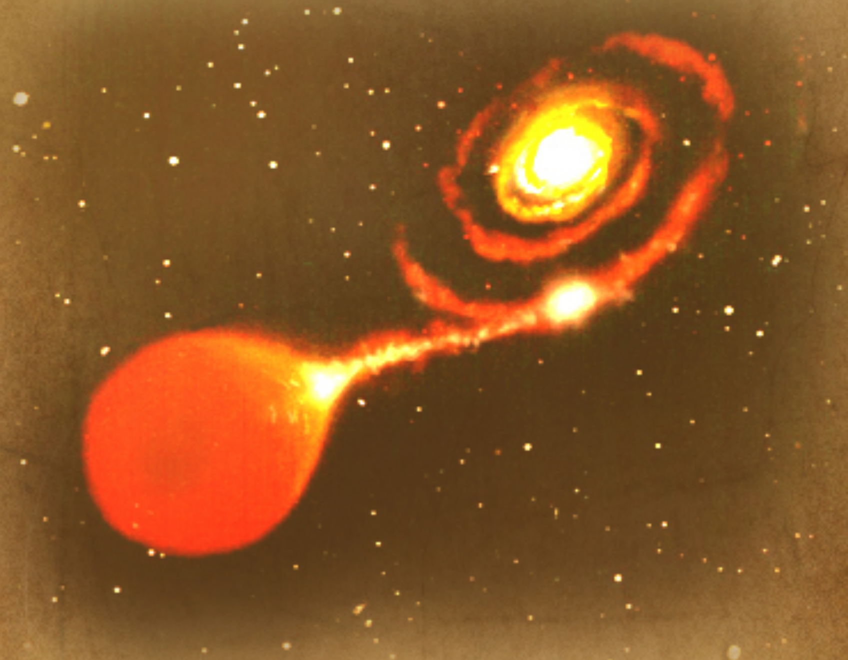
WANTED

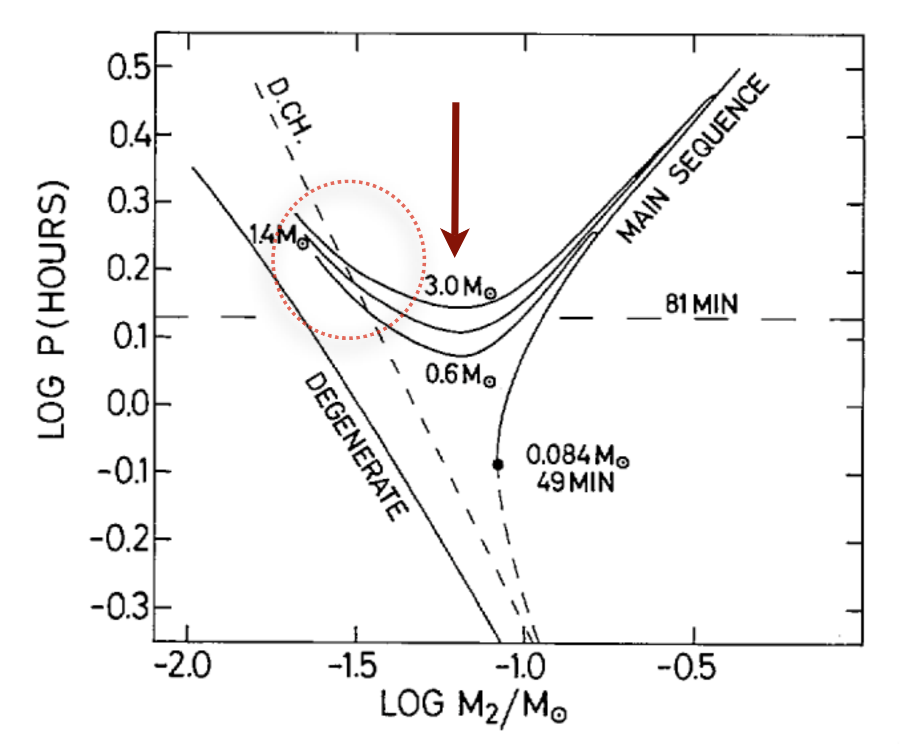
THE TRUE BOUNCE-BACK SYSTEMS

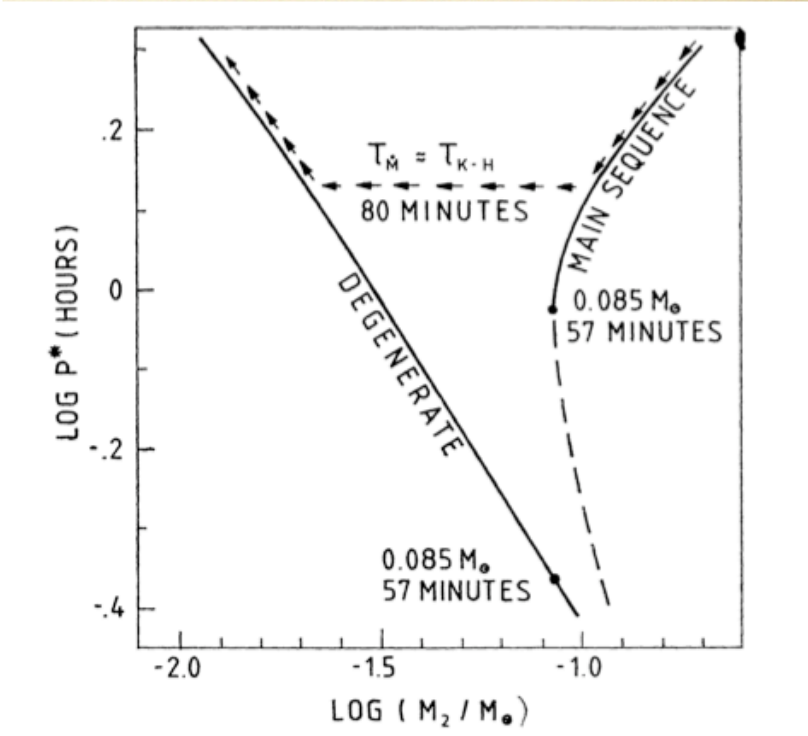


Sergey Zharikov & Gagik Tovmassian

WANTED THE TRUE BOUNCE -BACK SYSTEMS

Paczynski, B. & Sienkiewicz, R., 1981, ApJ, 248, L27 Paczynski, 1981, AcA, 31, 1





After reach the period minimum the CVs should be evolving back toward longer periods and form so-called bounce-back systems.

WANTED THE TRUE

Patterson http://xxx.lanl.gov/abs/0903.1006 Absolute Magnitudes of Dwarf Novae

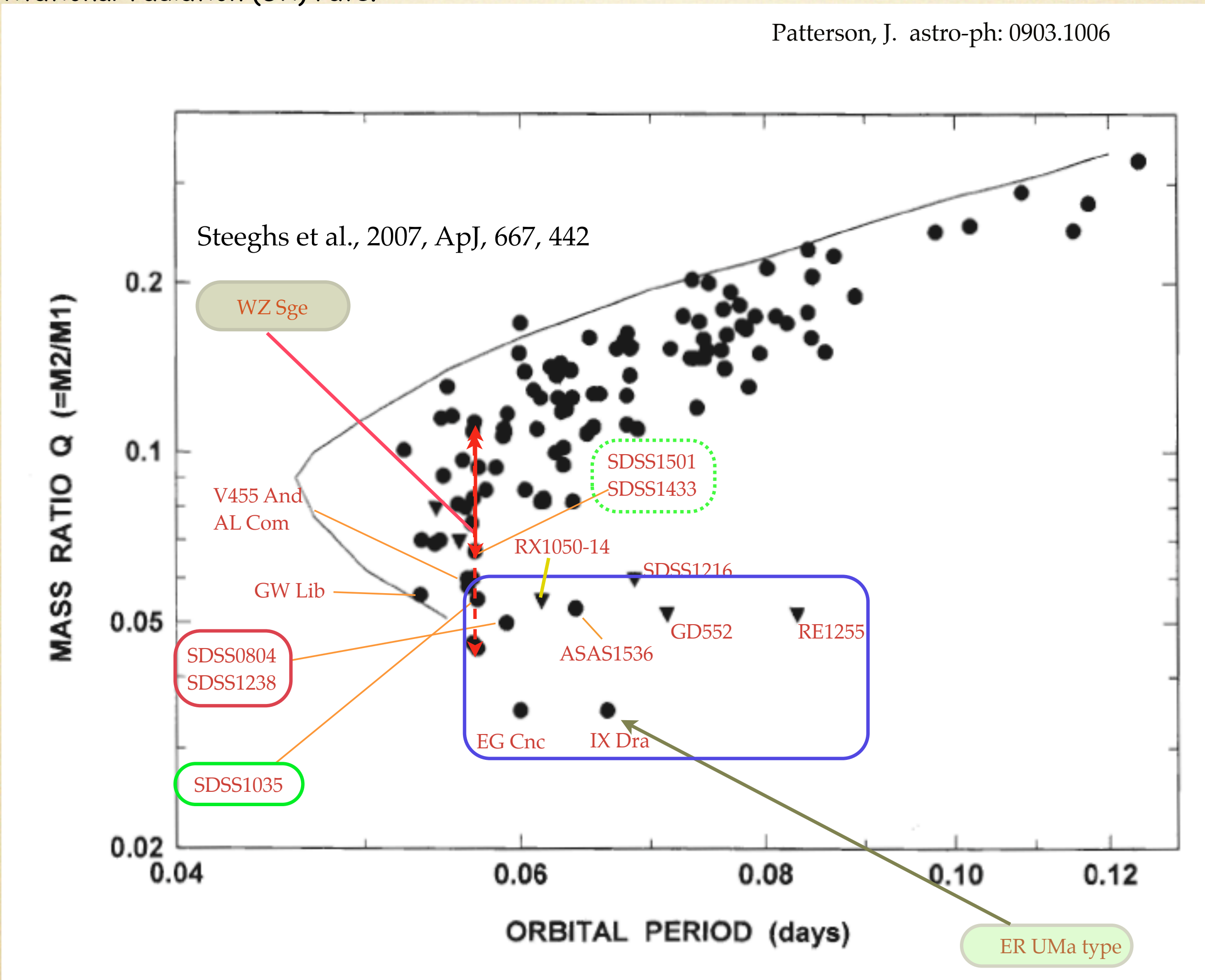
TABLE 3 – PERIOD-BOUNCER CANDIDATES (NONMAGNETIC)

Star	P_{orb} (d)	d (pc)	q[1]	$(M_v)_{qui}$[2]	$\langle M_{ve} \rangle$[3]	$\langle M_{ve} \rangle_{corr}$[4]	T_{WD}* (× 1000 K)[5]	References
GD 552	0.0713	74	<0.052 *v*	13.2		>11.7	10.5 *gsd*	Unda-Sanzana et al. 2008, Patterson et al. 2009
RE 1255+266	0.0830	180	<0.052 *v*	13.6		>11.6	<12 *g*	PTK
EG Cnc	0.0600	330	0.035 *s*	12.3	11.2	11.2	12 *gsd*	Patterson et al. 1998, Szkody et al. 2002
SDSS 1035+05	0.0570	170	0.055 *e*	14.0		>10.4	10.7 *se*	Littlefair et al. 2006
RX 1050–14	0.0615	80	<0.055 *v*	14.0		>10.9	<12 *g*	Mennickent et al. 2001, PTK
WZ Sge	0.0567	43	0.045 *sv*	12.8	12.8	11.6	13.5 *s*	Patterson et al. 2002, P98, Thorstensen 2003, Godon et al. 2006
V455 And	0.0563	90	0.06 *s*	12.2	>10.8	>10.0	10.5 *gs*	Betancor et al. 2005, Patterson et al. 2009 in prep
SDSS 1216+05	0.0686		<0.06 *v*			>9.9	<12 *g*	Southworth et al. 2008
ASAS 1536–08	0.0641	140	0.065 *s*	11.8	>11.4	>11.4		PTK, Patterson et al. 2009 in prep
PQ And	0.0558	160	<0.07?	13.8	>10.8	>10.8	<11	Patterson et al. 2005b
GW Lib	0.0533	104	0.056 *s*	12.8	10.6	11.4	13.2	Copperwheat et al. 2009, Patterson et al. 2009 in prep
AL Com	0.0567	320	0.06 *s*	>12.5	11.1	11.4		Patterson et al. 1996, this paper
SDSS 1433+10	0.0542	250	0.069 *e*	12.7		>10.5	13.5 *ge*	Littlefair et al. 2008
SDSS 1238–03	0.0559	120		13.2	>10.4	>10.7		Zharikov et al. 2006
SDSS 0804+51	0.0590	140	0.047	11.8	>10.2		<11 *g*	Zharikov et al. 2008, Pavlenko et al. 2006
BW Scl	0.0543	110		12.3		>11.5	14.6 *s*	Patterson et al. 2009
IX Dra	0.0665		0.035 *s*					Olech et al. 2004
SDSS 1501	0.05684	330	0.067					Littlefair et al., 2008

BOUNCE-BACK SYSTEMS

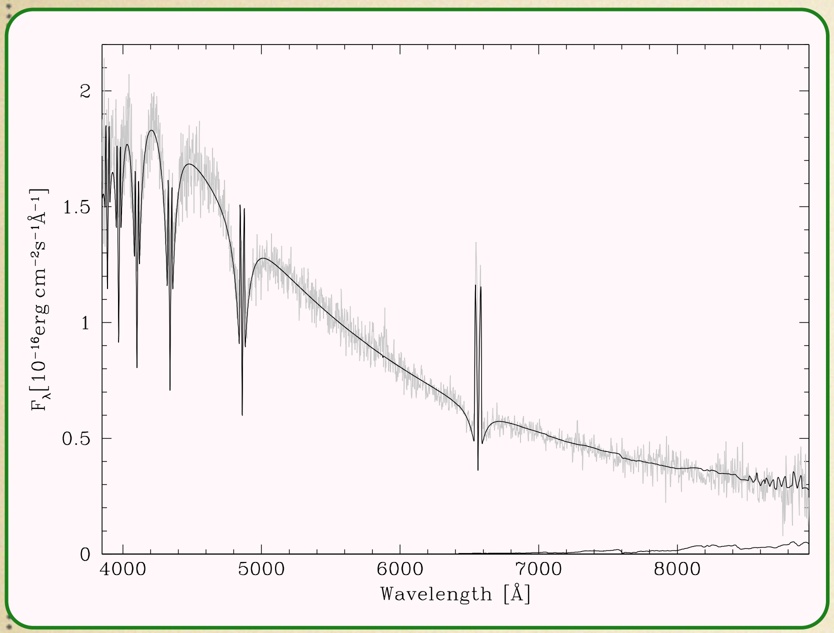
WANTED THE TRUE BOUNCE -BACK SYSTEMS

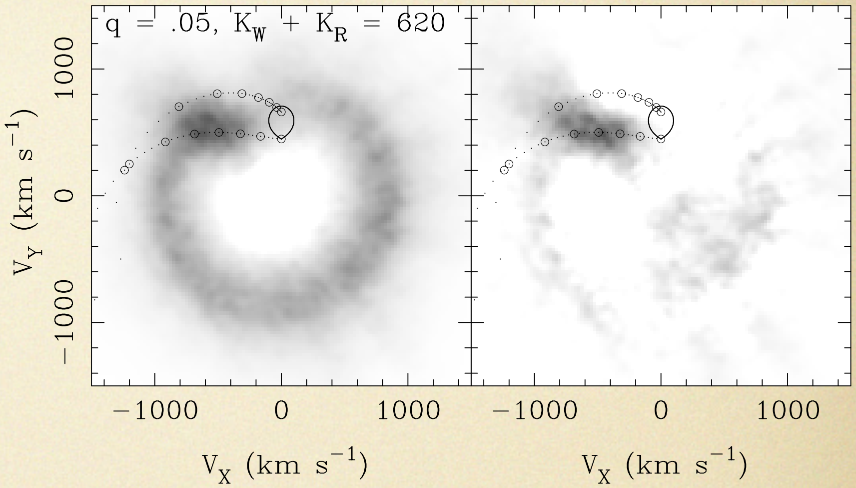
Mass ratio q versus Porb. Circles are positive measurements from eclipses and super-humps; triangles are upper limits on q from radial-velocity studies. The curve is the predicted trend if CV evolution is driven by angular-momentum loss at the gravitational-radiation (GR) rate.

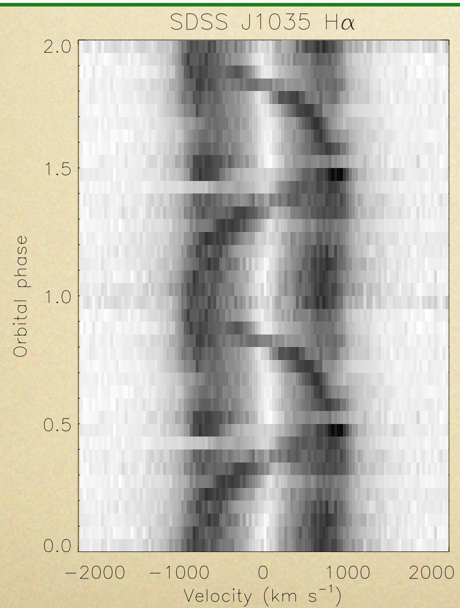


SDSS1035 is the first solid example bounce-back system.
Littlefair et al. 2006

SDSS1035 is the first solid example bounce-back system. Littlefair et al. 2006, Southworth et al 2006







q	0.055
M1	0.94
M2	0.052
Porb	0.0570

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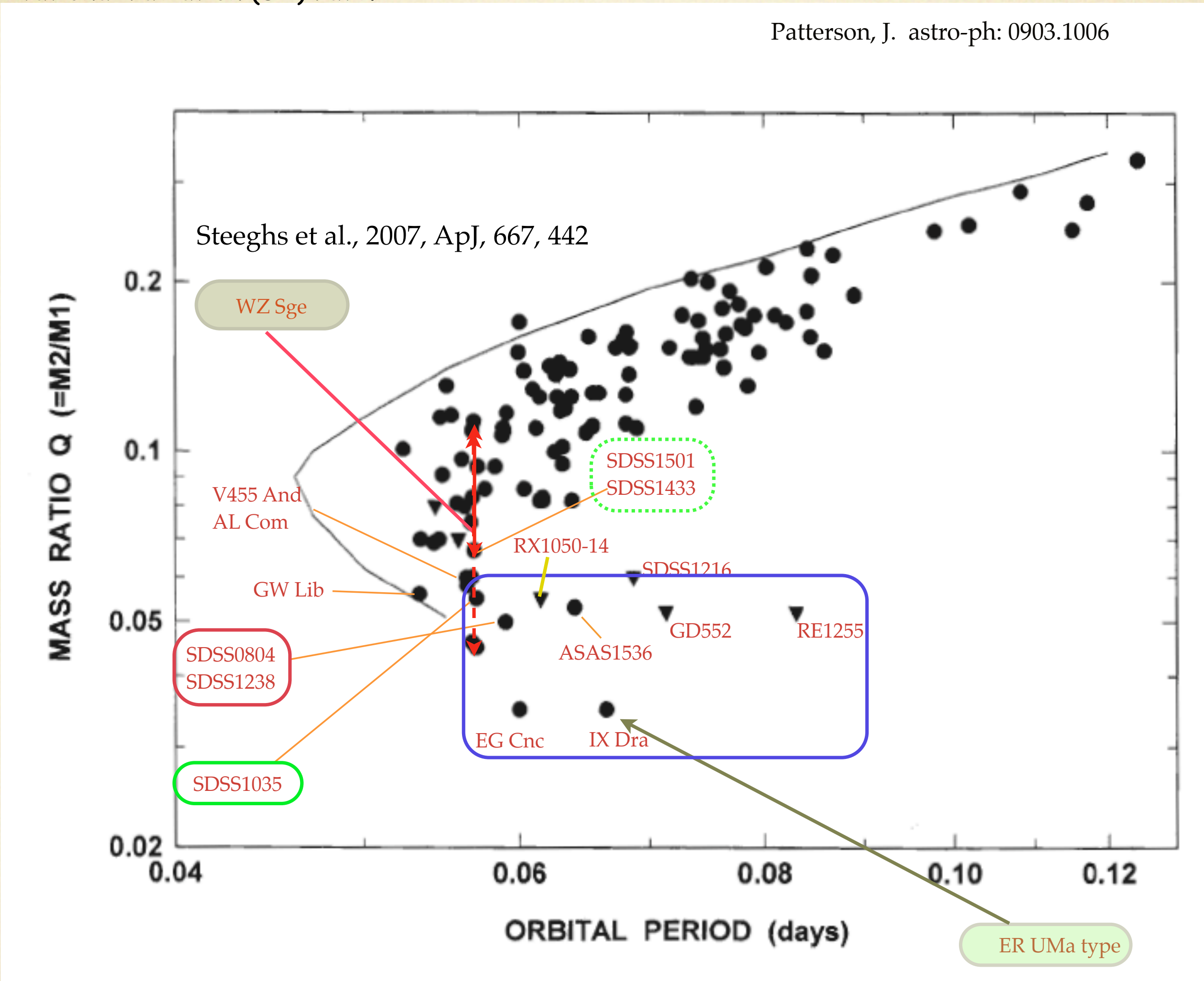

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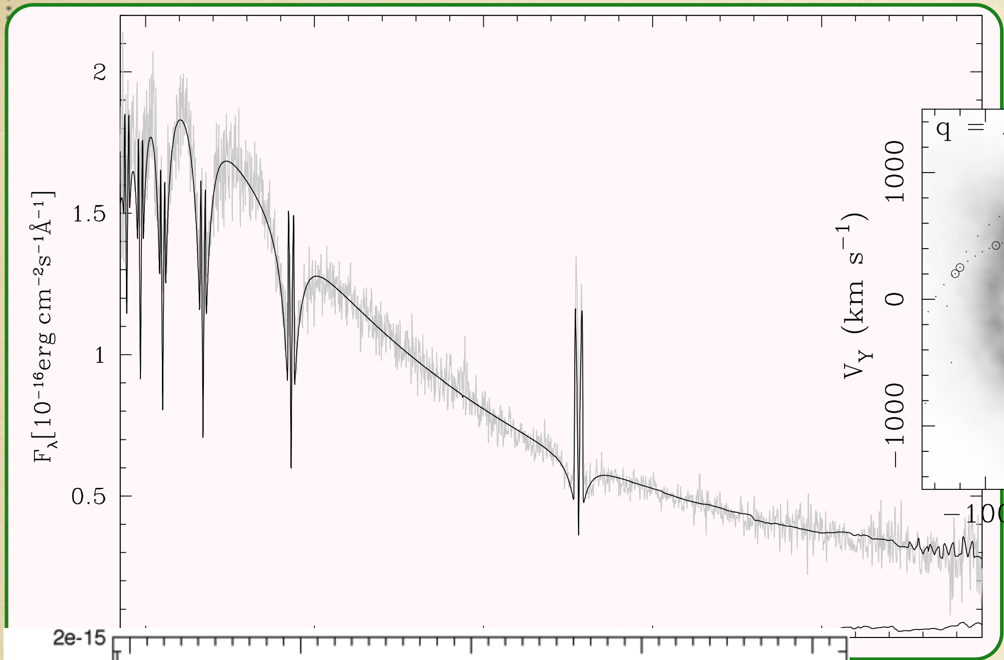
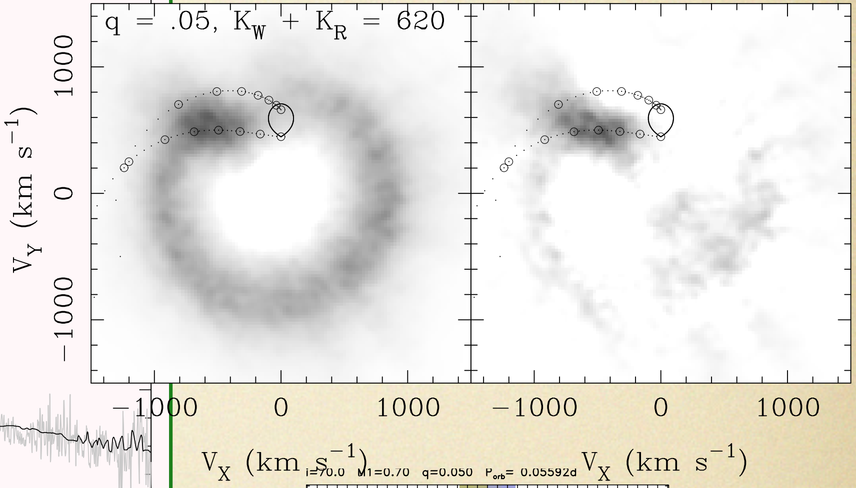
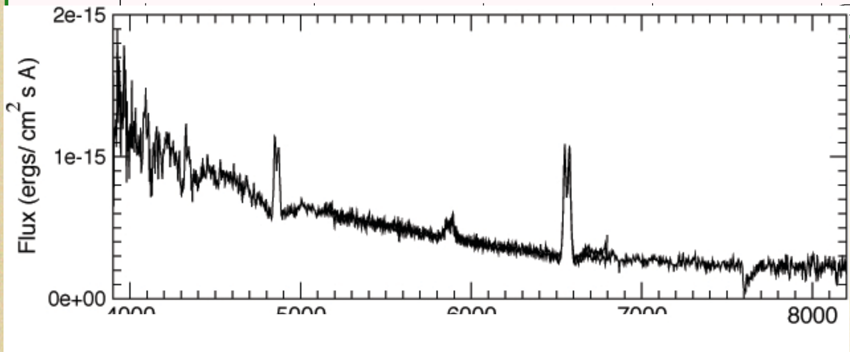
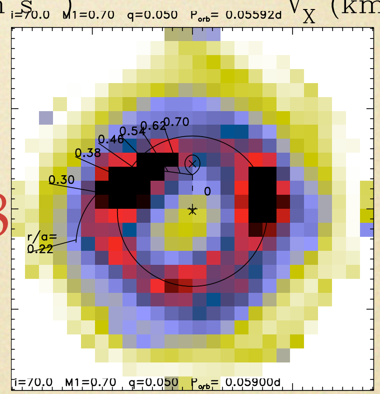


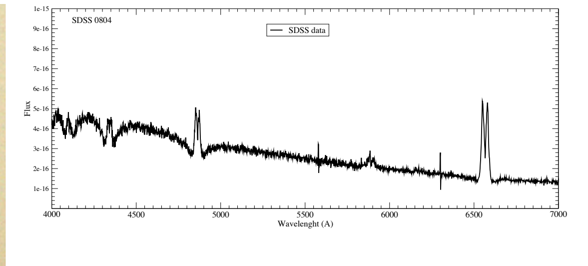
SDSS 1035



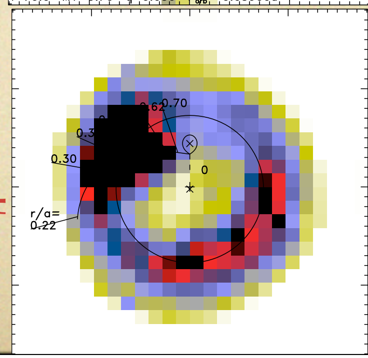


SDSS 1238



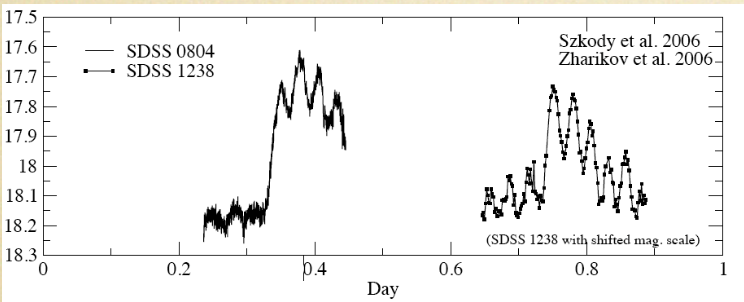


SDSS 0804



WANTED THE TRUE BOUNCE -BACK SYSTEMS

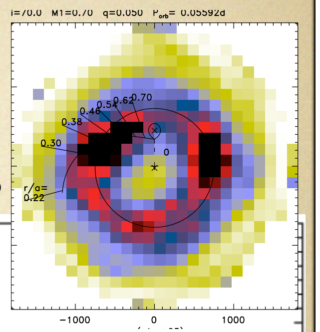
SDSS1238 was identified by Szkody et al. (2003) as a weak cataclysmic variable star (r = 17.82 mag), whose spectrum is characterized by a blue continuum with double emission Balmer lines, originated in a high inclination accretion disk, surrounded by absorption lines formed in the photosphere of the white dwarf. By the way, Zharikov et al. (2006) establish its orbital period, been 80.5 min, using spectroscopic data, they also computed a surface temperature for the white dwarf of 15 600 +/- 1000 K, which is in the temperature range observed in short period systems below the period gap, this calculation was made using stellar atmosphere models. A particular feature of SDSS1238 was observed in its light curve in a way of a variability with 40.25 minutes period and 0.15 mag of amplitude . The presence of double-humped light curve has been proposed as an additional criterion for a WZ-Sge classification in short period CV. The most intriguing feature of this object is an abrupt increase in brightness of 0.45 mag in a time scale near half orbital period, after which the system go back to its quiescence state in a scale of 3 – 4 hours, such brightening occurred cyclically about every ~9 hours.

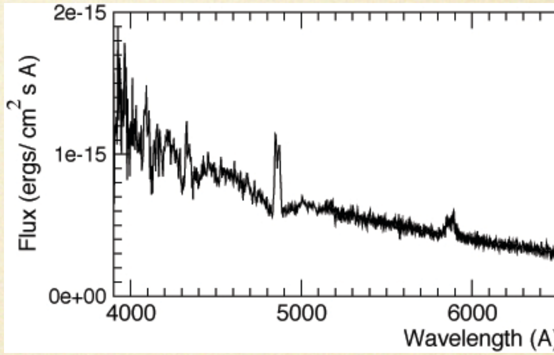


A similar behavior was found late in the light curve of another short period cataclysmic variable, SDSS J080434.20+510349.2 (Szkody et al 2006) which was observed in super outburst in 2006 (Pavlenko et al. (2006) and exhibits all the necessary attributes to be classified as a WZ Sge type system. Since both objects show similar spectral features in their quiescence level; we carried out multi longitude photometric observations of SDSS 1238 to establish the origin of the brightening and its relation with the amplitude on the light curve of the double hump.

SDSS 1238

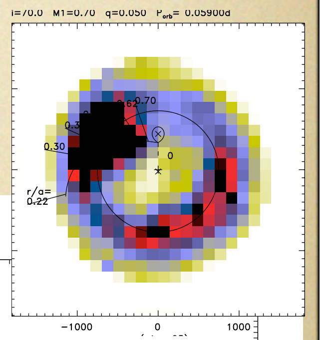
Szkody et al., 2003, Zharikov et al., 2006

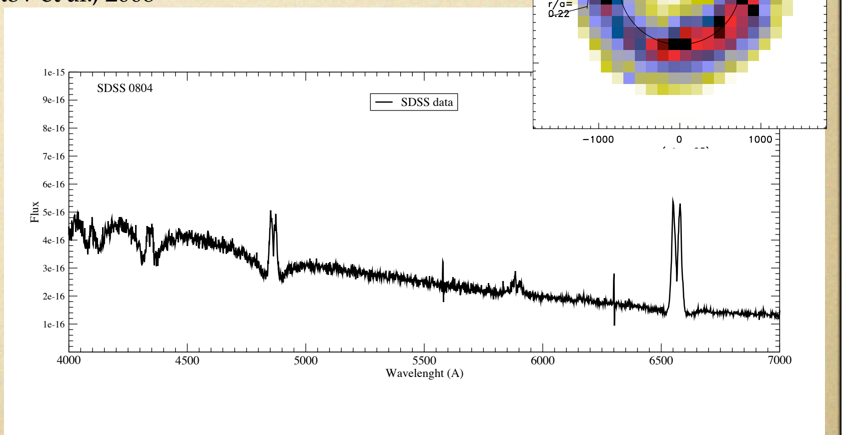


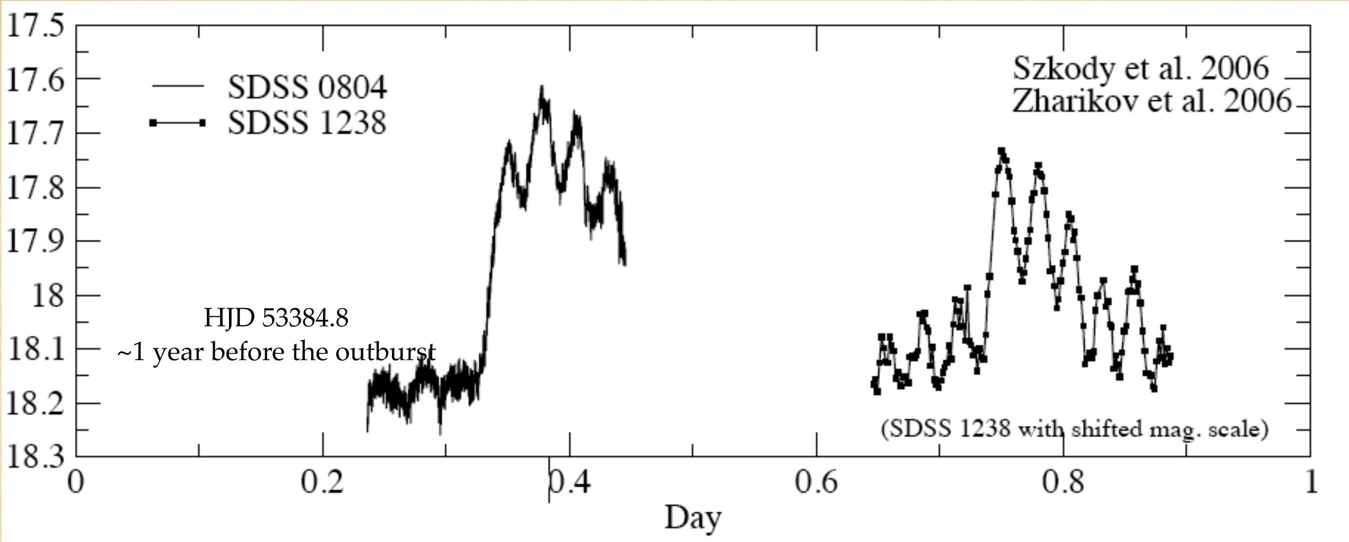


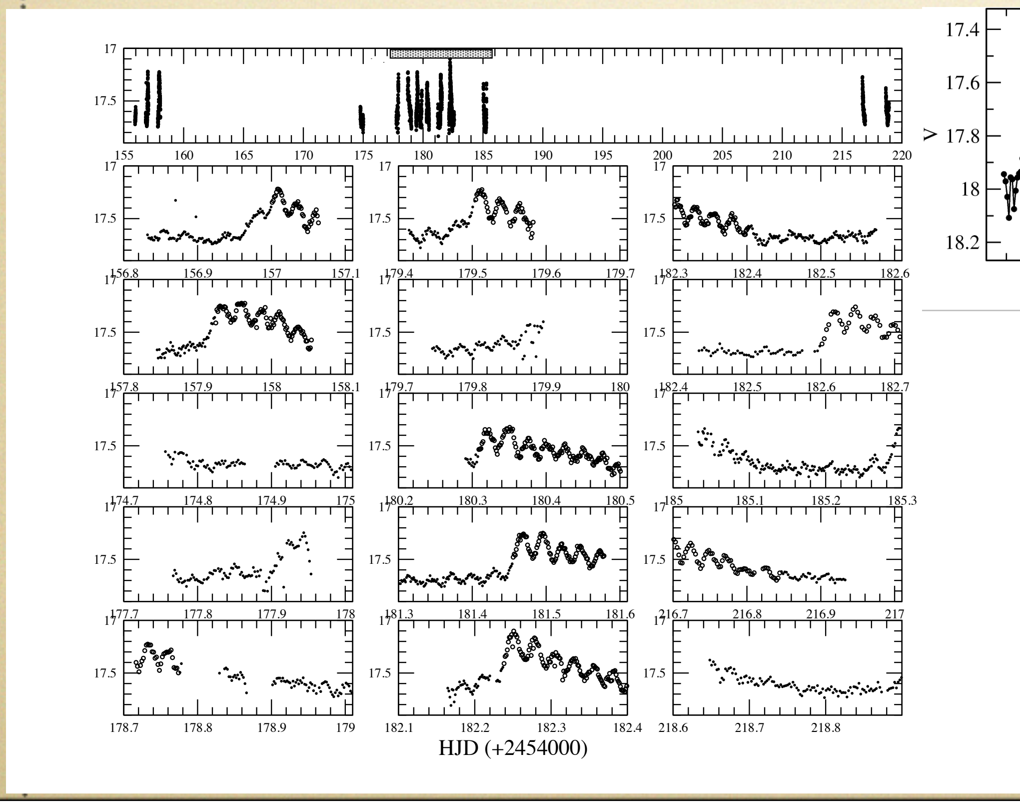
SDSS 0804

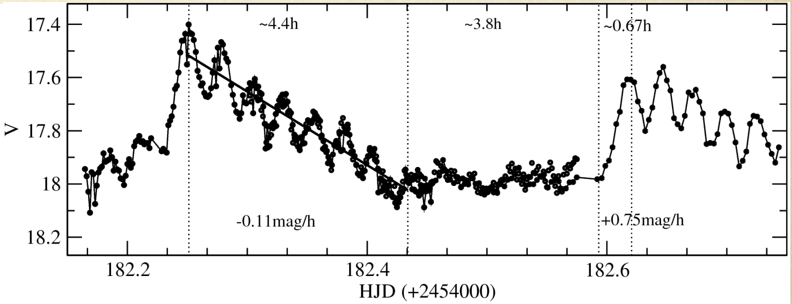
Szkody et al., 2006, Pavlenko et al., 2006, Zharikov et al., 2008

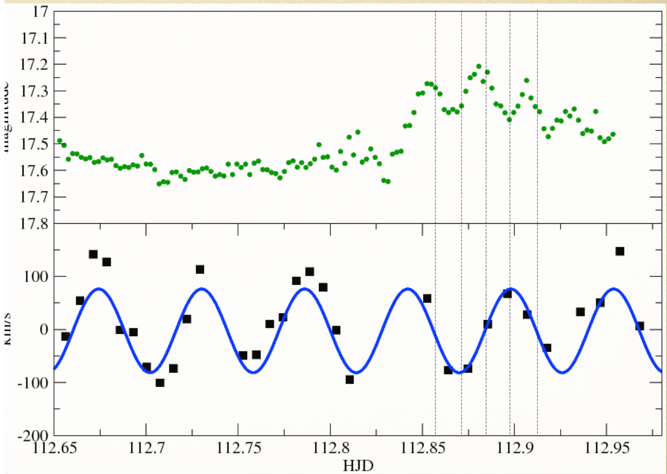





SDSS 0804
SDSS 1238
Szkody et al. 2006
Zharikov et al. 2006
HJD 53384.8
~1 year before the outburst
(SDSS 1238 with shifted mag. scale)
Day
17.5
17.6
17.7
17.8
17.9
18
18.1
18.2
18.3
0
0.2
0.4
0.6
0.8
1

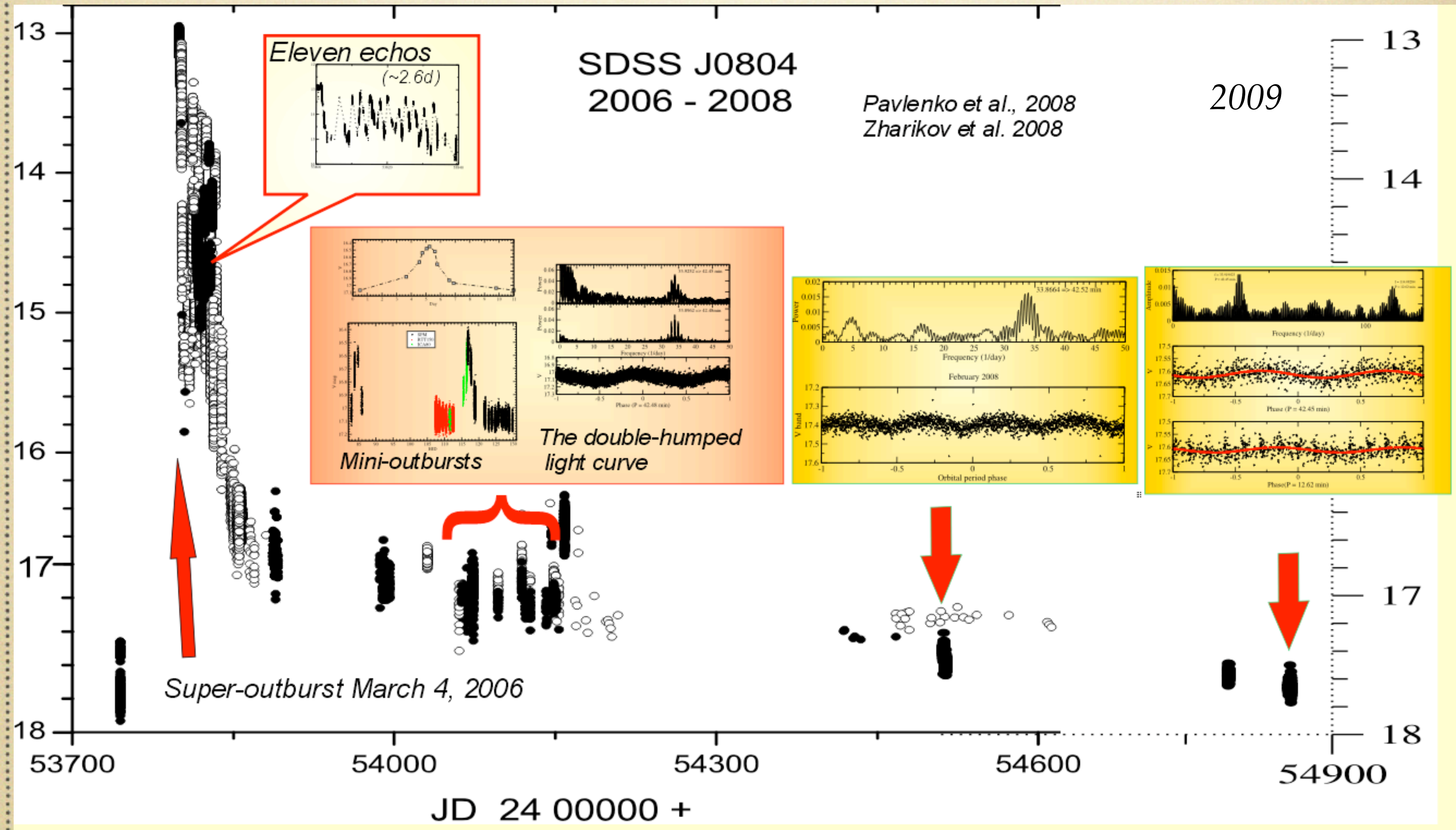

HJD (+2454000)


~4.4h
~3.8h
~0.67h
-0.11mag/h
+0.75mag/h
V
HJD (+2454000)
17.4
17.6
17.8
18
18.2
182.2
182.4
182.6


HJD
112.65
112.7
112.75
112.8
112.85
112.9
112.95

SDSS 0804

Szkody et al., 2006, Pavlenko et al., 2006, Zharikov et al., 2008, in preparation



Porb = 85 ± 3 min $q \sim 0.05$

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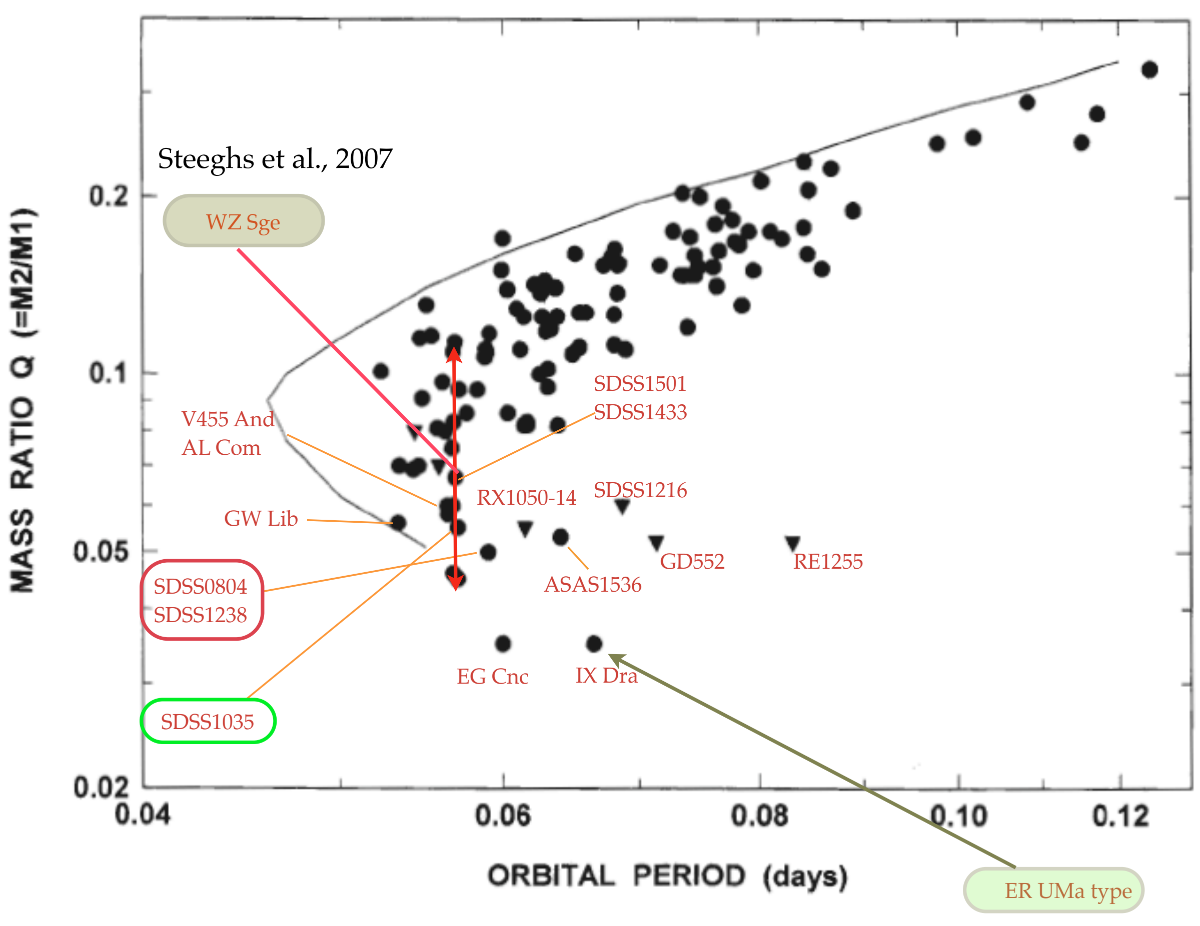
Patterson, J. http://xxx.lanl.gov/abs/0903.1006



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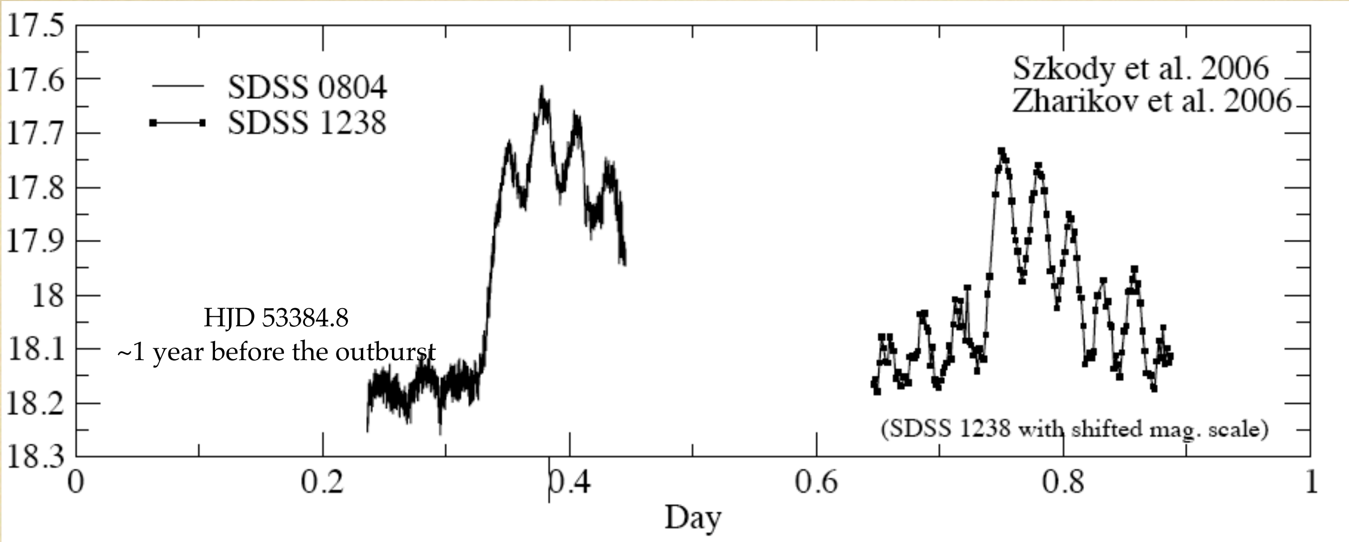
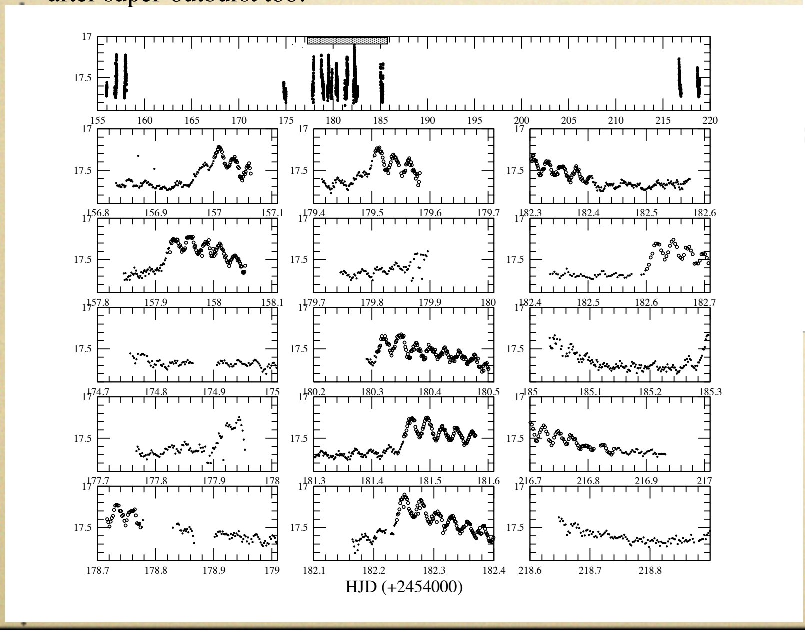
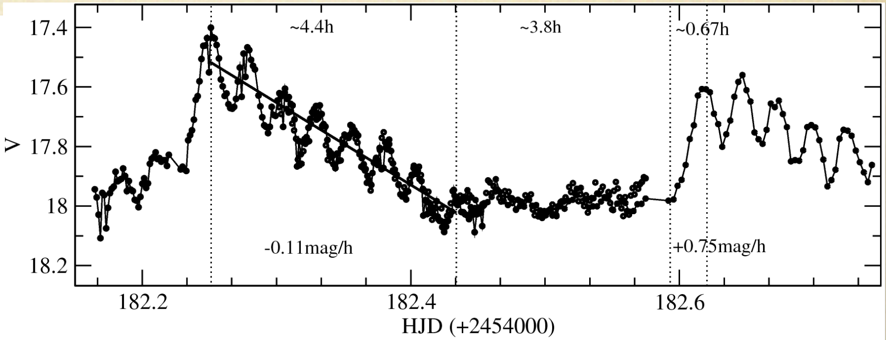
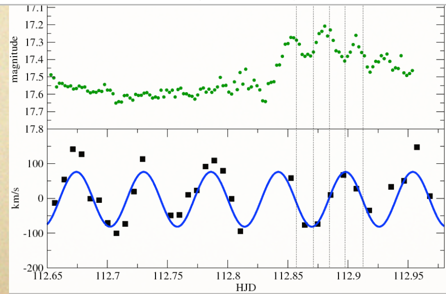


There are six WZ Sge-type systems that have shown double-peaked humps *in outbursts*: AL Com (Kato et al. 1996; Patterson et al. 1996), EG Cnc (Patterson et al. 1998), RZ Leo (Ishioka et al. 2001), HV Vir (Ishioka et al. 2003), Var Her 04 (Price et al. 2004), and WZ Sge itself (Kato et al. 2004).

SDSS 1238 and SDSS0804 have shown permanent double-peaked humps in quiescence together with the ciclic brightenings. SDSS0804 shows such brightening before the outburst 2006, SDSS 1238 have shown the ciclic brightening until now. The double-peaked light curve in SDSS 0804 observed after super-outburst too.







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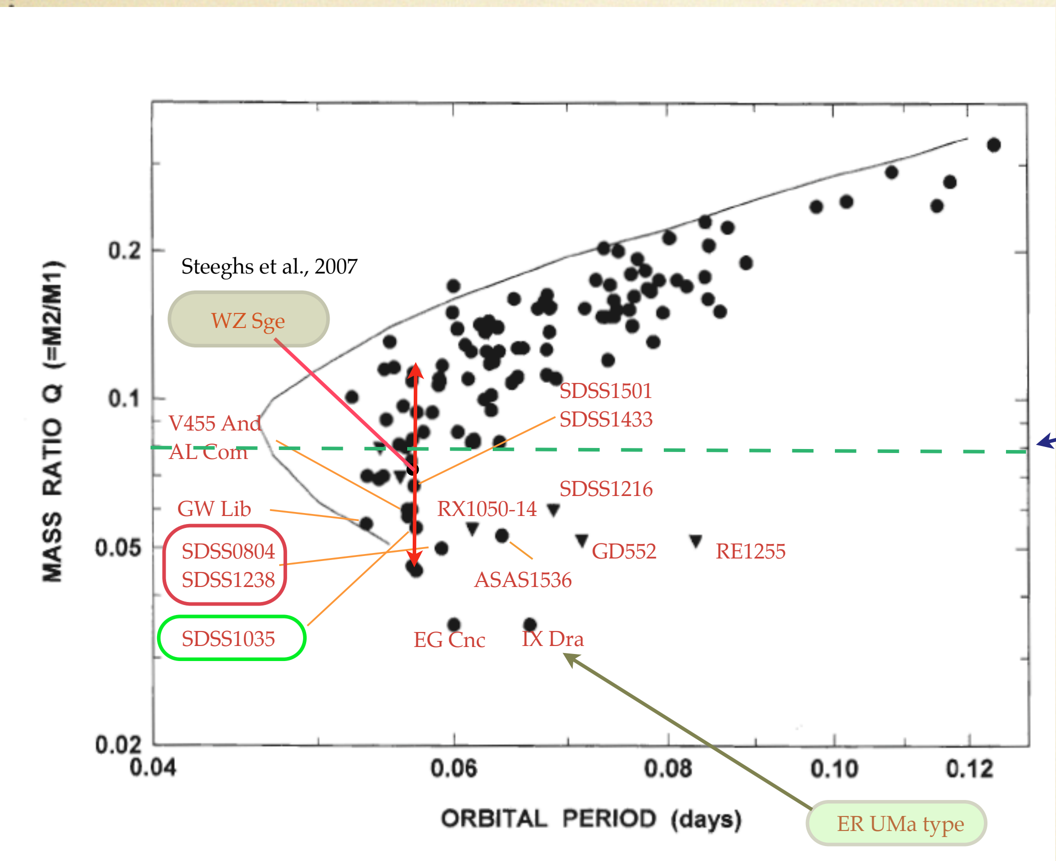


Patterson, J. http://xxx.lanl.gov/abs/0903.1006

Lin & Papaloizou 1979, MNRAS, 186, 799

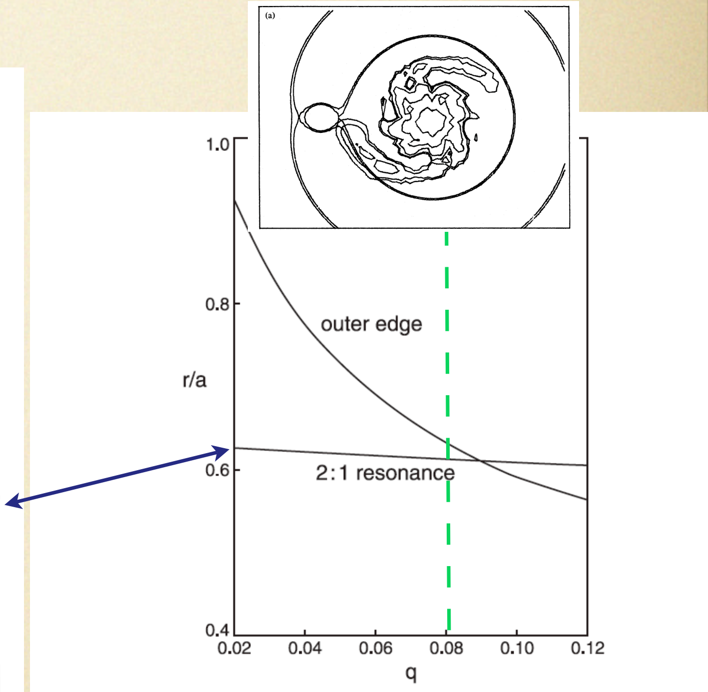


Fig. 1. Outer edge of the disk and radius of the 2:1 resonance, measured in units of binary separation a, as a function of the mass ratio q.

Y. Osaki and F. Meyer A&A 383, 574{579 (2002)

$$R_{2:1}/a = (2^2(1+q))^{-1/3}$$

In order to avoid an earlier occurrence of normal outburst in WZ Sge-type systems, we must choose an extremly low viscosity parameter

a~0.001

(Smak (1993), Osaki (1994, 1995,1996), Howell (1995)).

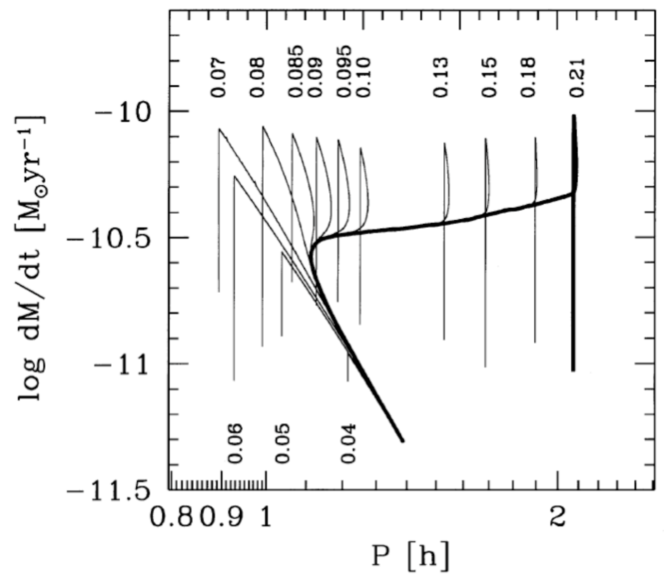


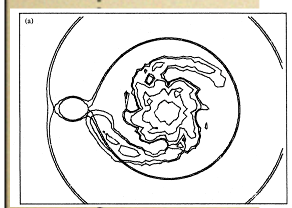
Figure 1. Mass transfer rate versus orbital period for sequences of Set A (white dwarf mass 0.6 $M_\odot$). Labels indicate the initial donor mass (in units of $M_\odot$). Kolb & Barafe, 1999

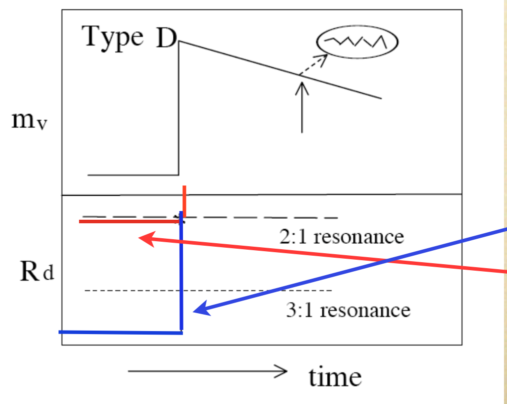
M1 - **increase**
M2 - **decrease**
q - **decrease**
$\dot{M}$ - **decrease**

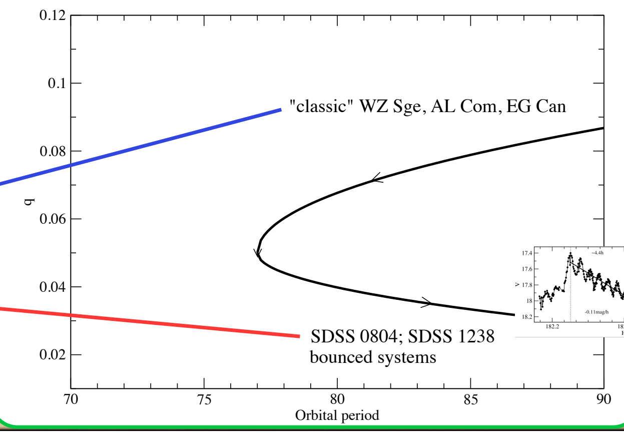
The radius of primary Roshe lobe- increase

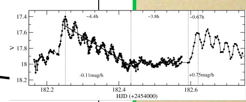
The WZ Sge stars are thought to be of the lowest end of cataclysmic variable's evolution in that they pass the period minimum of the cataclysmic variables, having a degenerate secondary star. The extremely large and rare outbursts of WZ Sge are understood in term of extremely low viscosity in quiescence (Osaki, 2005).

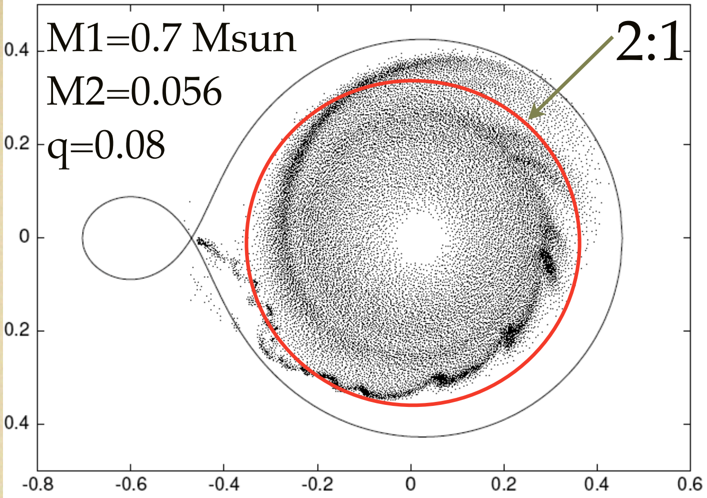
Lower mass transfer -> lower viscosity -> larger accretion disk size.











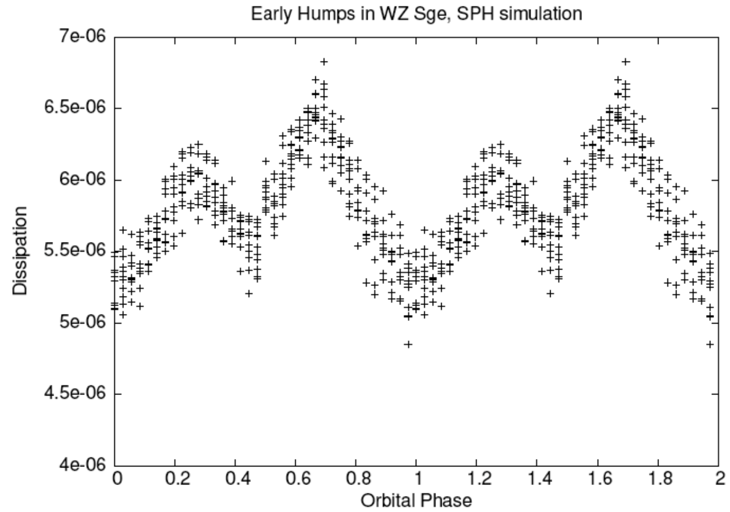
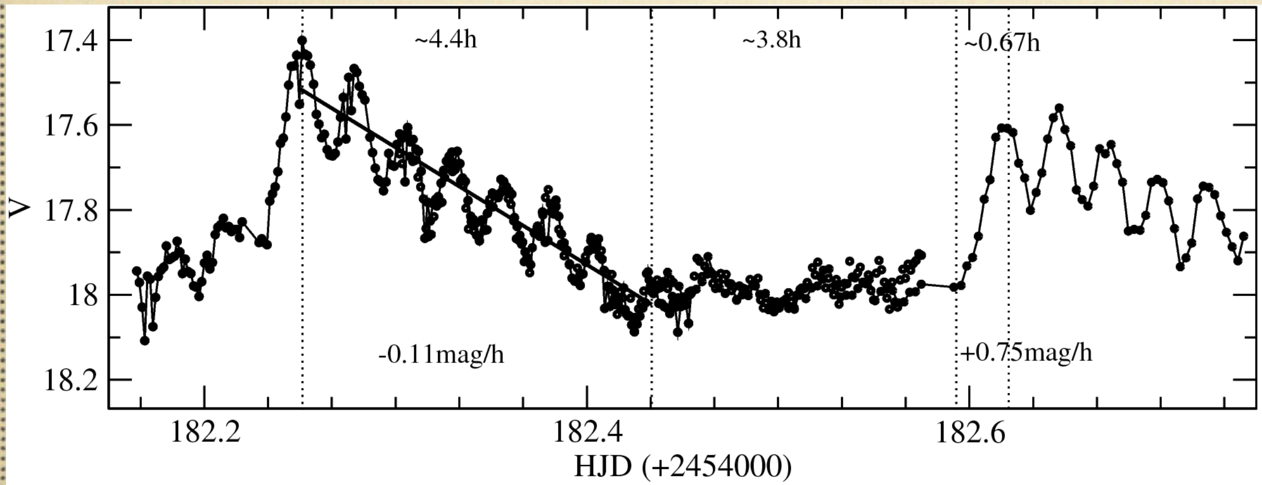
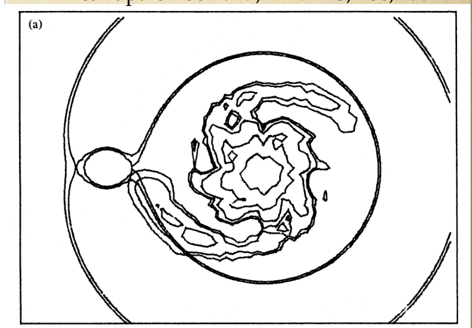


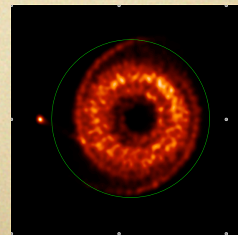
Figure 1. SPH simulation of the disk of WZ Sge during the early superhump phase. Left: Snapshot of the disk, the two-armed spiral is clearly visible. Right: Phase-resolved pseudo-lightcurve

Kunze & Speith, 2005

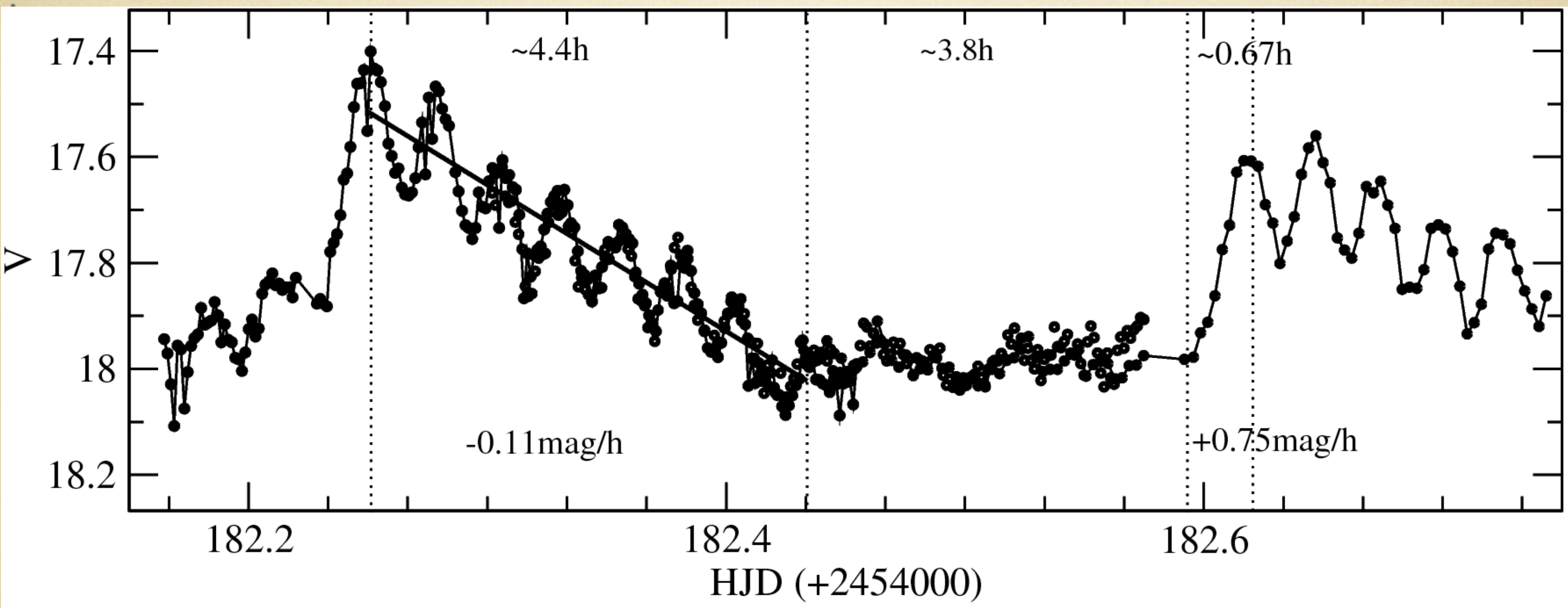


Lin & Papaloizou 1979, MNRAS, 186, 799





Conclusion



We propose that the double-humped light curve in quiescence in short -period WZ Sge type CVs could be indirect evidence to classify such system as a bounce-back object.