variable stars?

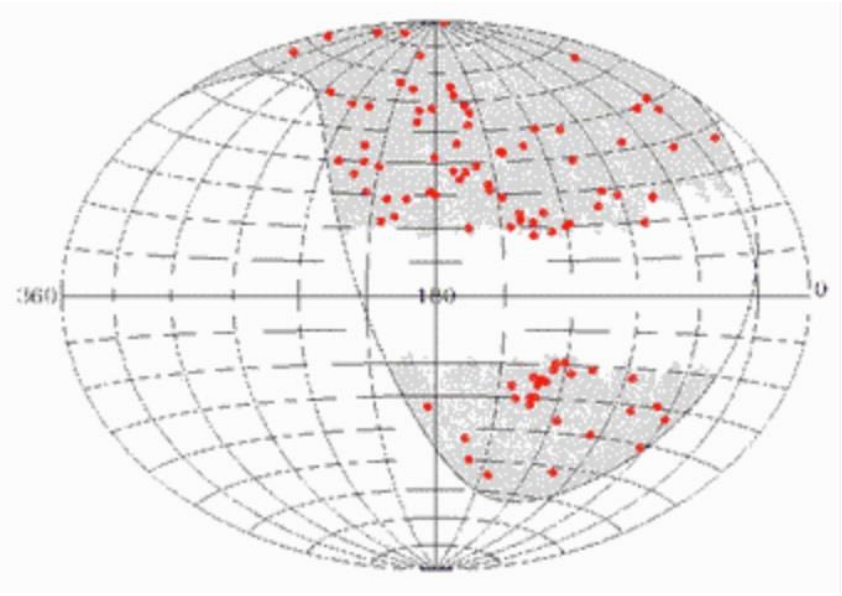






CVs from the Hamburg Quasar Survey

- Photographic Schmidt prism survey
- Northern sky, high galactic latitude
- B < ~18.5
- 11,000 sq. degrees; 50,000 spectra
- CVs selected by peculiar emission line spectra
- 96 CVs, 53 new



80cm Hamburg Schmidt telescope
Calar Alto Observatory

Boris launches a long-term monitoring project.....

most of the new CVs have no or very rare outbursts…a large fraction of long-period CVs, some of them clear members of the SW Sex class, but in some cases it is very difficult to unambiguously identify the CV subtype.

The observing strategy: to get a good long-term light curve, one would wish for one data point per night

Monitoring the long-term variability of CVs from the Hamburg Quasar Survey

Most cataclysmic variables (CVs) have been discovered either because of their variability, strong X-ray emission, or very blue colours. We have started a program to find CVs because of their peculiar emission line spectra, selecting candidates from the Hamburg Quasar Survey. The motivation of this project has been to test whether this selection would unravel new types of CVs (which it did, e.g. the low accretion rate polars such as HS1023+3900), and we had the hope to find the many short-period CVs that CV evolution theory predicts. Interestingly enough, most of the new CVs have no or very rare outbursts, but instead of numerous short-period systems, we found a large fraction of long-period CVs, some of them clear members of the SW Sex class, but in some cases it is very difficult to unambiguously identify the CV subtype. While some systems appear to be rather normal dwarf novae, such as the recently outbursting HS0417+7445, it it is very important for the majority of the systems to gather detailed long-term light curves of these systems to better understand their nature.

The sample of HQS CVs contains by now more than 50 systems, and I will add more systems to the table below over the next days. The magnitudes are rough estimates, quite often taken from uncalibrated images or determined from spectrophotometry. As you can see, are rather faint, so it will need CCD imaging to obtain reliable magnitudes during their faint/quiescent states. Ideally, filtered observations would be best to minimise instrumental differences, but if this turns out not to be possible, filterless values will also be good. The observing strategy: to get a good long-term light curve, one would wish for one data point per night. Before starting, we need to sort out the issue of comparison stars and filters. I would probably favour V-filter, but any help/suggestions will be welcome.

An overview of the project and the related background has been given at several meetings (Göttingen 2001, Strasbourg 2004) and in the Calar Alto Newsletter (N.6, August 2003). The pages on individual objects include often links to literature via the ADS abstract service, which now provides also links to astro-ph, so you can grab a copy of those papers also without having a subscription to the astronomy journals.

If you want to know more, or have some feedback on these pages, please write me at Boris.Gaensicke(AT)warwick.ac.uk

News:

18-Oct-2006	I have added four new dwarf nova, which have either rare outbursts or undetermined subtypes and would need regular monitoring: HS1016+3412, HS1340+1524, HS1857+7127, HS2214+2845
20-Oct-2006	Tim Crawford reports that AAVSO charts and sequences from Arne Henden are available for a few of the HS objects. I have therefore added two more columns in the table below.
23-Oct-2006	Tim Crawfort made charts including the Henden sequences for HS0417+7445, HS0805+3822, HS2219+1824, and HS2331+3905, which are now linked below in the table.
9-Feb-2007	Mike Simonsen mentions that HS0618+7336 (MU Cen) has also a Henden sequence

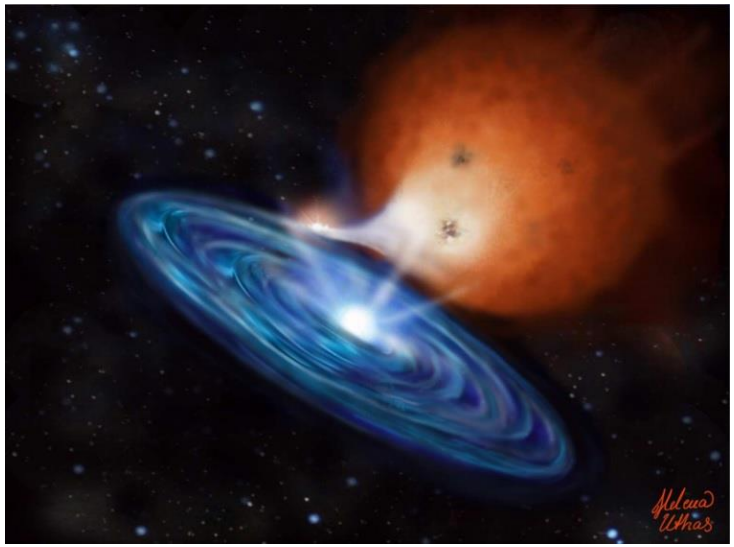
#	System	Alt. name	RA/Dec (2000)	Type	min. mag	max. mag	Porb (min)	AAVSO chart	Henden sequence
1	HS0128+3547	RX J0131.4+3602	01 31 25.9 +36 02 40	CV/DN:	16.4	-	-	-	-
2	HS0129+2933	TT Tri	01 31 59.8 +29 49 22	CV/SW	-	14.7	201	-	-
3	HS0139+0559	-	01 41 39.8 +06 14 38	CV/NL:/ZC:	-	15.2	242	-	-
4	HS0220+0603	-	02 23 01.6 +06 16 52	CV/SW	19.3	16.3	215	-	-
5	HS0229+8016	-	02 35 58.0 +80 29 46	CV/NL:/ZC:	15.0	13.7	232	-	-
6	HS0357+0614	KUV03580+0614	04 00 36.9 +06 22 50	CV/NL/SW	-	15.4	205.5	-	-
7	HS0417+7445	1RXS J042332.8+745300	04 23 33.0 +74 52 52	CV/DN/SU	18.8	13.7	104	-	X
8	HS0455+8315	-	05 06 48.5 +83 19 22	CV/NL/SW	-	15.0	214.17	-	-
9	HS0506+7725	-	05 13 36.9 +77 28 42	CV/NL/SW:	18.5	15.1	212	-	-
10	HS0551+7241	LS Cam	05 57 23.9 +72 41 52	CV/NL/SW:	19.5	16.9	204.9	-	-
11	HS0552+6753	LU Cam	05 58 18.0 +67 53 46	CV/DN	17.0	14.0	216.6	X	X
12	HS0618+7336	1RXS J062518.2+733433, MU Cam	06 25 16.6 +73 34 38	CV/IP	-	15.1	283.2	-	-
13	HS0642+5049	-	06 46 19.6 +50 45 48	CV/NL:/ZC:	-	15.6	225.9	-	-
14	HS0728+6738	-	07 33 41.3 +67 32 15	CV/SW	-	15.3	192.34	-	-
15	HS0752+6314	HT Cam	07 57 01.4 +63 06 01	CV/IP	18.0	16.5	85.98	X	X
16	HS0756+1624	DW Cnc	07 58 53.1 +16 16 45	CV/IP/VY	16.5	14.5	86	X	X
17	HS0758+4019	-	08 02 15.2 +40 10 47	CV/NL	-	16.3	-	-	-
18	HS0805+3822	SDSS J080908.39+381406.2	08 09 08.3 +38 14 06	CV/SW	-	15.5	192	-	X
19	HS0907+1902	GY Cnc	09 09 50.6 +18 49 48	CV/DN/UG	16.3	12.0	252.64	X	X

13 years later: 5 far northerly CVs

Why select *northerly* CV's?

- not well observed
- minimal seasonal gaps
- not covered by sky surveys

System	Alt. name	RA/Dec (2000)	Type	min. mag	max. mag	Porb (min)
HS0229+8016	-	02 35 58.0 +80 29 46	CV/NL:/ZC:	15	13.7	232
HS0417+7445	V342 Cam	04 23 33.0 +74 52 52	CV/DN/SU	18.8	13.7	104
HS0455+8315	-	05 06 48.5 +83 19 22	CV/NL/SW	19.9	14.6	214.17
HS0506+7725	-	05 13 36.9 +77 28 42	CV/NL/SW:	18.5	15.1	212
HS0551+7241	LS Cam	05 57 23.9 +72 41 52	CV/NL/SW:	19.5	16.9	204.9



CV #1
V342 Cam (HS 0417+7445)

V342 Cam (HS 0417+7445)

- Quiescence: double-humped light curve, P_{orb} = 105.1 or 109.9 min
- Identified as SU UMa during 1st observed superoutburst in 2001

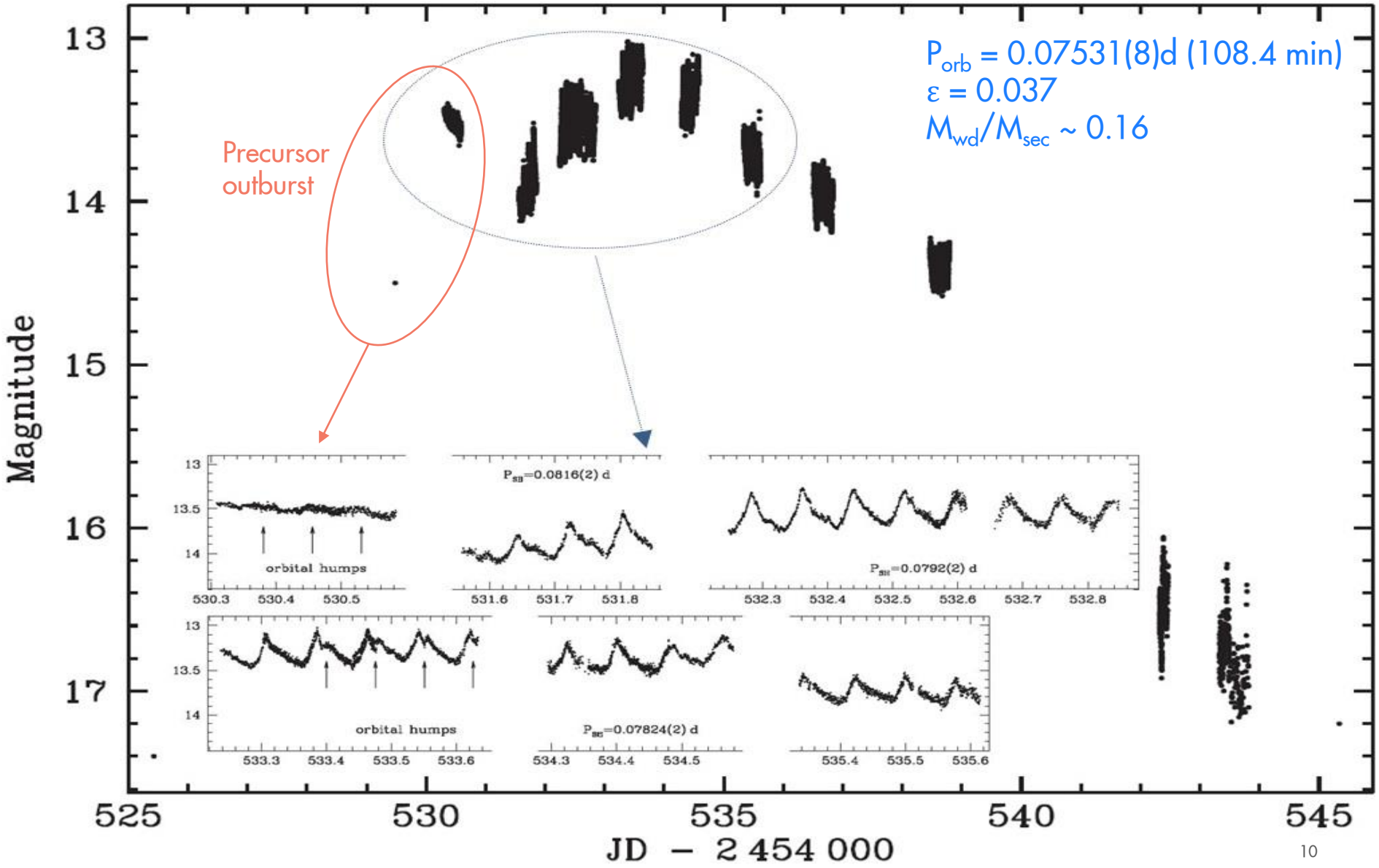
Aungwerojwit, A., Gänsicke, B.T., Rodríguez-Gil, P. et all A&A 455 (2006)

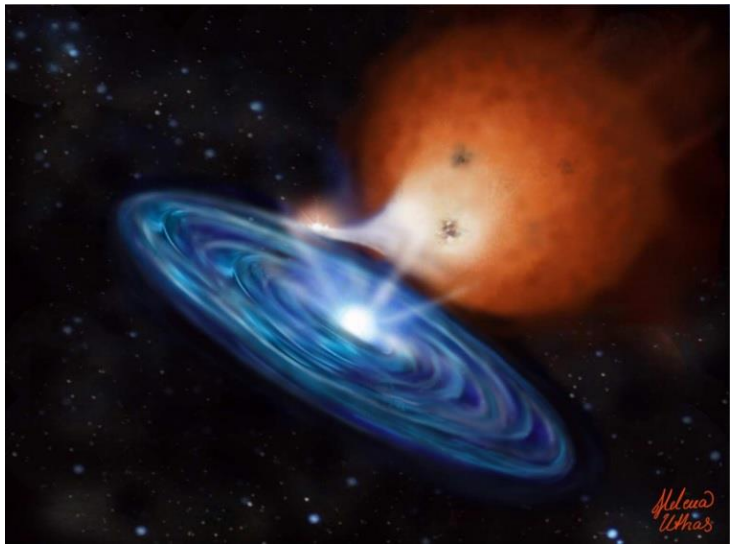
- 11 outbursts between April 2005 and October 2010 (AAVSO IDB)
  - outburst interval: mean 197 ± 59 d, median 193 d
  outburst rather long: up to 8 days
  - at least 2 superoutbursts

- Superoutburst of 2008 March observed
  - amplitude of 4.2 mag
  - duration16 days

Shears, Gänsicke, Brady, Dubovsky, Miller, Staels, New Astronomy, 16, 311 (2011)

2008 outburst of V342 Cam





CV #2
HS 0455+8315

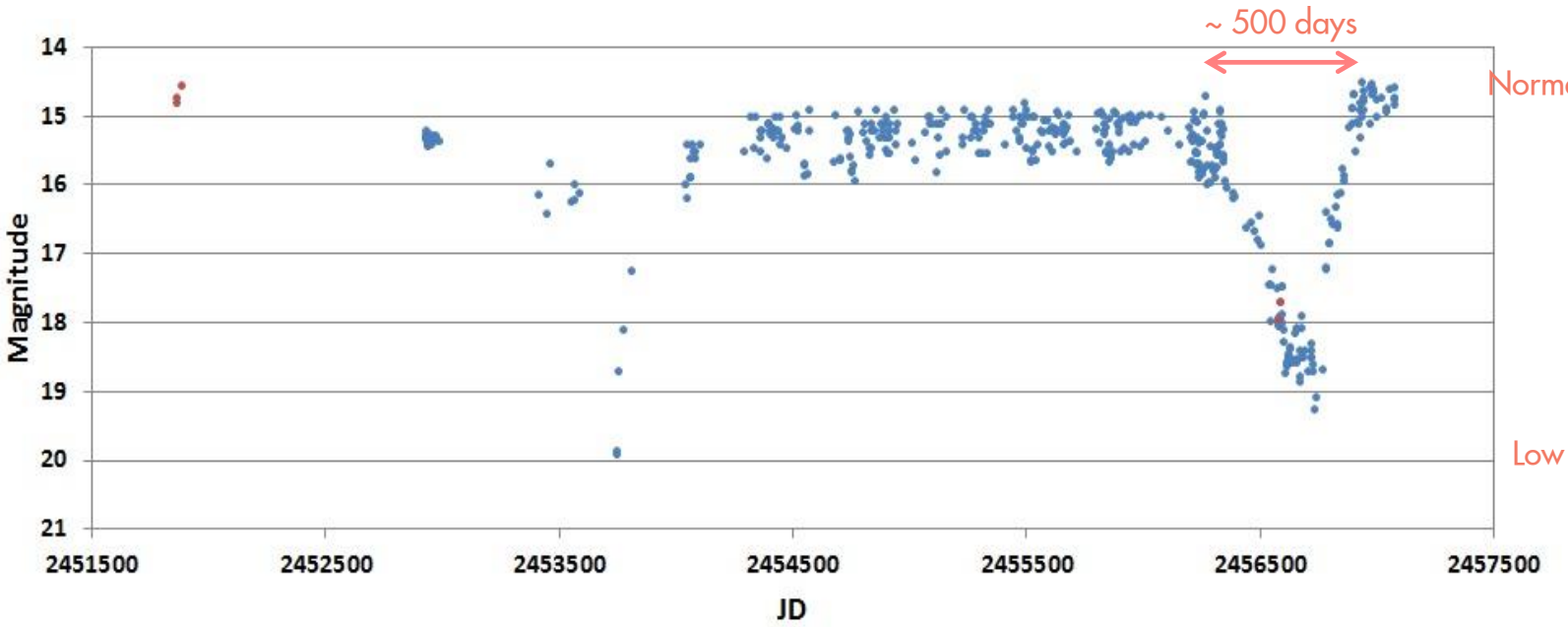
HS 0455+8315: an SW Sex star in Cep

- SW Sex stars nova-like CVs, P_{orb} 3- 4 h
- Single-peaked emission lines, strong He II
- Emission and transient absorption features at orbital phase 0.5
- Many are eclipsing
- High luminosities + hot white dwarfs = high accretion rates
- Maybe evolutionary phase in all CVs

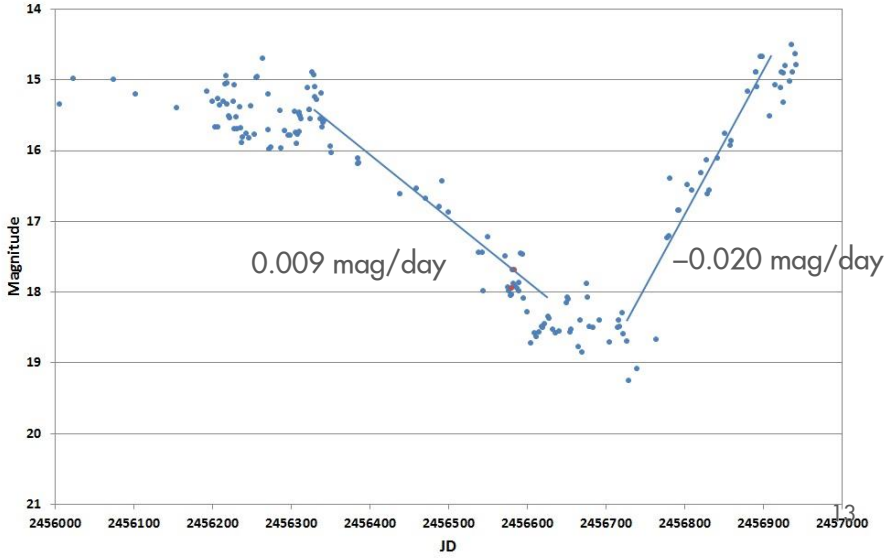
- HS 0455+8315 identified as SW Sex-type by Gänsicke et al (2002)[1]
  deep eclipses (~ 1.5 mag), P_{orb} = 3.569h
- refined eclipse ephemeris was published by Boyd (2012) [2]
  constant to 1 part in 2×10^6 over 10 years

1. Gänsicke B.T. et al., The physics of cataclysmic variables and related objects, ASP Conference Series, 261, 623–624 (2002)
2. Boyd D., JAAVSO, 40, 295–314 (2012)

HS 0455+8315: VY Scl-like low states



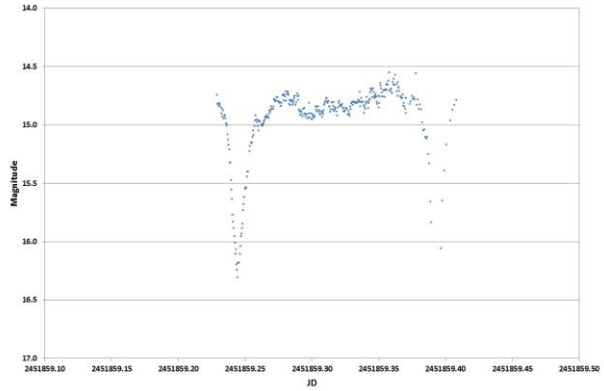
2000 November to 2015 February

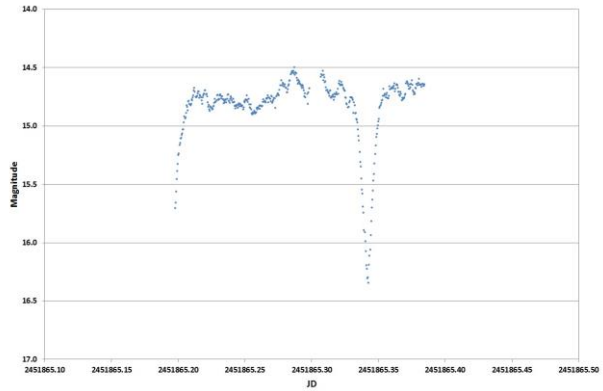


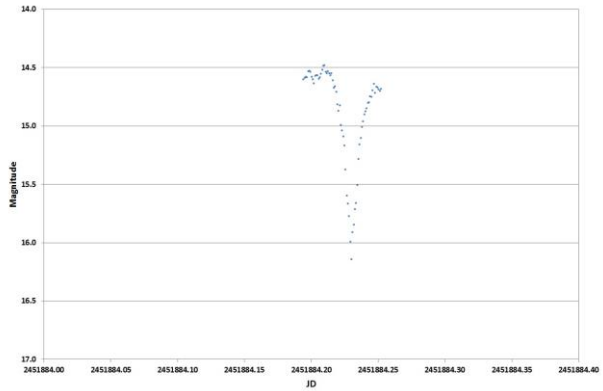
Shears, Gänsicke, Rodríguez−Gil, Boyd, Darlington & Miller 2016 JBAA..126...42S

HS 0455+8315: ~12 min eclipses

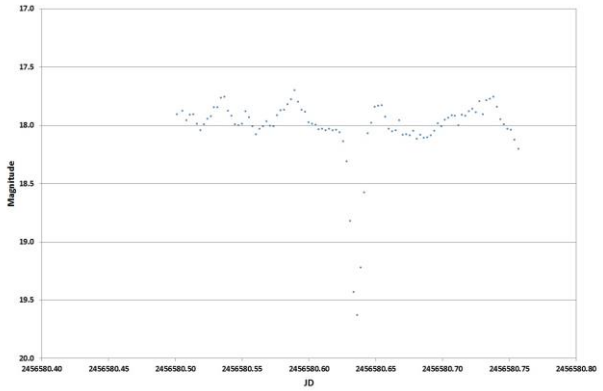
Normal state

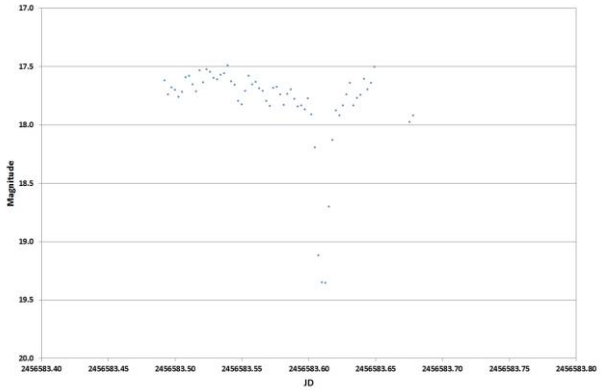




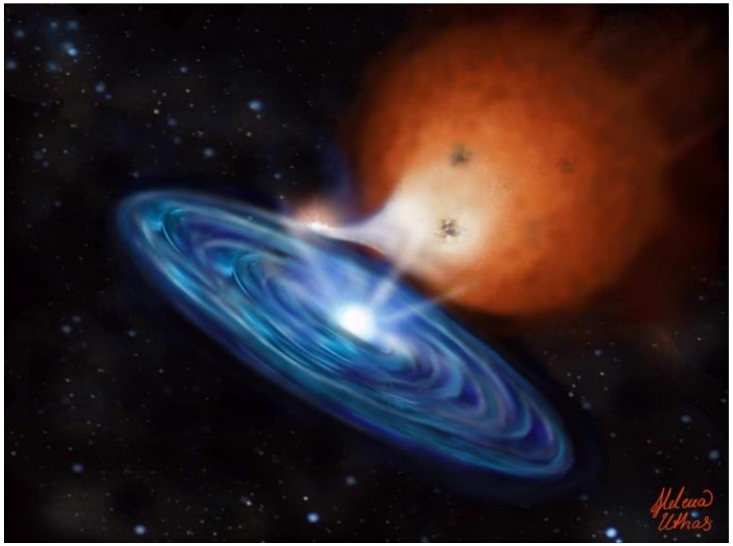


Low state





80cm m telescope, Instituto de Astrofísica de Canarias
courtesy of Pablo Rodríguez–Gil



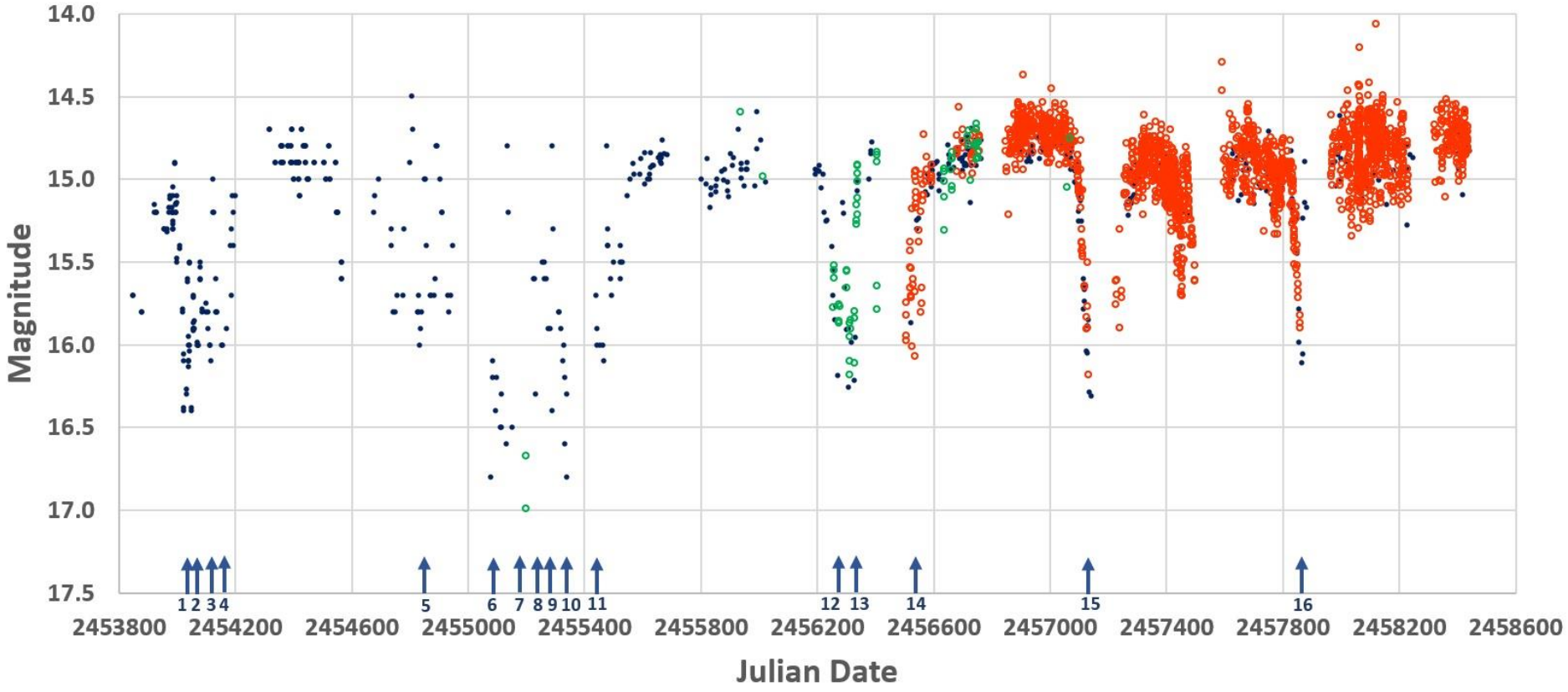
CV #3
HS 0506+7725 (Cam)

HS 0506+7725 (Cam)

- NL SW Sex system
- P_{orb} = 212.7 min (3.545 h)
- Low inclination (no eclipses)
- Low sate (B ~18.3) detected => VY Scl

Aungwerojwit, Gänsicke, Rodríguez-Gil et al. A&A. 443, 995-1005 (2005)

HS 0506+7725: multiple low states up to 2.3 mag deep

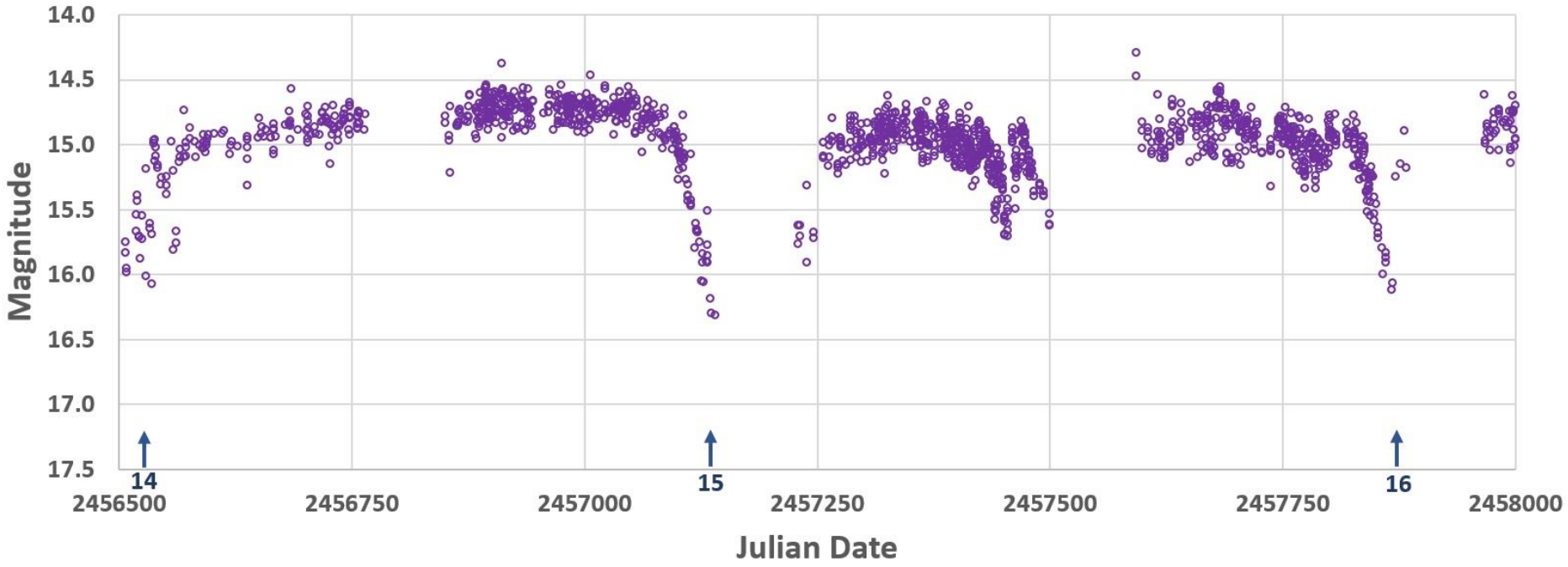


HS 0506+7725 between 2006 April 22 and 2018 Nov 18

- CV photometry by Shears
- ASAS-SN V-band.
- AAVSO Photometric All-Sky Survey (APASS) V-band data

Shears, JBAA, 129, 232-232 (2019)

HS 0506+7725: fades in 2015, 2017



Fade #15: 2015, 1.6 mag, up to 160 days?

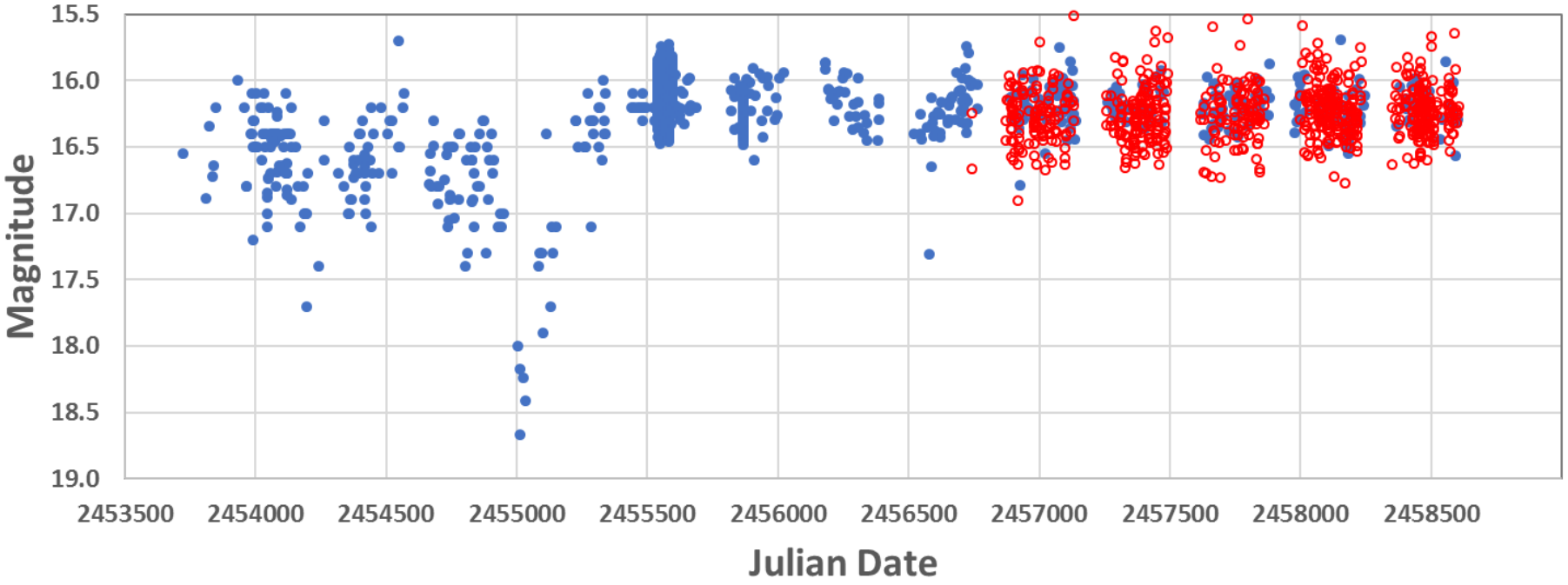
Rate of fade: 0.037 mg/d

Fade #16: 2017, 1.4 mag, ~43 days

Rate of fade: 0.034 mag/d; faster rise -0.09 mag/g

CV #4
LS Cam (HS 0551+7241)

LS Cam – 13year light curve



LS Cam between 2005 Dec 17 and 2019 May

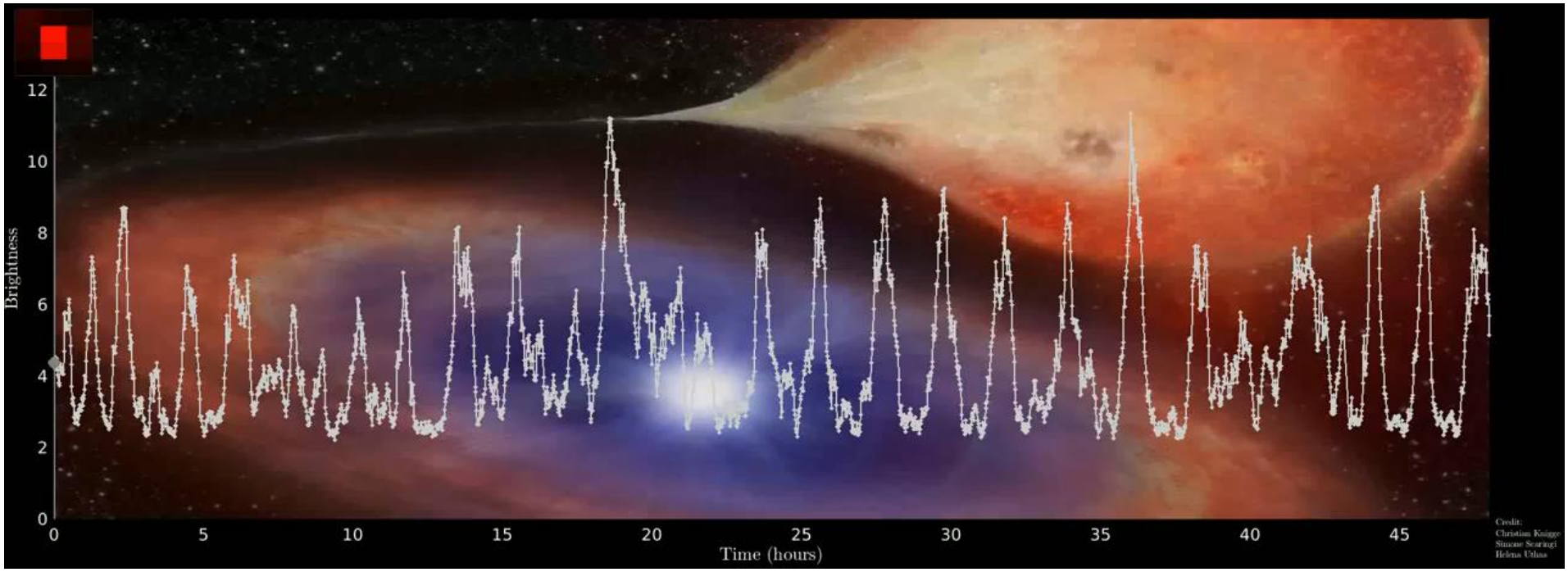
Observers (AAVSO IDB):

- Boyd, David; Brady, Steve; Cook, Lew; Curto Amigo, Juda; Leyland, Paul; Rodriguez Perez, Diego; Shears, Jeremy; Sanchez Lopez, Joaquin; Ulowetz, Joseph

- ASAS-SN (V-band)

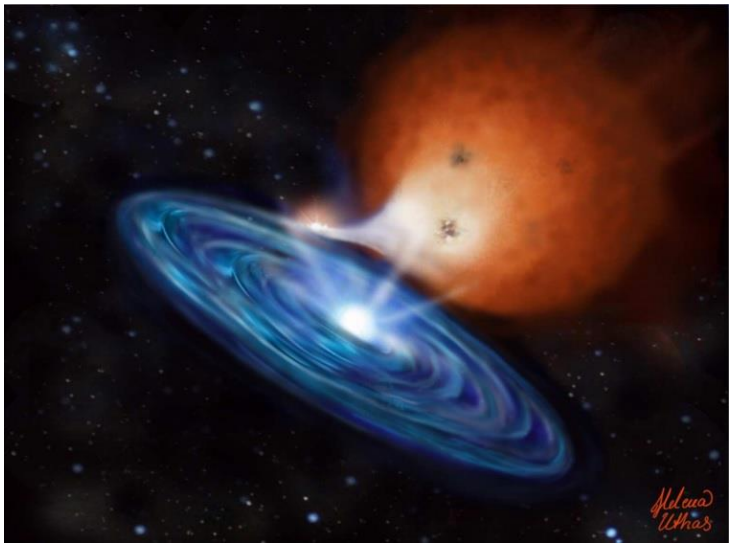
VY Scl stars and reduction in mass transfer

Magnetically gated accretion bursts in MV Lyr



Quasiperiodic (~2h) pulses during low state controlled by WD magnetic field

Credit: Christian Knigge, Simone Scaringi, Helena Uthas
See: S. Scaringi, T. J. Maccarone, C. D'Angelo, C. Knigge & P. J. Groot, Nature, 552, 210–213 (2017)



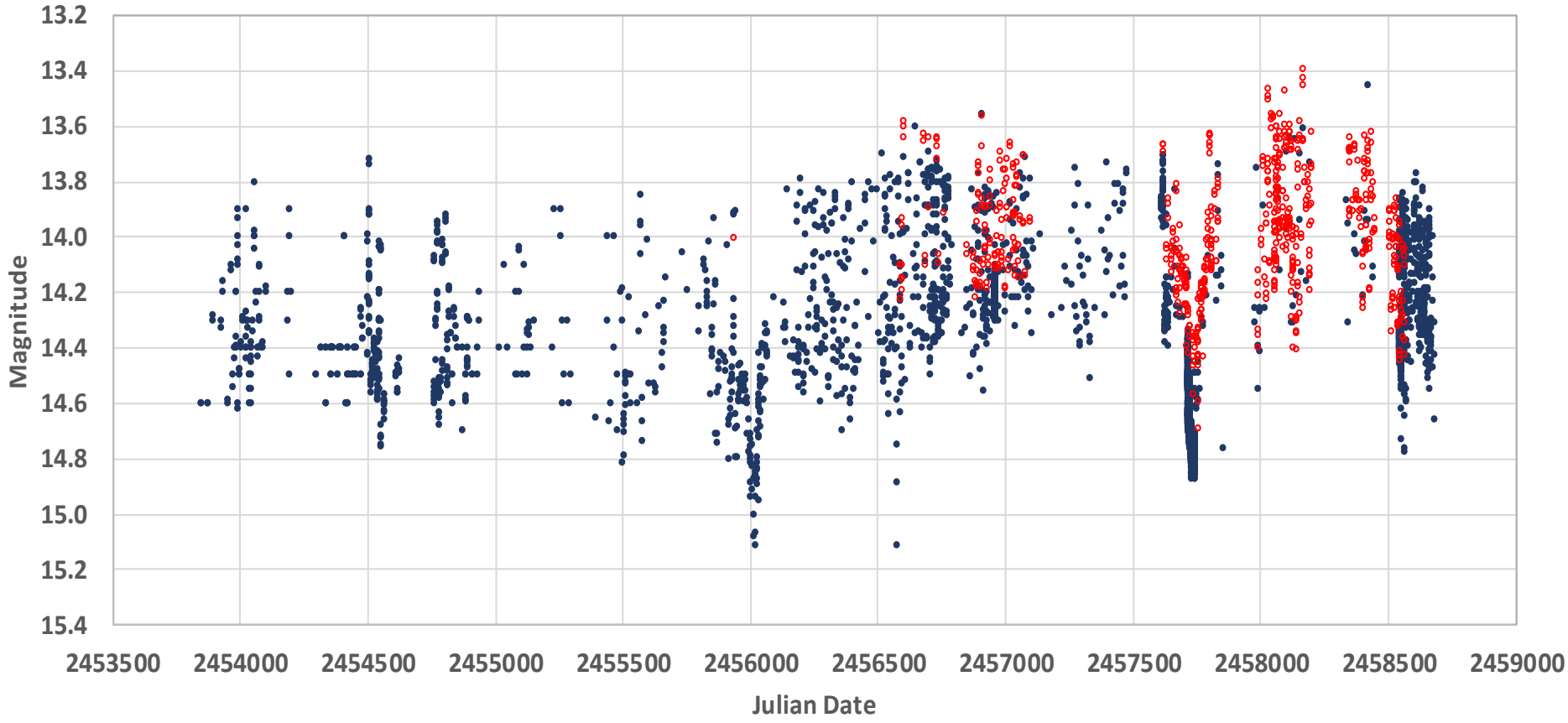
CV #5
HS 0229+8016 in Cep

HS 0229+8016 in Cep

Boris' HQS website:

- P_{orb} = 3.88h
- spectroscopy and photometry suggested a NL star, i.e. with a hot thick disc spectrum
- On one occasion a little fainter than usual, and the emission lines were more pronounced
- UX UMa novalike or a Z Cam dwarf nova that we observed mostly during standstills
- Monitoring is necessary to tell whether this is indeed a novalike, which is always bright (and, possibly does show some deep low states, as the VY Scl stars), or if it is a Z Cam dwarf nova which we just happened to observe always in outburst or standstill

HS 0229+8016, 2006 April 22 and 2019 Jul 18



Armiński, Andrzej
Boardman, James *
Boyd, David *
Cook, Lewis (Lew)
de Miguel, Enrique
Dufoer, Sjoerd *
Fleming, George *
Johnston, Steve
Joslin, Mel *
Kautter, William *
Menzies, Ken *
Miller, Ian *
Mobberley, Martin *
Morales Aimar *
Morelle, Etienne
Padovan, Stefano
Popov, Velimir
Poyner, Gary *
Reichenbacher, Frank
Roe, James
Sabo, Richard *
Schwendeman, Erik *
Shears, Jeremy *
Smith, Dave *
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Staels, Bart
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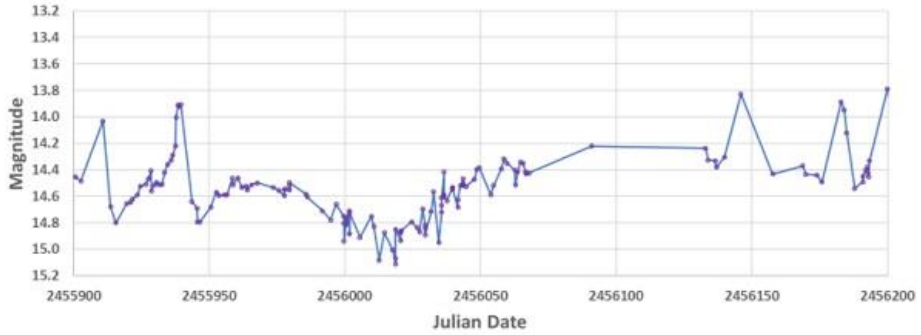
Stone, Geoffrey
Storey, David *
Swan, David *
Szaj, Robert
Taylor, Daniel
Tomlin, Ray *
Tordai, Tamas *
Vanmunster, Tonny *
Zecchin, Franck

○ ASAS-SN (V-band)

* Contributed to 2018/19 campaign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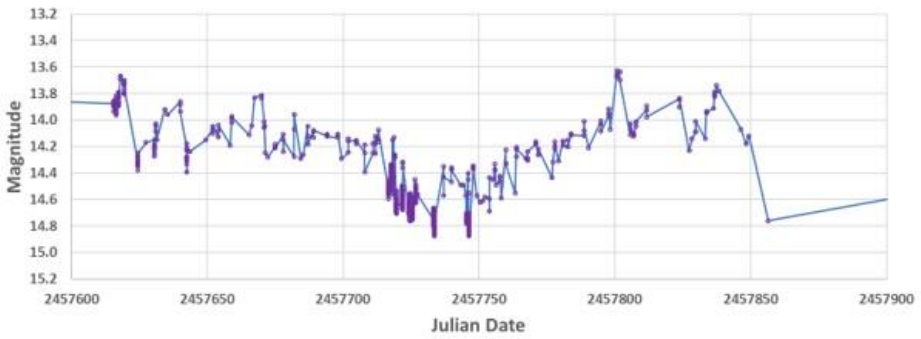
Julian Date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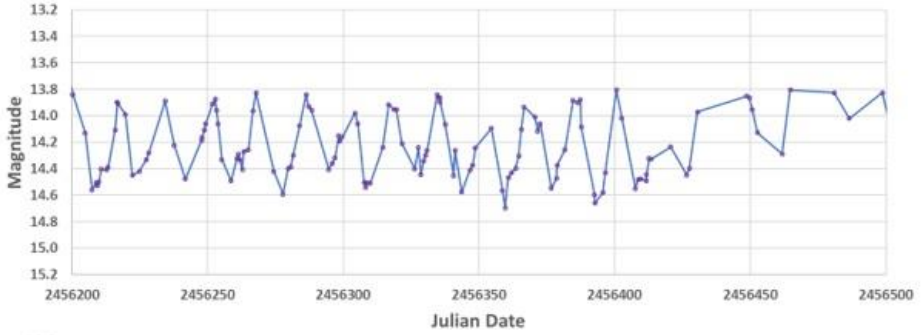
Julian Date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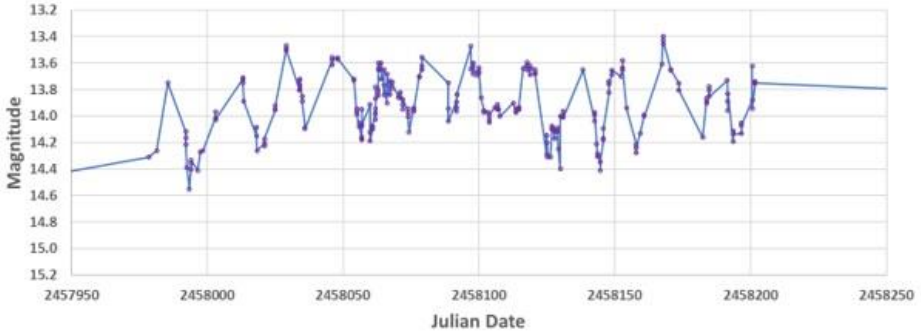
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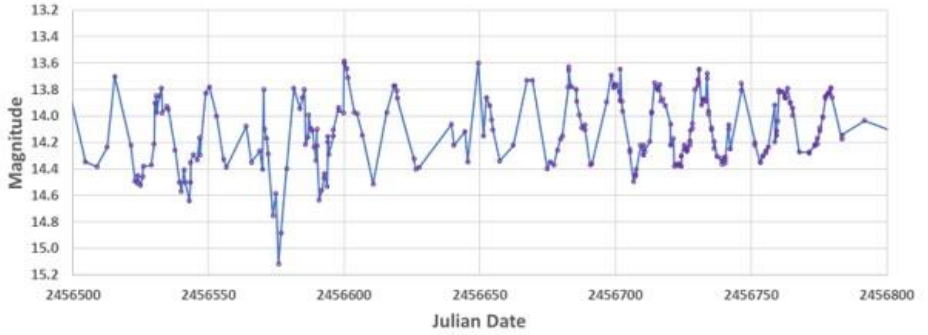
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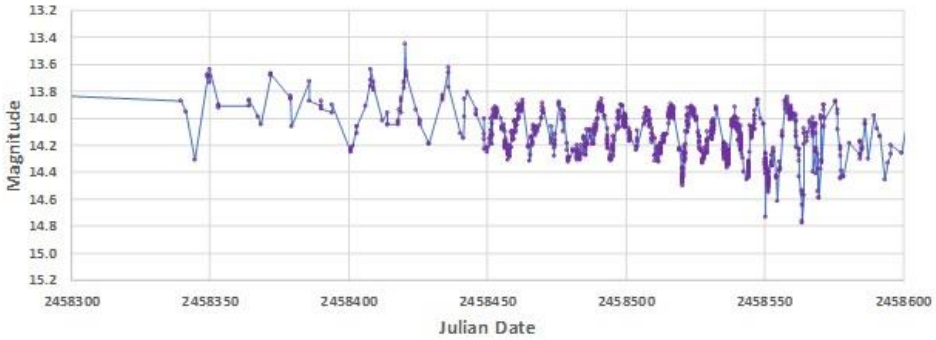
Julian Date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13.6
13.8
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14.4
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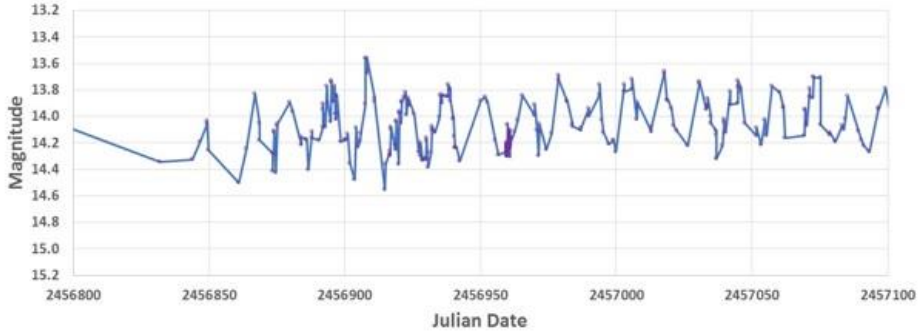
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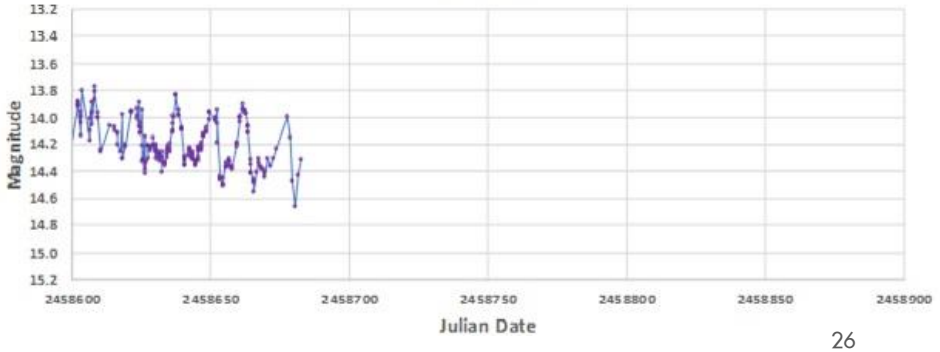
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15.2
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2458650
2458700
2458750
2458800
2458850
2458900
Julian Date

"Stunted" outbursts in HS 0229+8019

Mean **amplitude**: 0.6 mag (range 0.2 - 0.9 mag)

Mean **duration**: 9.5 d (range 5 - 13 d)

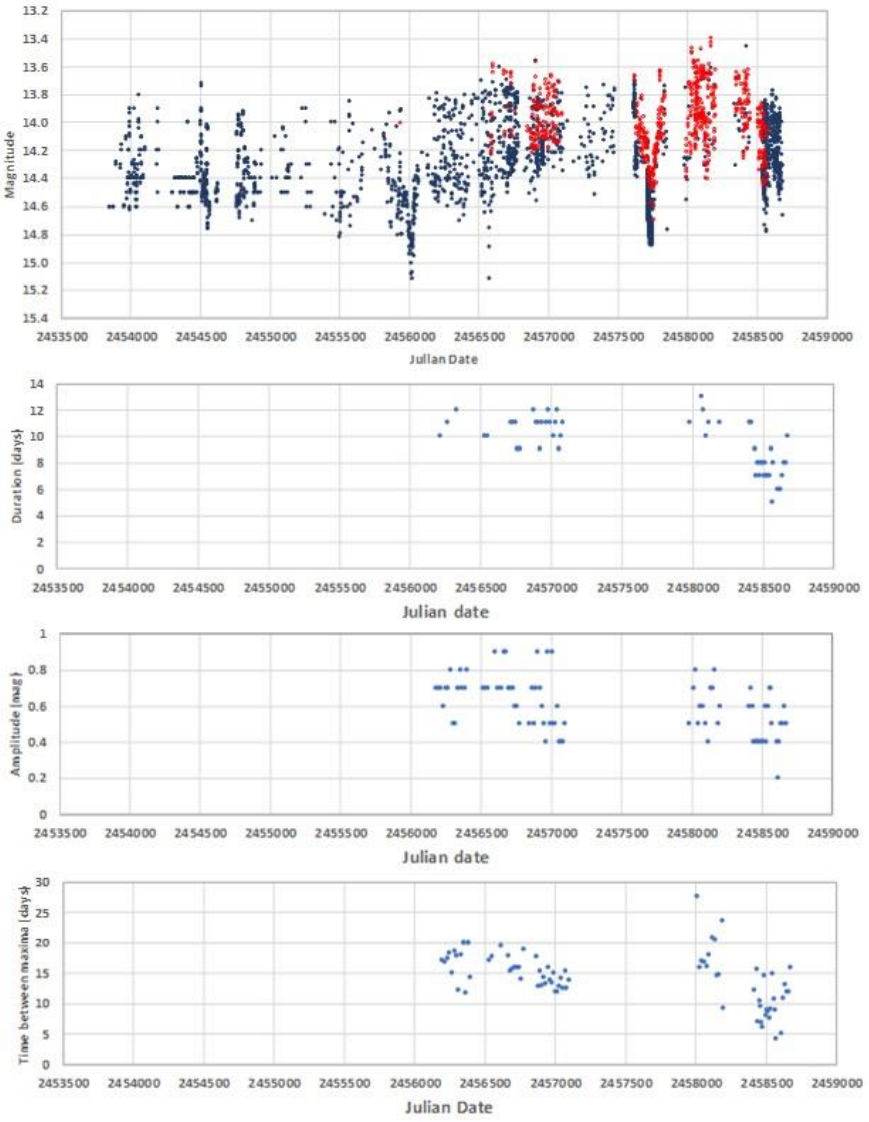
Mean **interval** between each maximum: 14.3 d (range 4.1 - 27.6 d)

Similar stunted outbursts seen in other NL CVs: UU Aqr, Q Cyg,CP Lac, W Ser and RW Sex

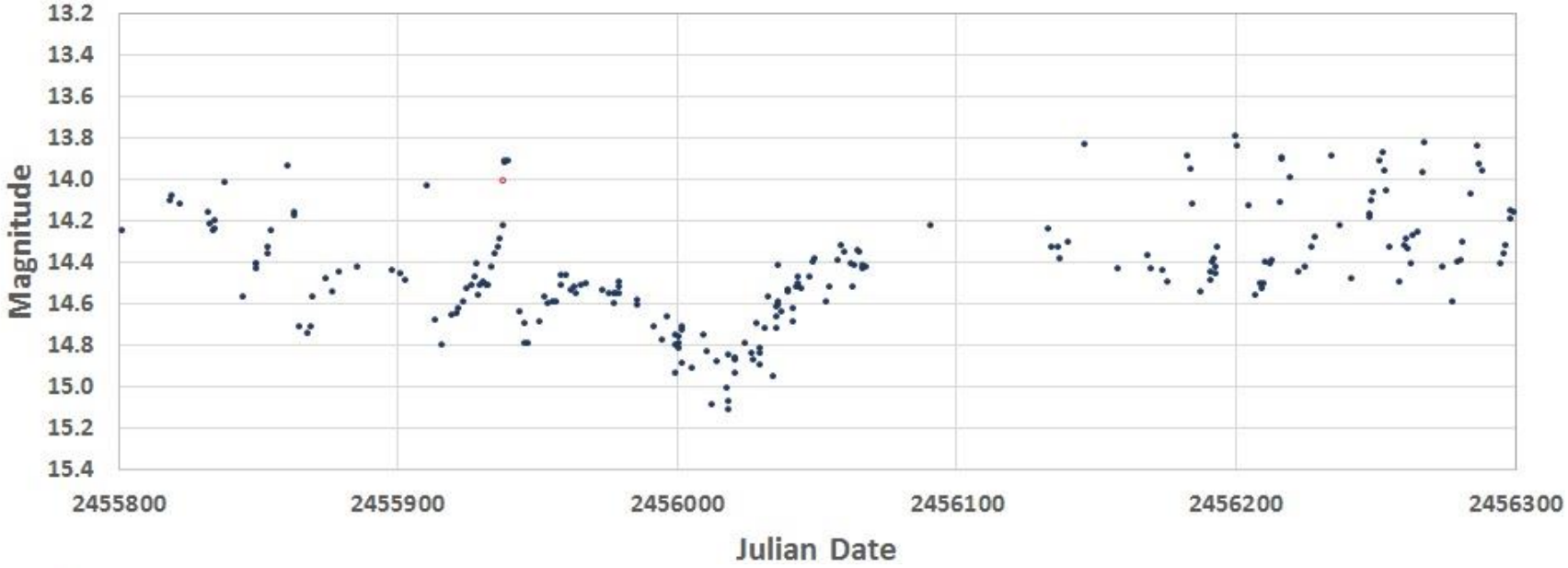
UU Aql: 0.6 mag outbursts every ~10 d

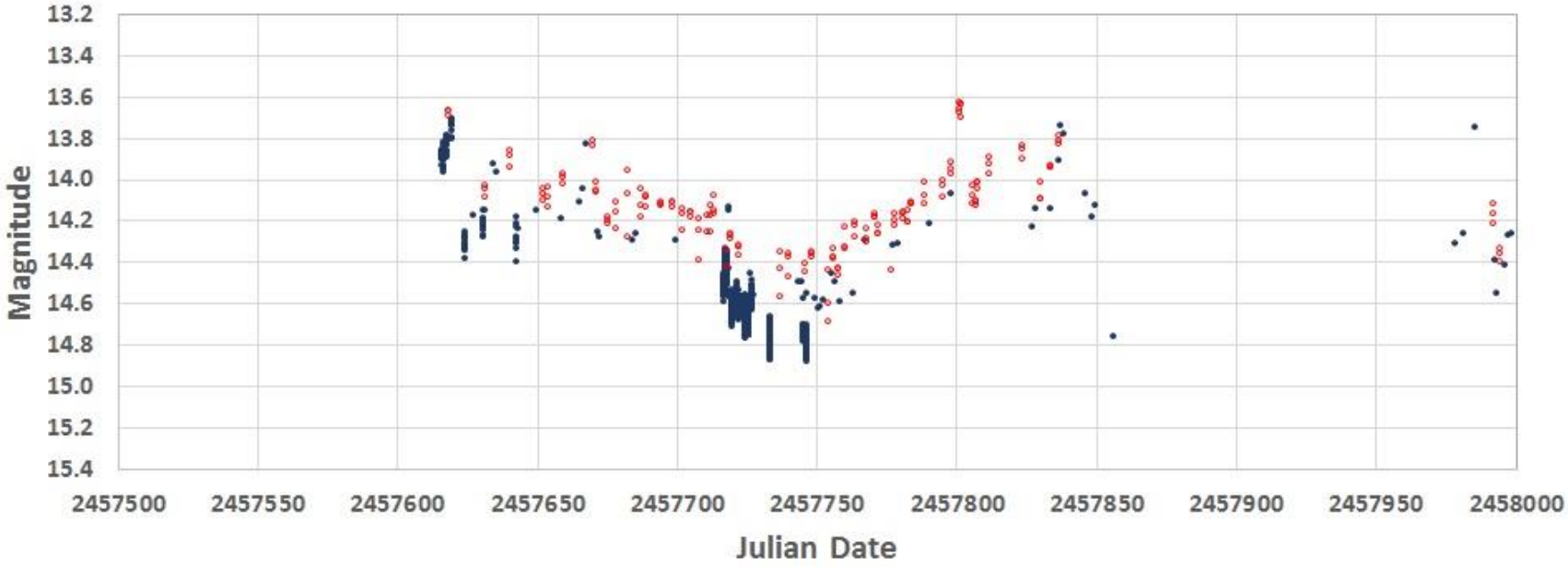
Enhanced mas transfer vs accretion disc instabilities?

Are the stunted outbursts becoming smaller, shorter and more frequent?

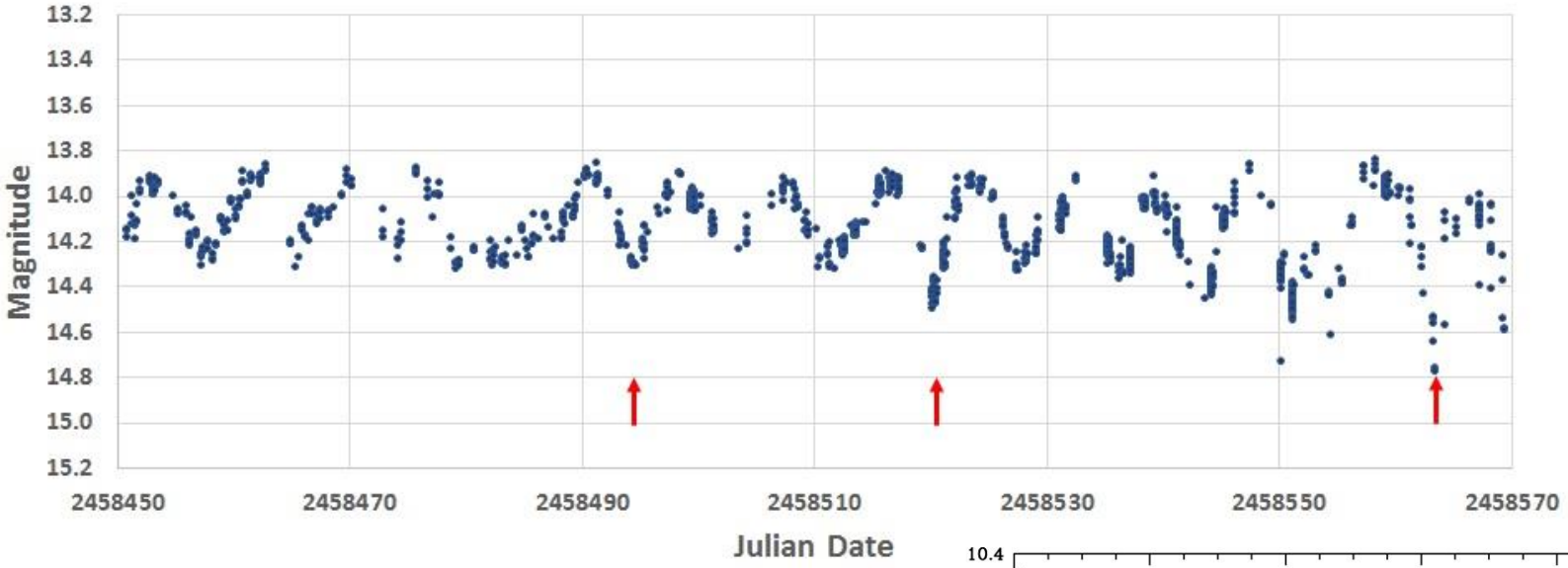


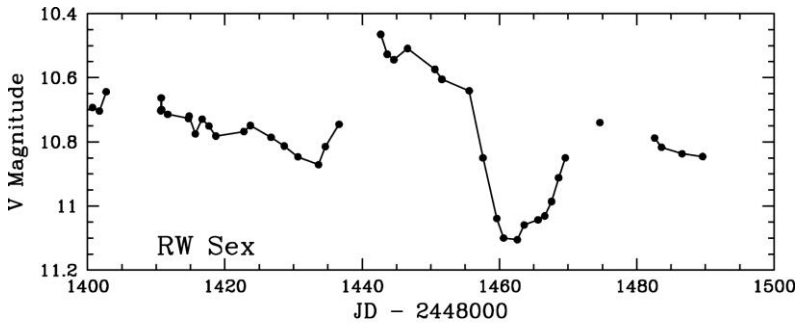
Stunted outbursts reduce or cease during fades

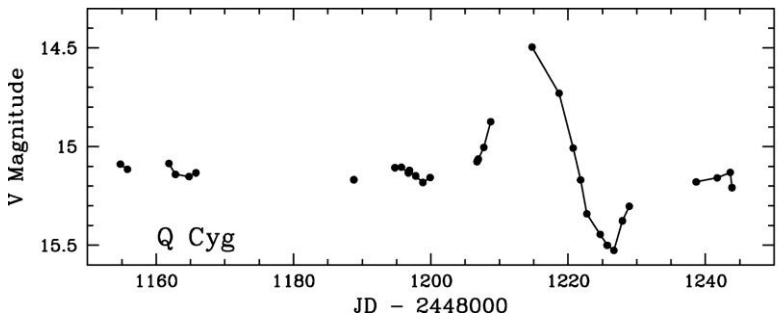




Post-outburst dips in HS 0229+8016



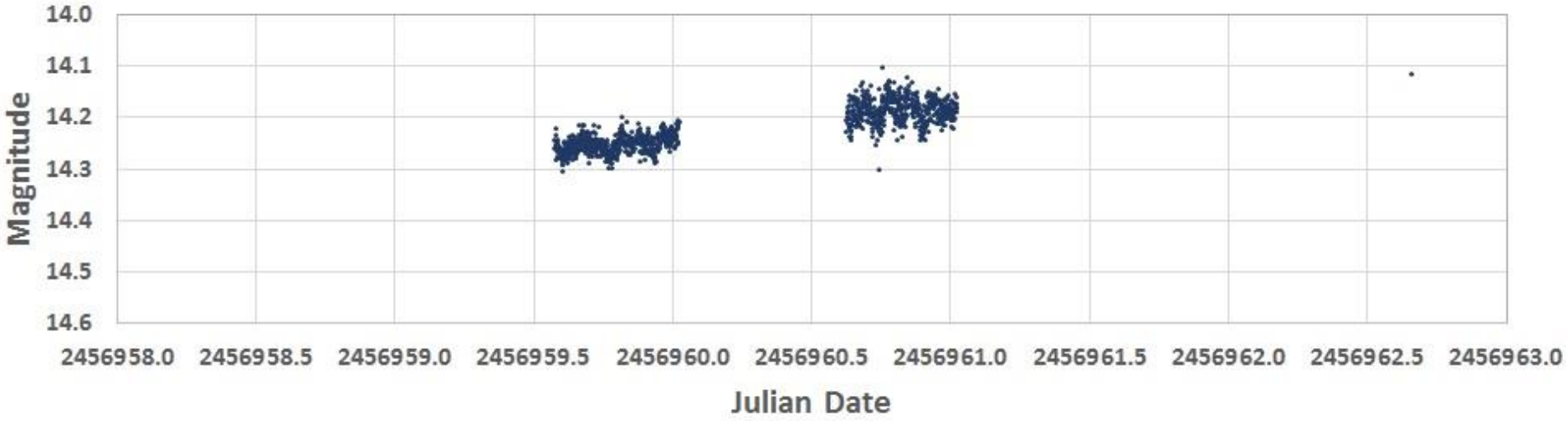


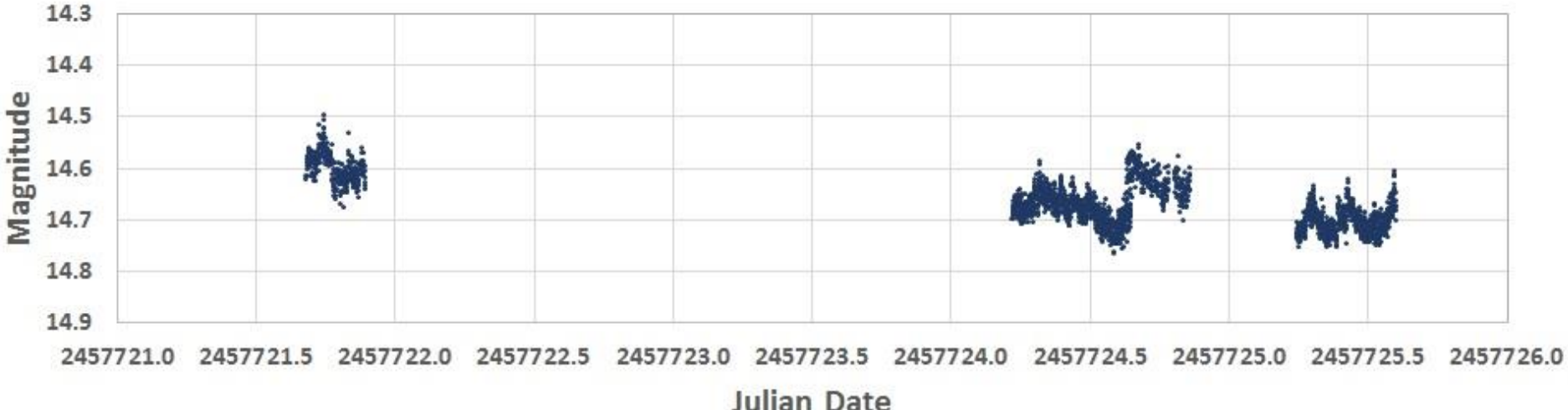


HS 0229+8019: Time resolved photometry

Variability with an amplitude of ~ 0.05 to 0.1 mag

No coherent period: quasi-periodic variations on time scales of ~ 20 – 40 min and some at 2 to 4 h





Summary: (some!) new light shed on 5 CVs

V342 Cam: SU UMa system, outbursts every ~6 months
4.2 mag superoutburst with precursor, measured P_{orb}, P_{sh}

HS 0455+8315: NL/SW Sex with two VY Scl low states (~4 mags, ~500 days)

HS 0506+7725: NL/SW Sex with multiple VY Scl low states (~2.3 mag, 10's of days). Likely many fades missed. Very few observers!!!

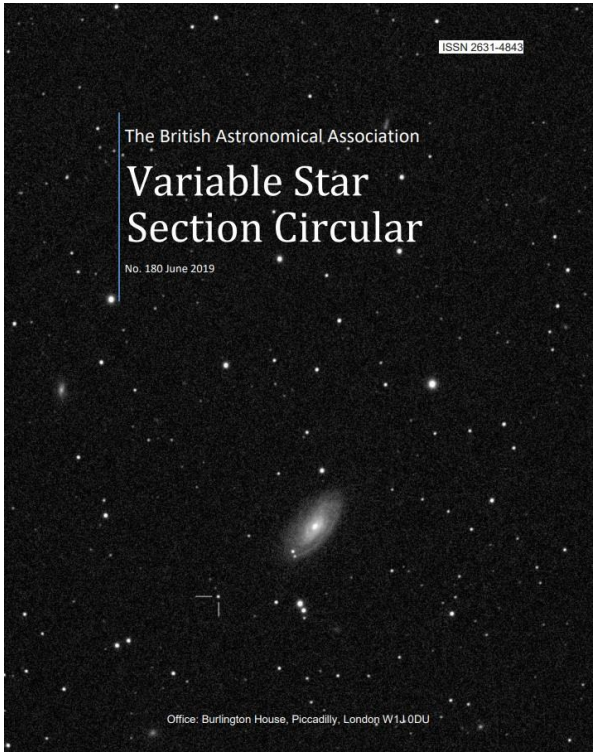
LS Cam: NL/W Sex with one VY Scl low states (~2.5 mag)

HS 0229+8016: NL system, with 0.6 mag stunted outbursts every 9.5 days.
Further observations required

Other potential targets….

BAA

britastro.org/vss/



BAA VSS MEETING

Saturday May 9, 2020

Northampton, England, NN1 1LD

Variable Star Section

BAA

British Astronomical Association