

THE UNIVERSITY OF
WARWICK

CSS100603:112253-111037:

The CV channel for AM CVn formation

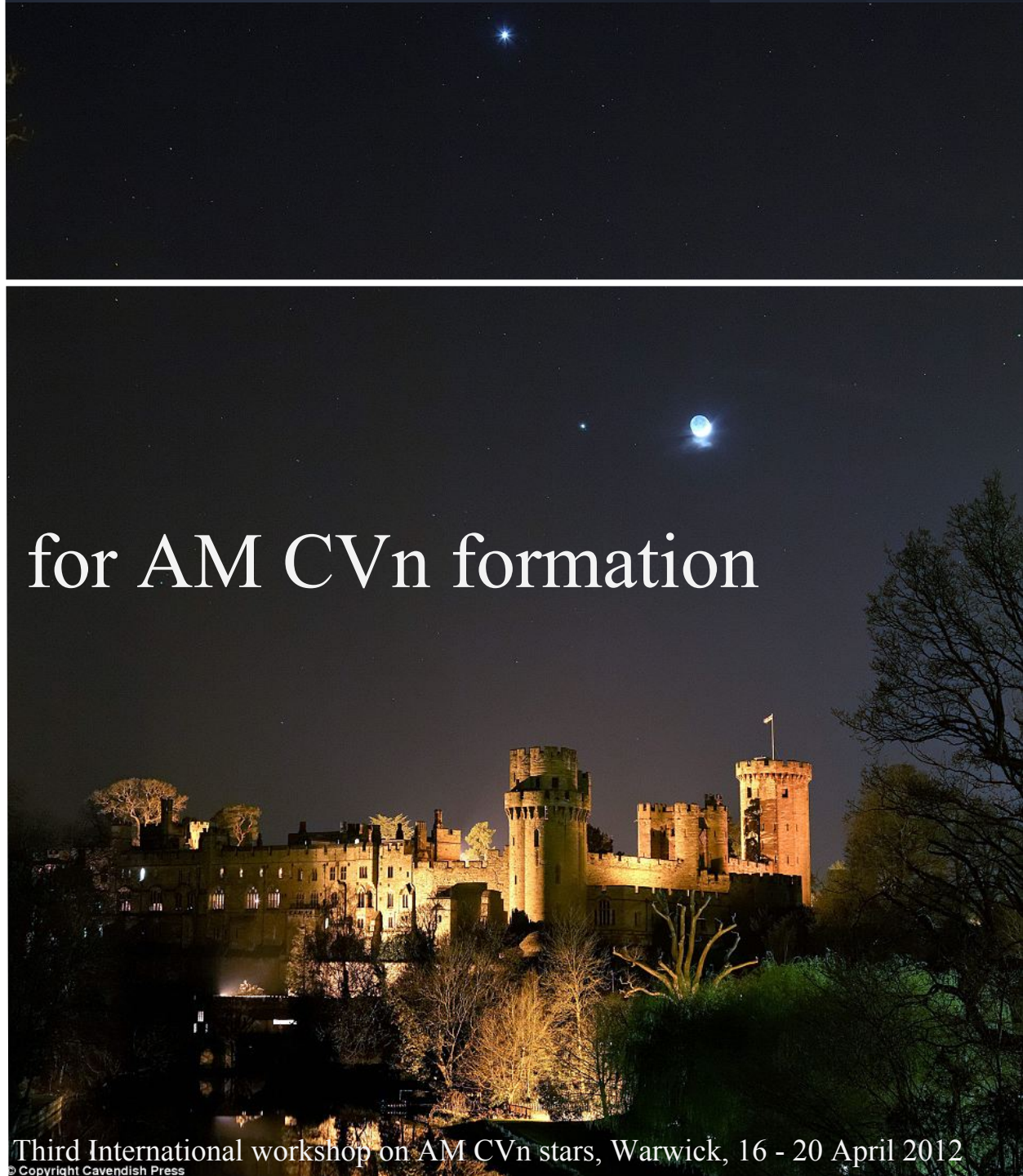
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Boris Gänsicke
Danny Steeghs
Tom Marsh
Chris Copperwheat
Andrew Drake

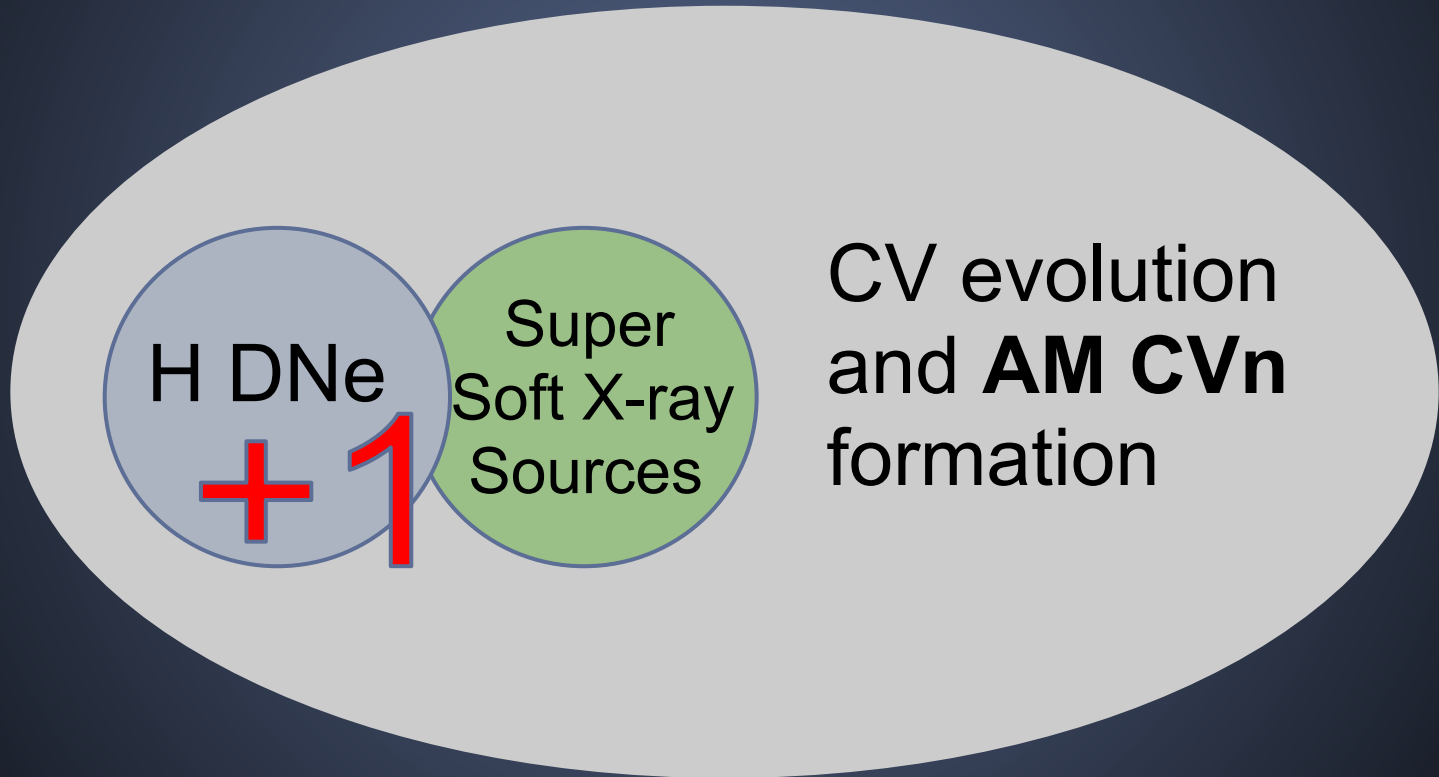


Third International workshop on AM CVn stars, Warwick, 16 - 20 April 2012

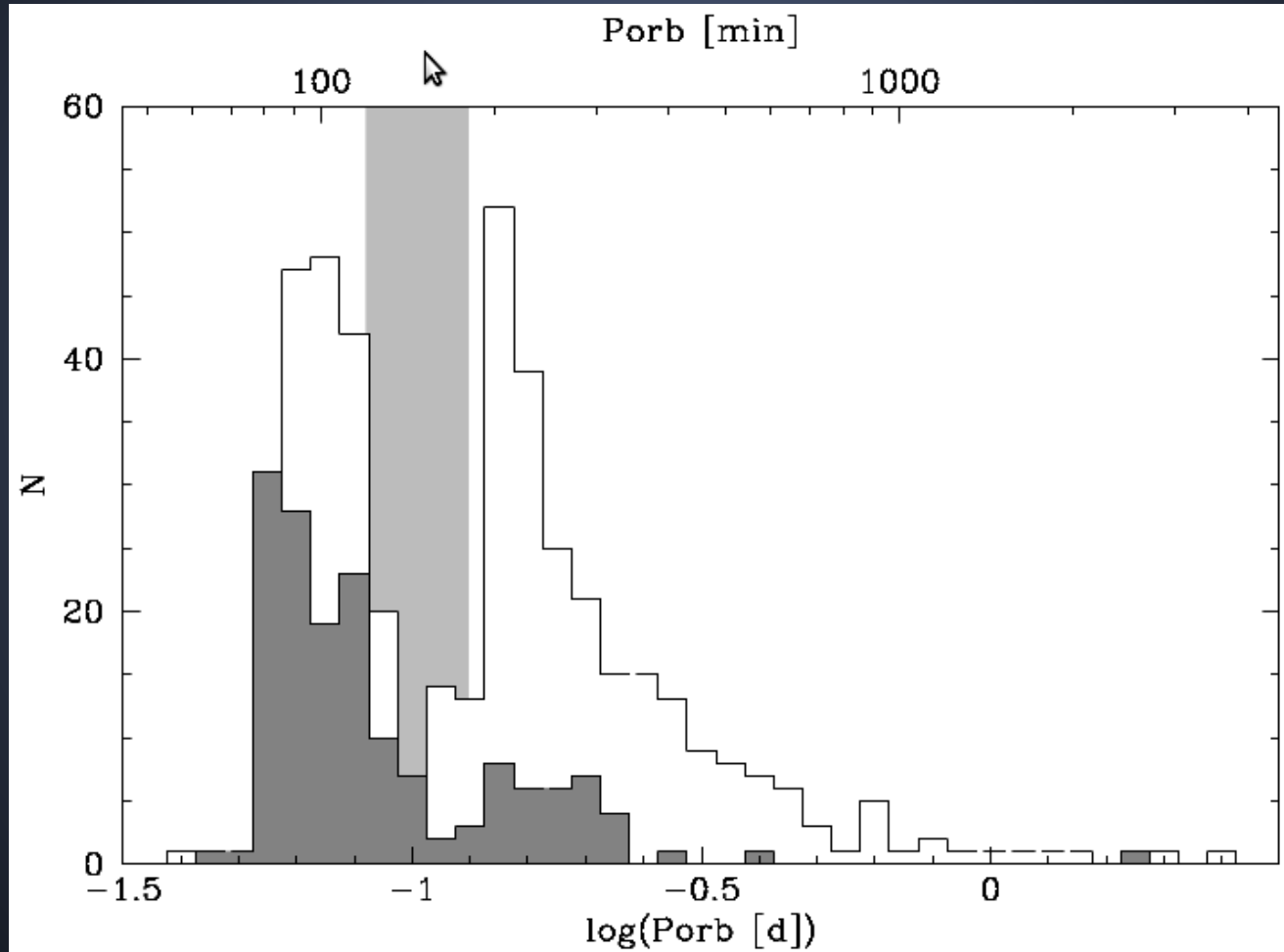
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Outline



Short-period hydrogen DNe

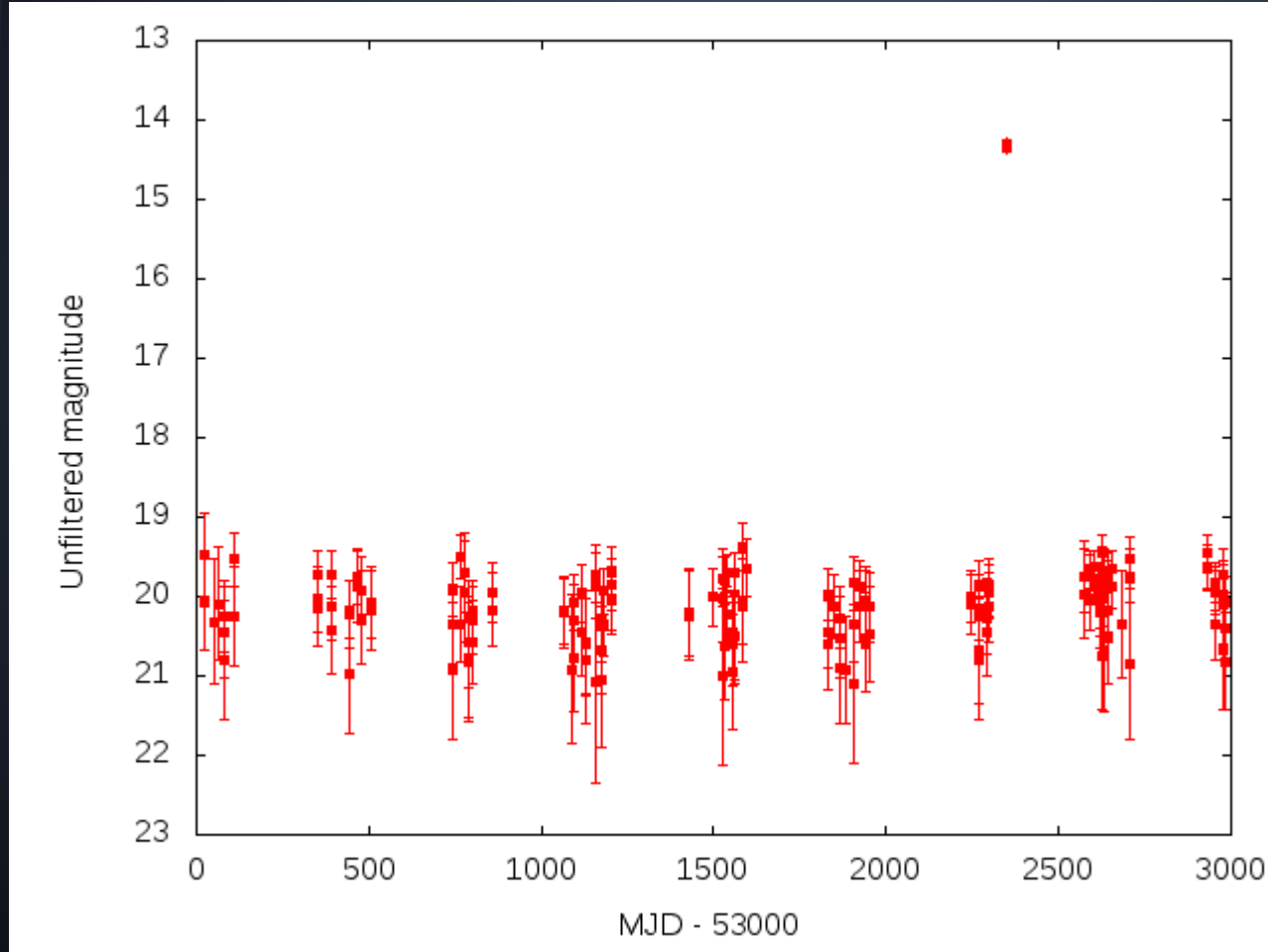


Short-period hydrogen DNe

+ V485 Cen	$P_{\text{orb}} = 59 \text{ min}$	--
+ EI Psc (1RXS J2329)	$P_{\text{orb}} = 64 \text{ min}$	$\varepsilon = 0.040$
+ CSS1028-08	$P_{\text{orb}} = 52 \text{ min}$	$\varepsilon = 0.053$
+ CSS2333-15	$P_{\text{orb}} = 62 \text{ min}$	$\varepsilon = 0.031$

(Augusteijn et al 1996 A&A 311 899; Thorstensen et al 2002 ApJ 567 L49;
Woudt et al 2012 MNRAS 421 2414; Woudt & Warner 2011 ATel 3705)

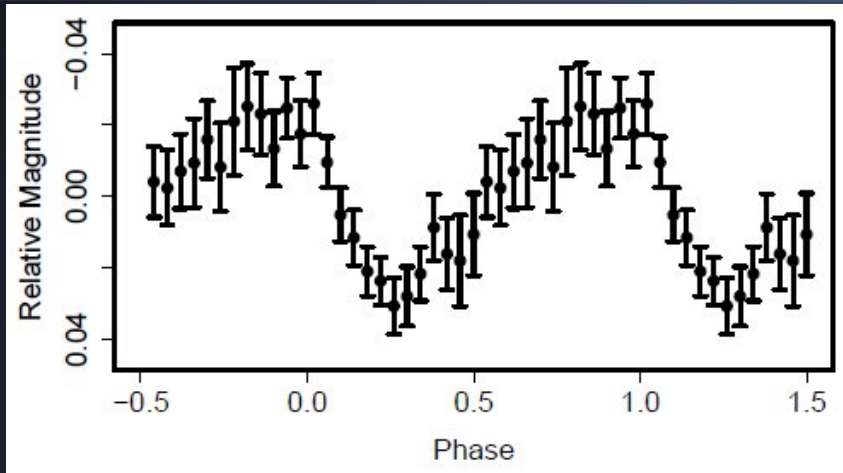
CSS100603:112253-111037 - discovery



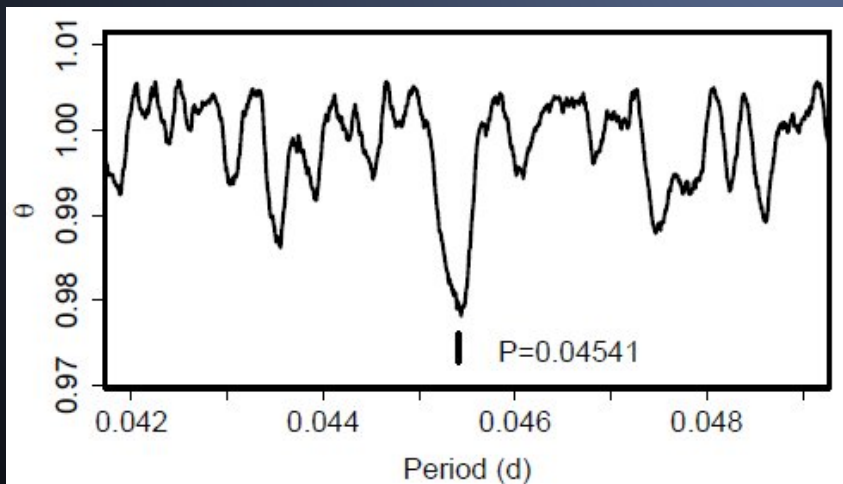
$m = 14.3$

$m = 20.2$

CSS100603:112253-111037 - superhumps

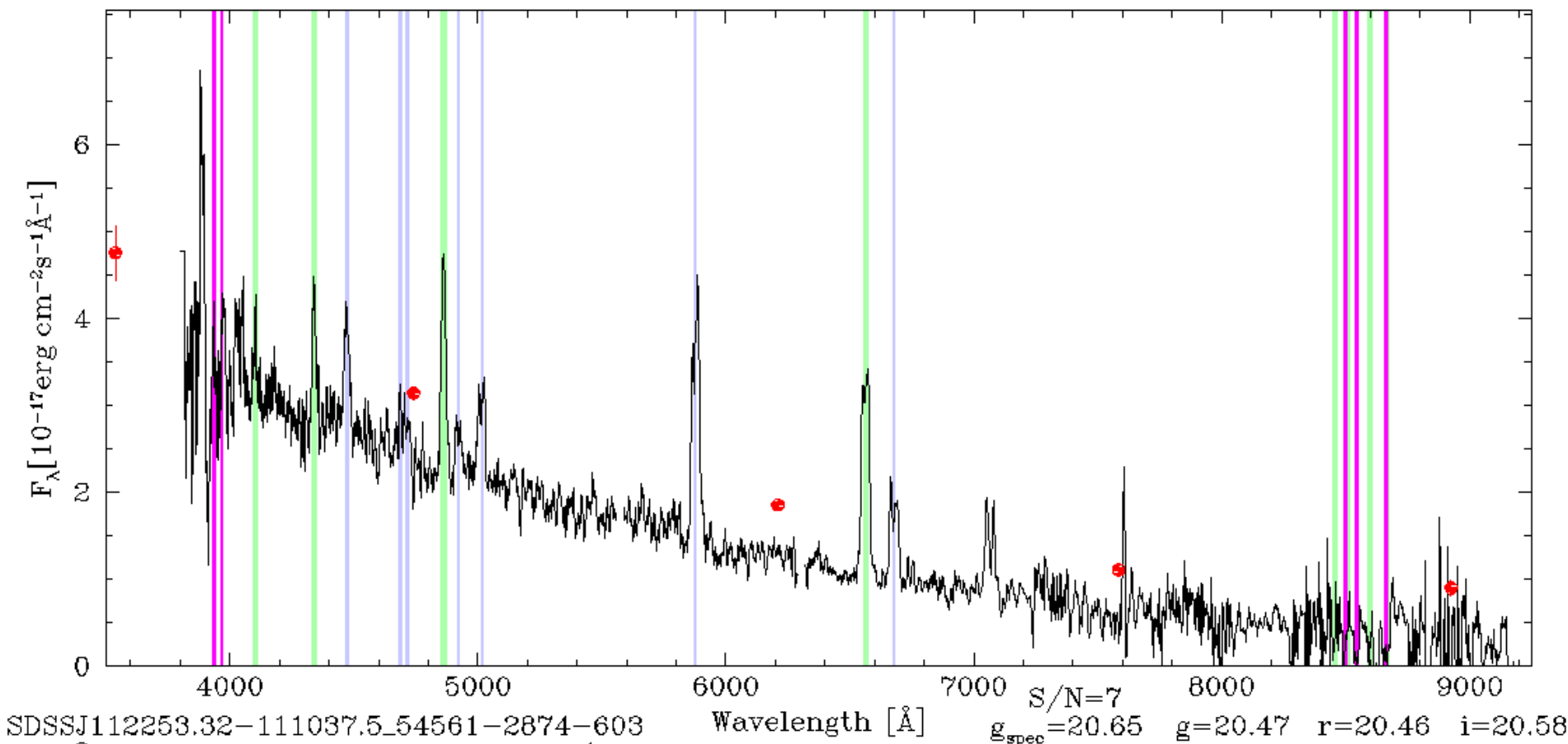


$$P_{\text{sh}} = 65.39 \pm 0.04 \text{ min}$$

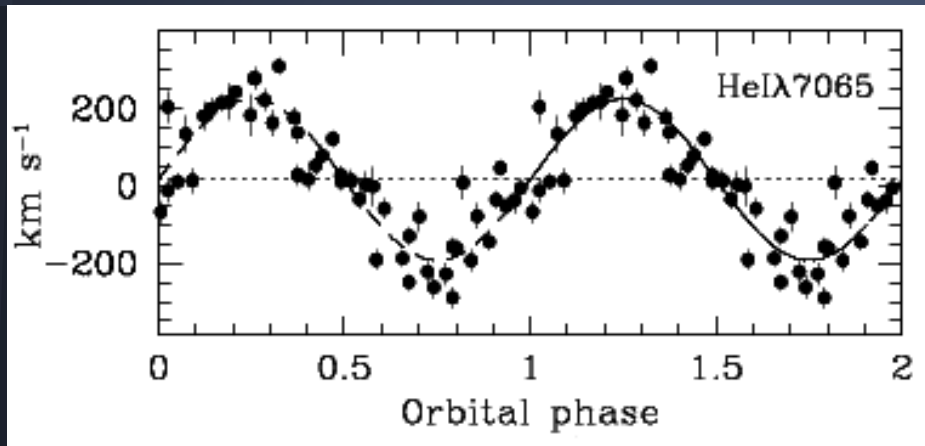


(Kato et al 2010, PASJ 62 1525)

CSS100603:112253-111037 - spectrum

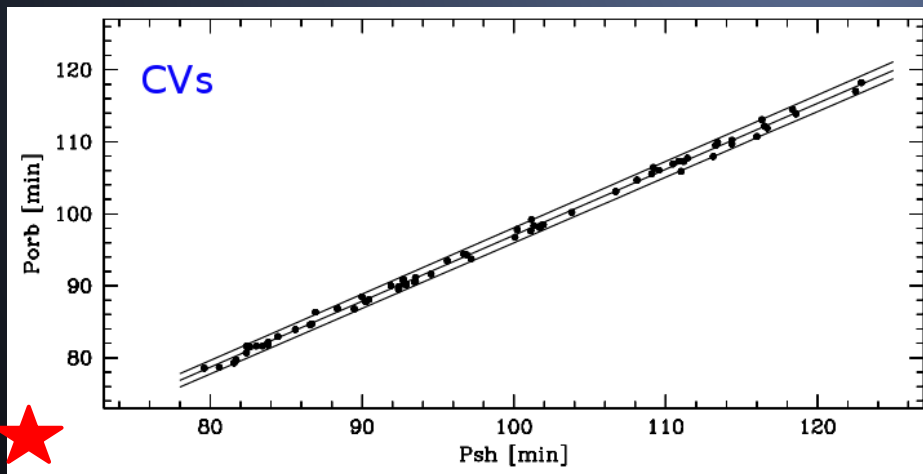


CSS100603:112253-111037 - orbital period



$$P_{\text{orb}} = 65.23 \pm 0.02 \text{ min}$$

$$\begin{aligned} \varepsilon &= (P_{\text{orb}} - P_{\text{sh}}) / P_{\text{orb}} \\ &= 0.003 \end{aligned}$$



ε - q relation

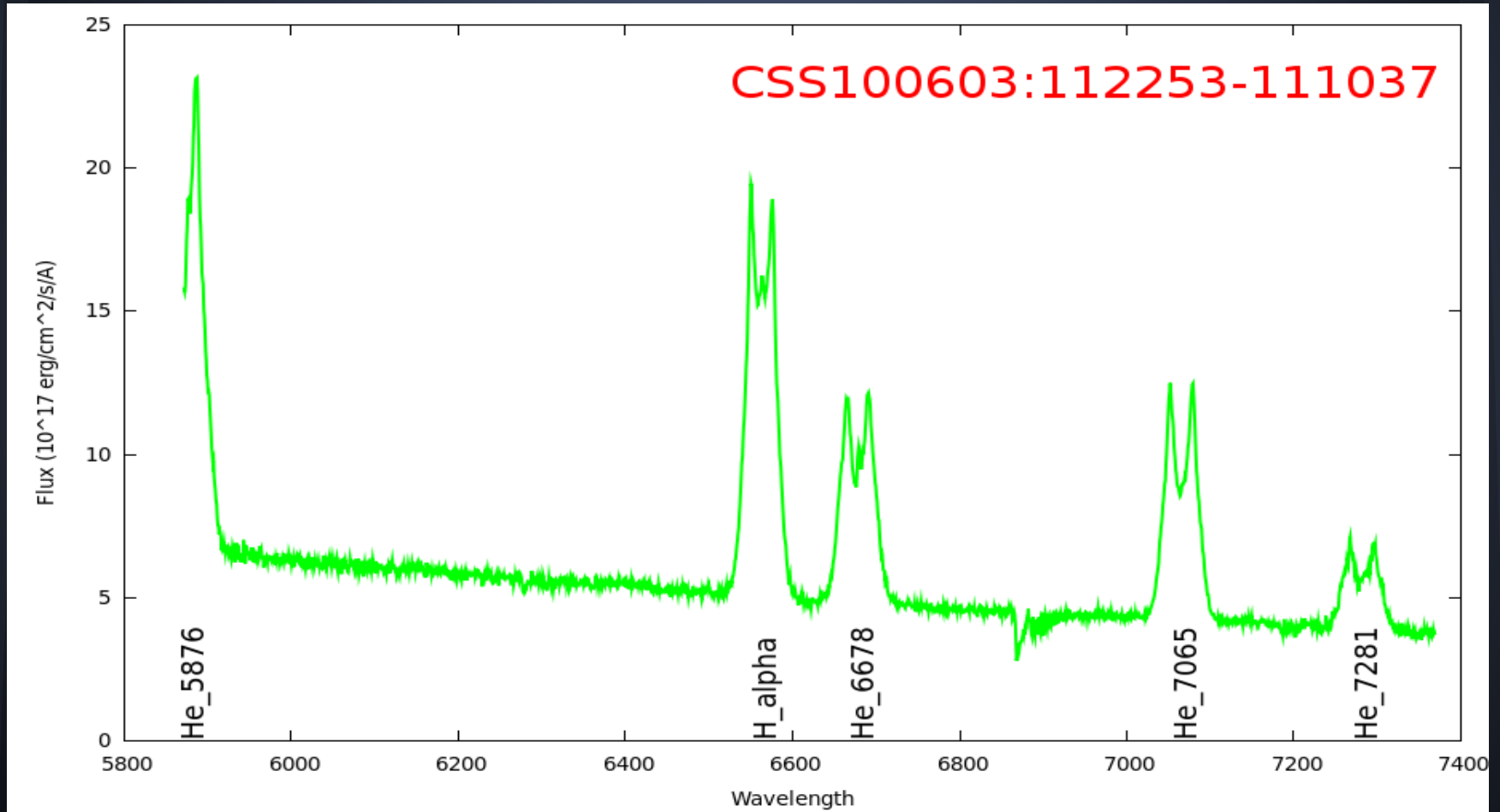
$$\Rightarrow q = 0.02$$

(Patterson et al 2005,
Knigge 2006,
Kato et al 2011)

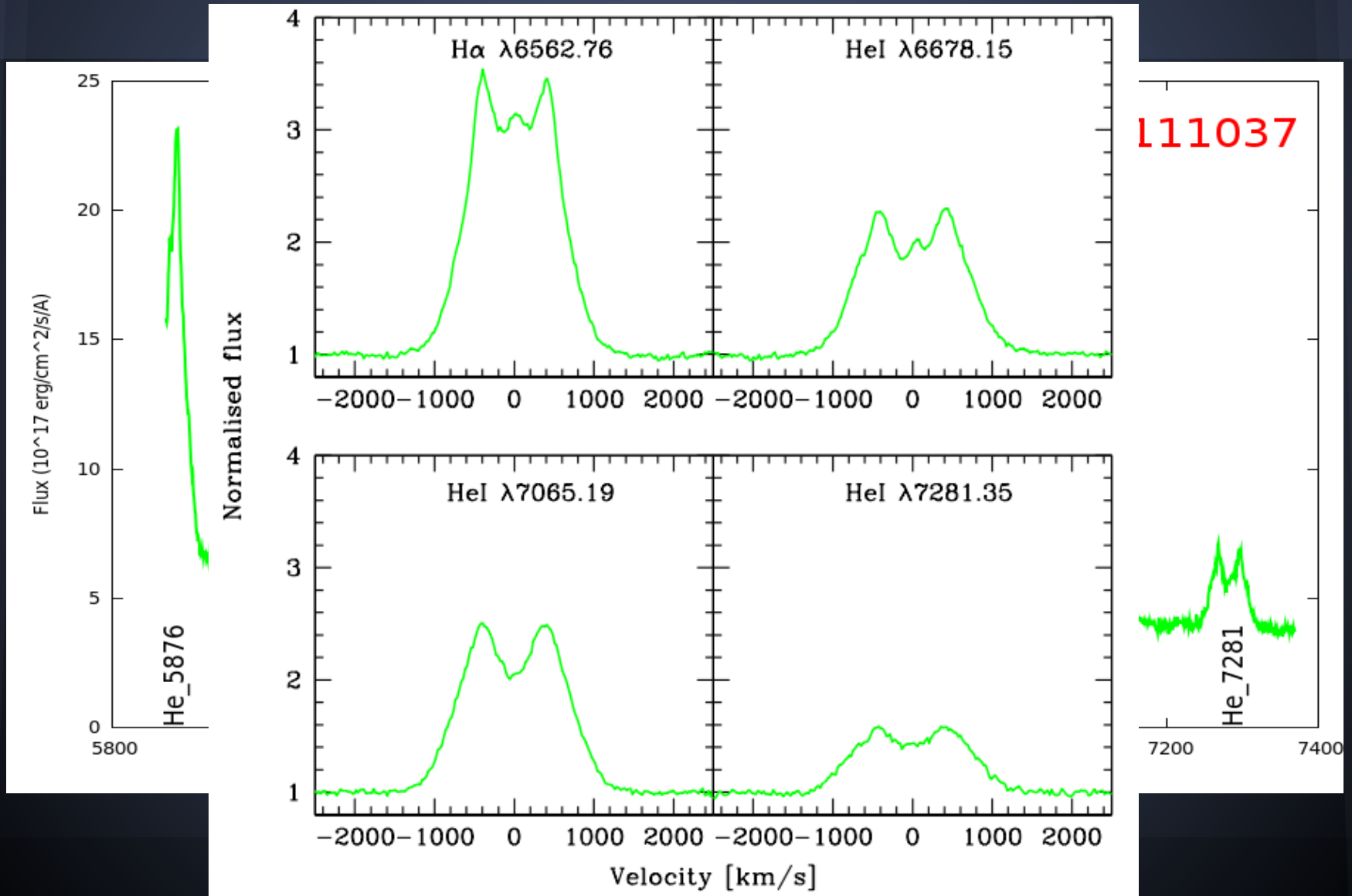


(Gänsicke et al 2009)

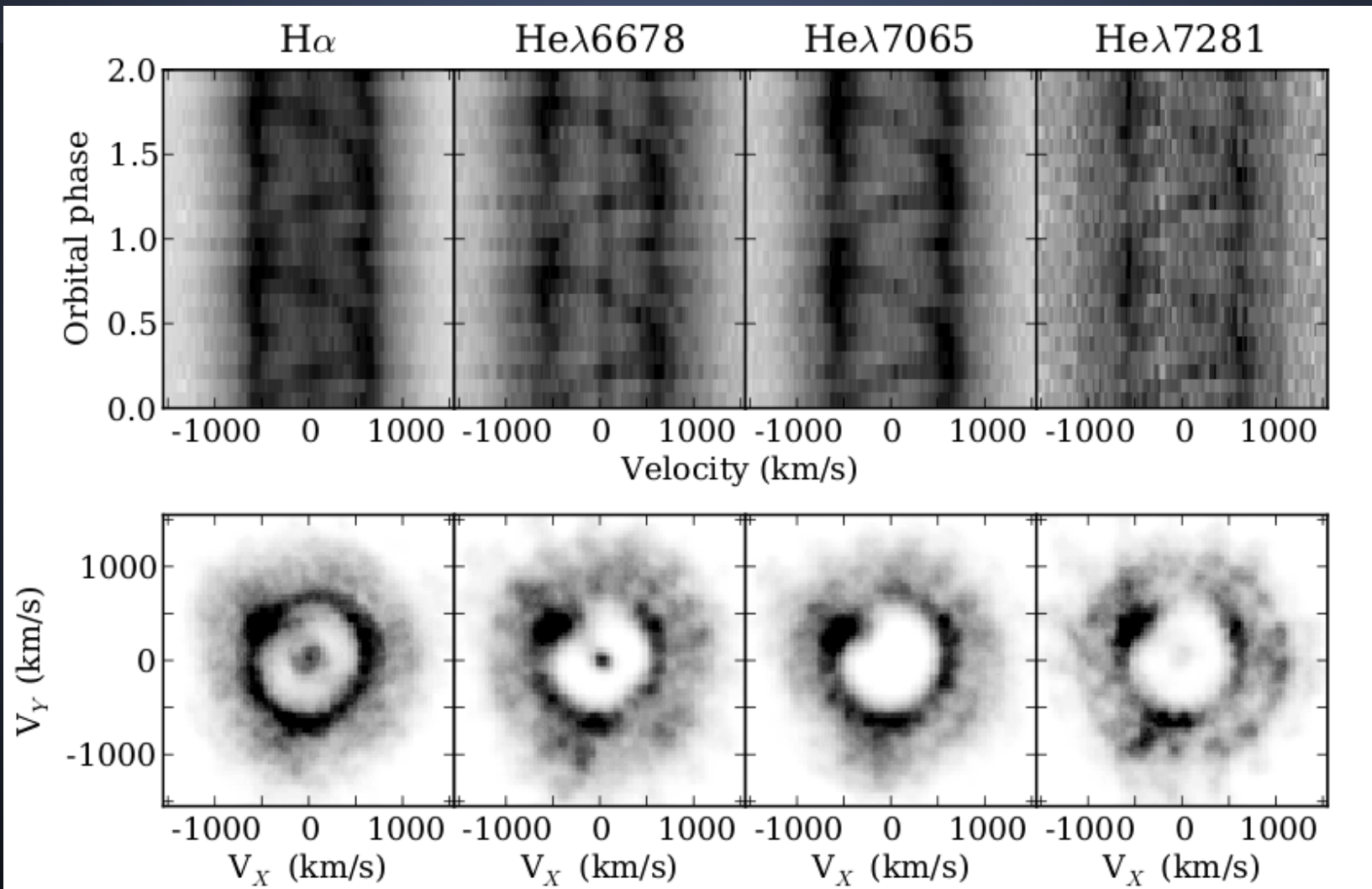
CSS100603:112253-111037 - no donor



CSS100603:112253-111037 - triple peak!



CSS100603:112253-111037 - triple peak!



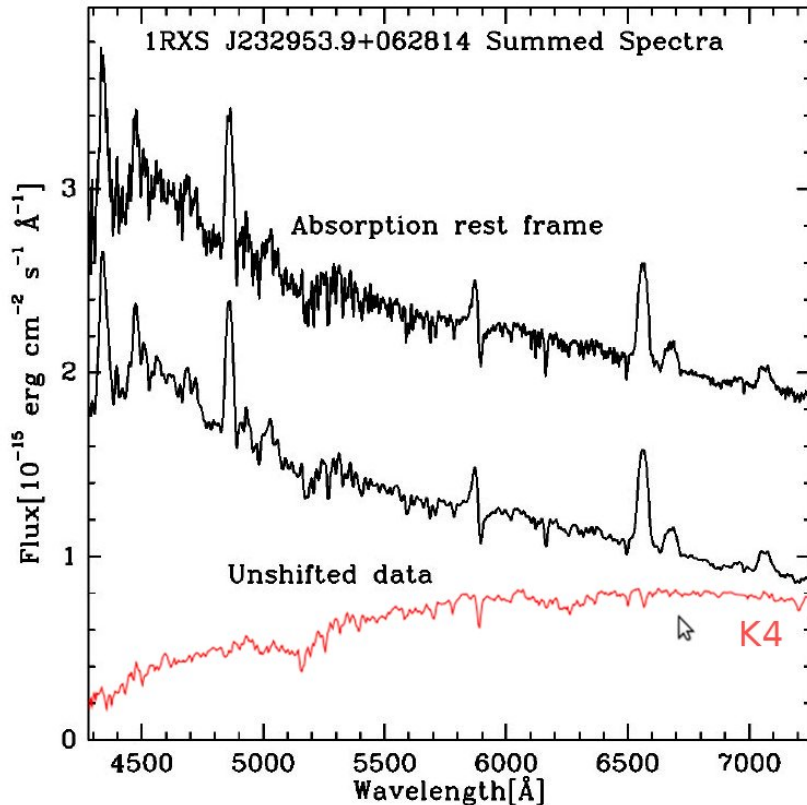
Breedt et al (in prep)

CSS100603:112253-111037

The first short period hydrogen dwarf nova
with AM CVn-type properties

Hot evolved donor

EI Psc ($P_{\text{orb}} = 64 \text{ min}$)



For Roche lobe filling stars:

$$\langle \rho_2 \rangle = \frac{3M_2}{4\pi R_2^3} \simeq 107 P_{\text{orb},h}^{-2} \text{ g cm}^3$$

Has to be an evolved donor

Mass transfer only starts when donor has started to evolve off the main sequence.

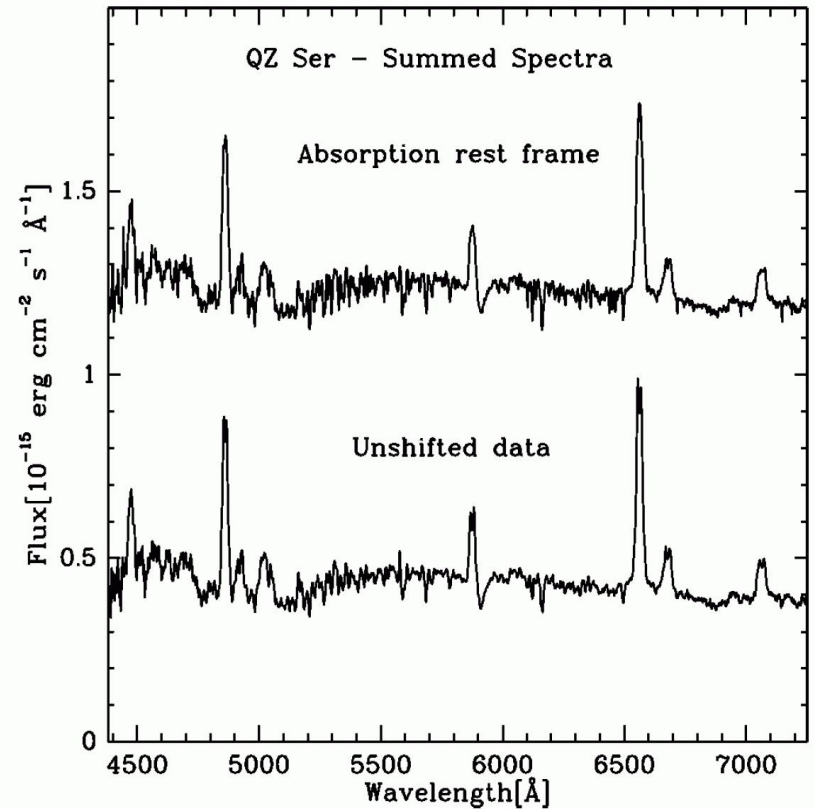
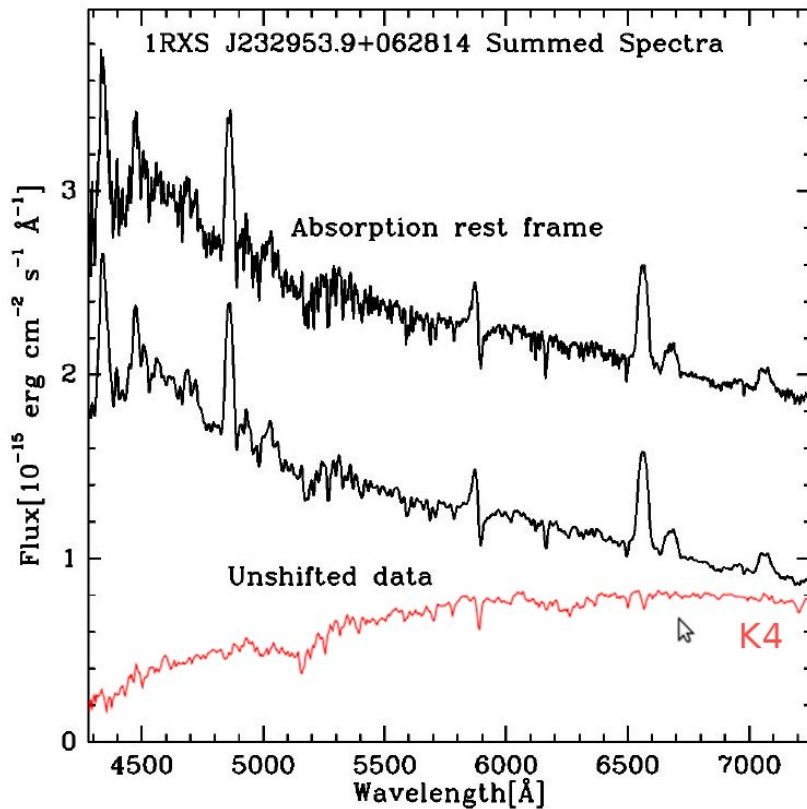
(Podsiadlowski et al 2003 MNRAS 340 1214)

(Thorstensen et al 2002 ApJ 567 L49)

Hot evolved donor

EI Psc ($P_{\text{orb}} = 64$ min)

QZ Ser ($P_{\text{orb}} = 120$ min)



(Thorstensen et al 2002 ApJ 567 L49)

(Thorstensen et al 2002 PASP 114 1117)

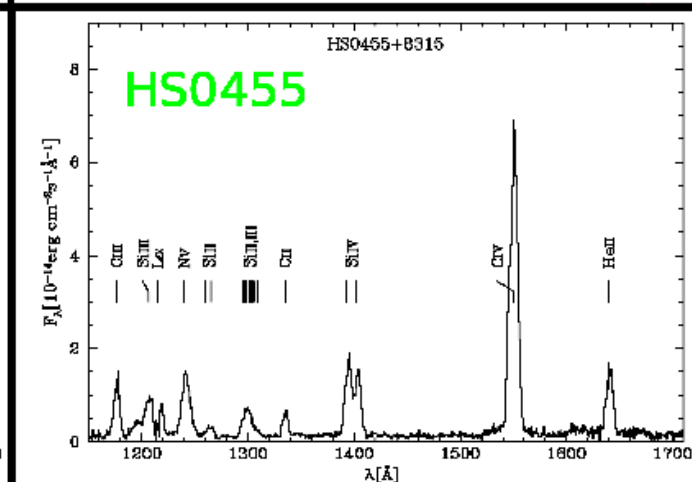
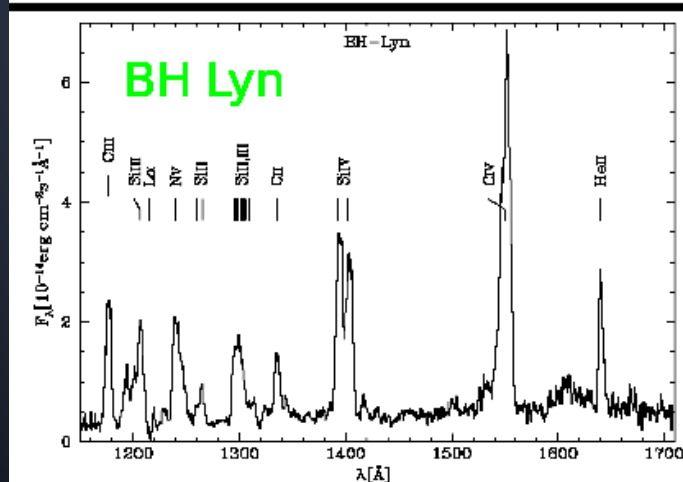
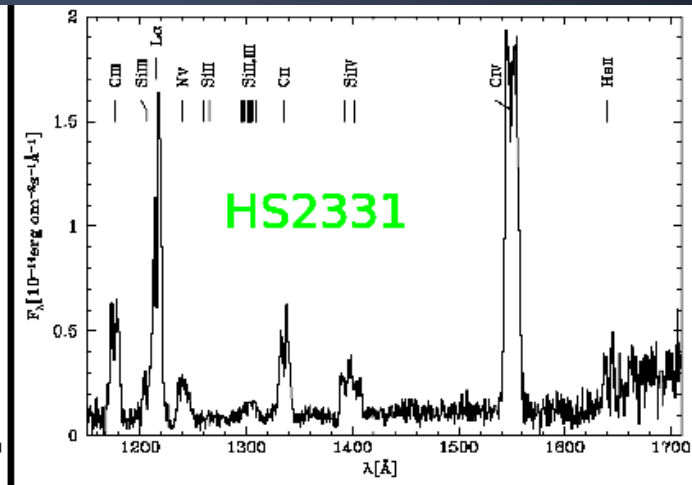
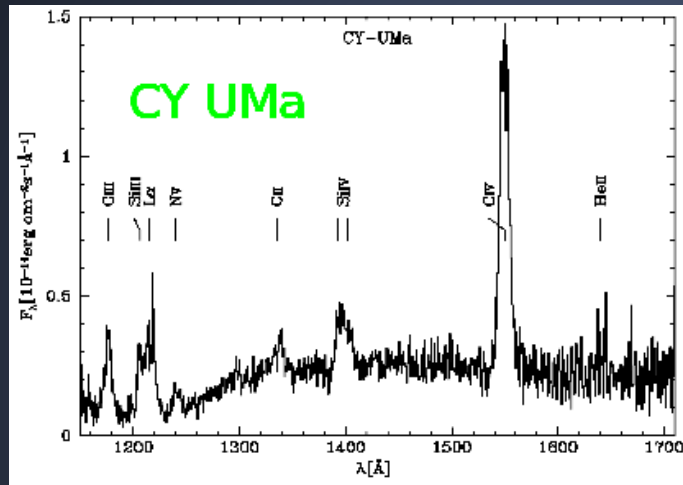
Super Soft X-ray Sources

- * Hot donor is the **exposed core** of the previously much more massive star
- * $q \sim 1$ at the onset of mass transfer
 - thermal timescale mass transfer
 - unstable
 - high enough rate to sustain nuclear burning on the wd surface
- * When $q < 5/6$, stable - 'normal' CV (Carbon depleted)
- * $\sim 1/3$ CVs formed this way



(Schenker et al 2002 MNRAS 337 1105)

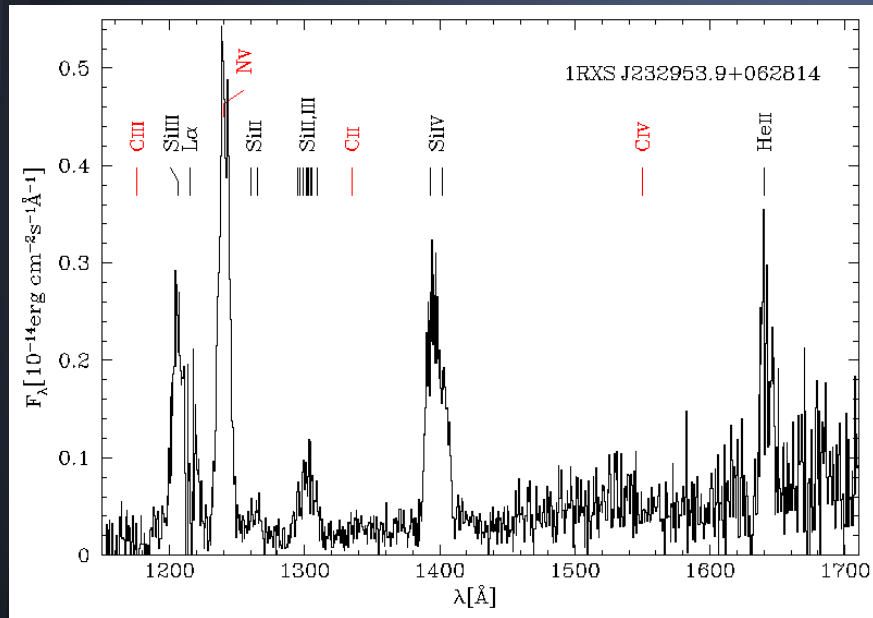
HST snapshot survey - measure Nv/Civ



(Gänsicke et al 2003 ApJ 594 443)

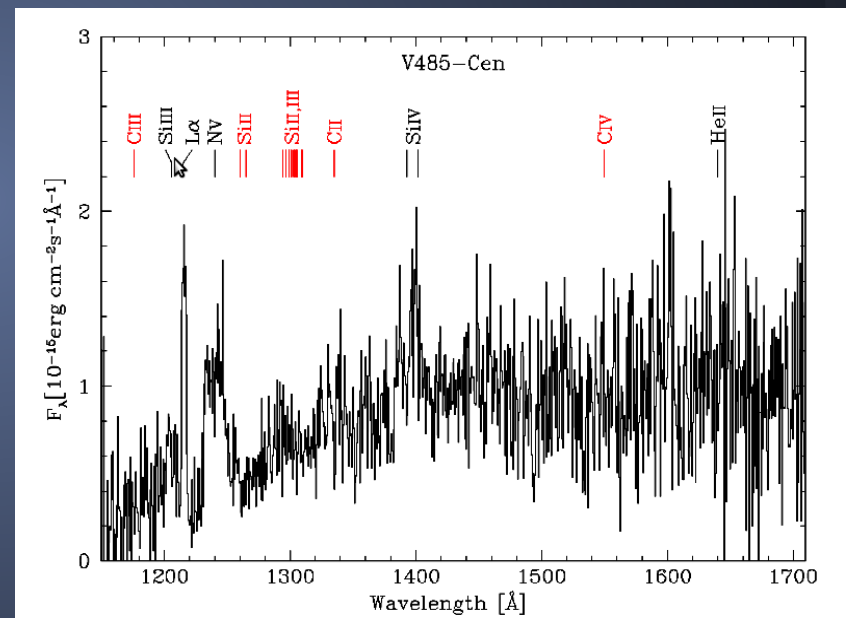
Anomalous Nv/CIV ratio

EI Psc



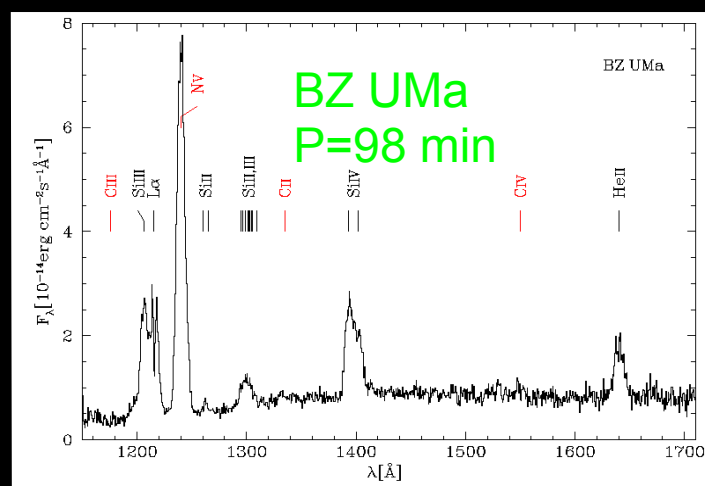
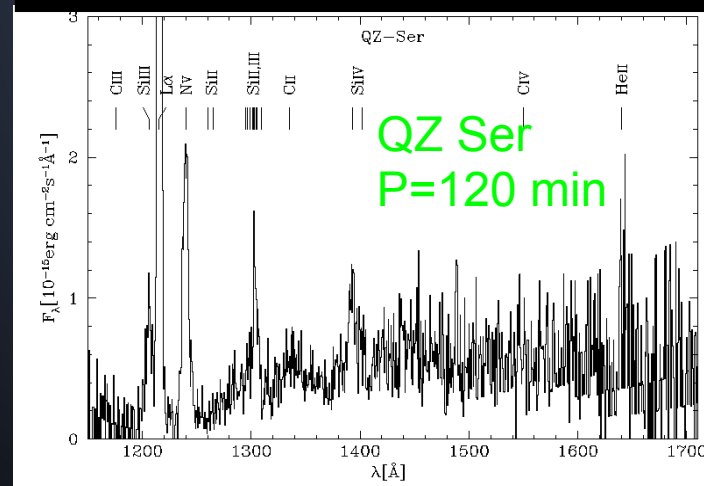
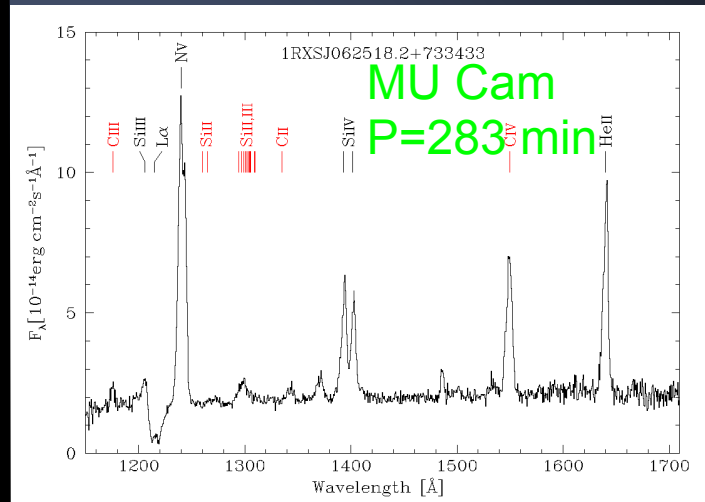
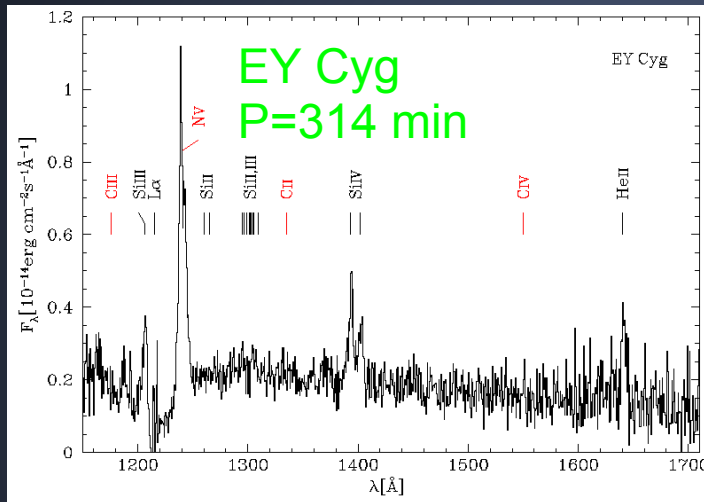
(Gänsicke et al 2003 ApJ 594 443)

V485 Cen

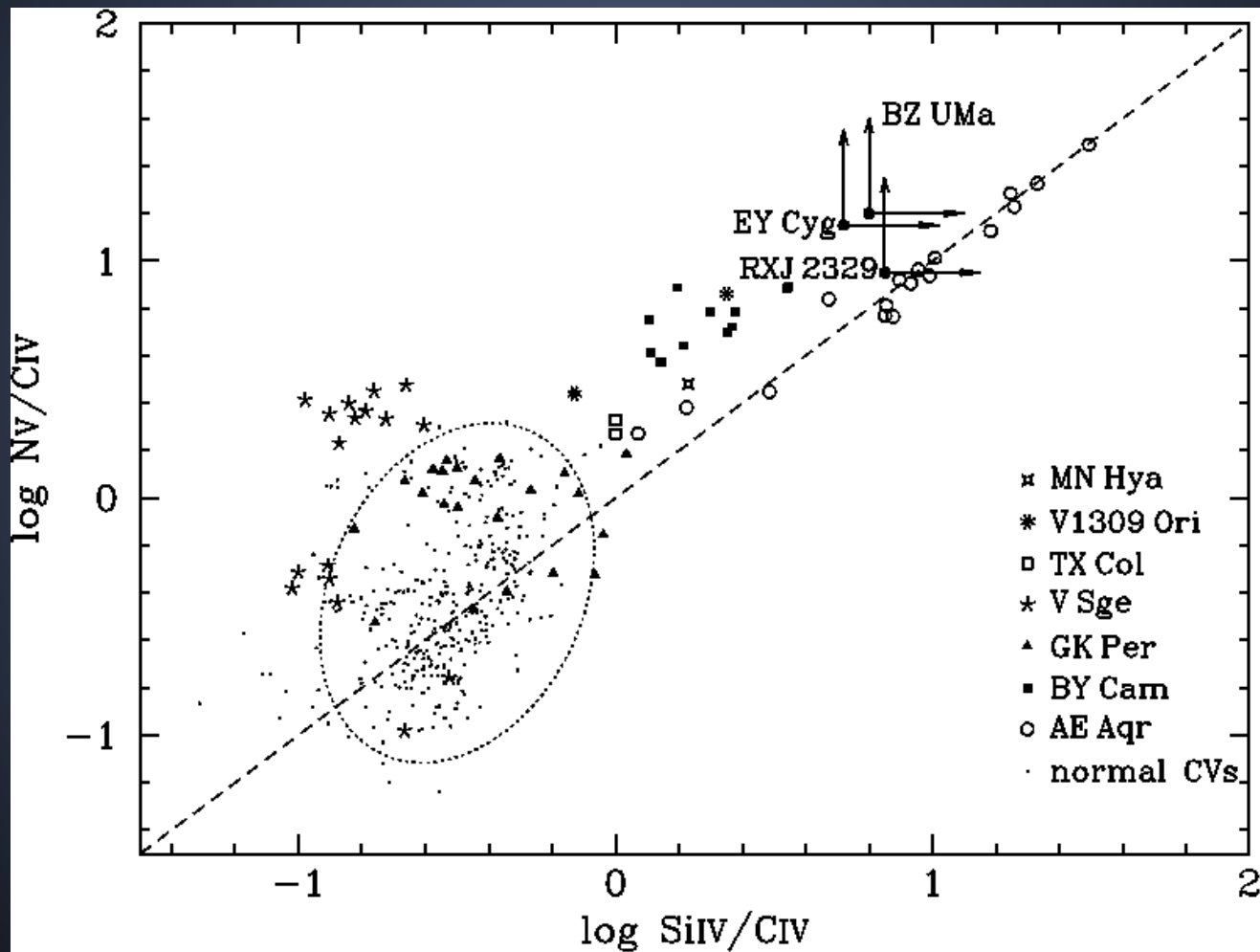


(Gänsicke et al, in prep)

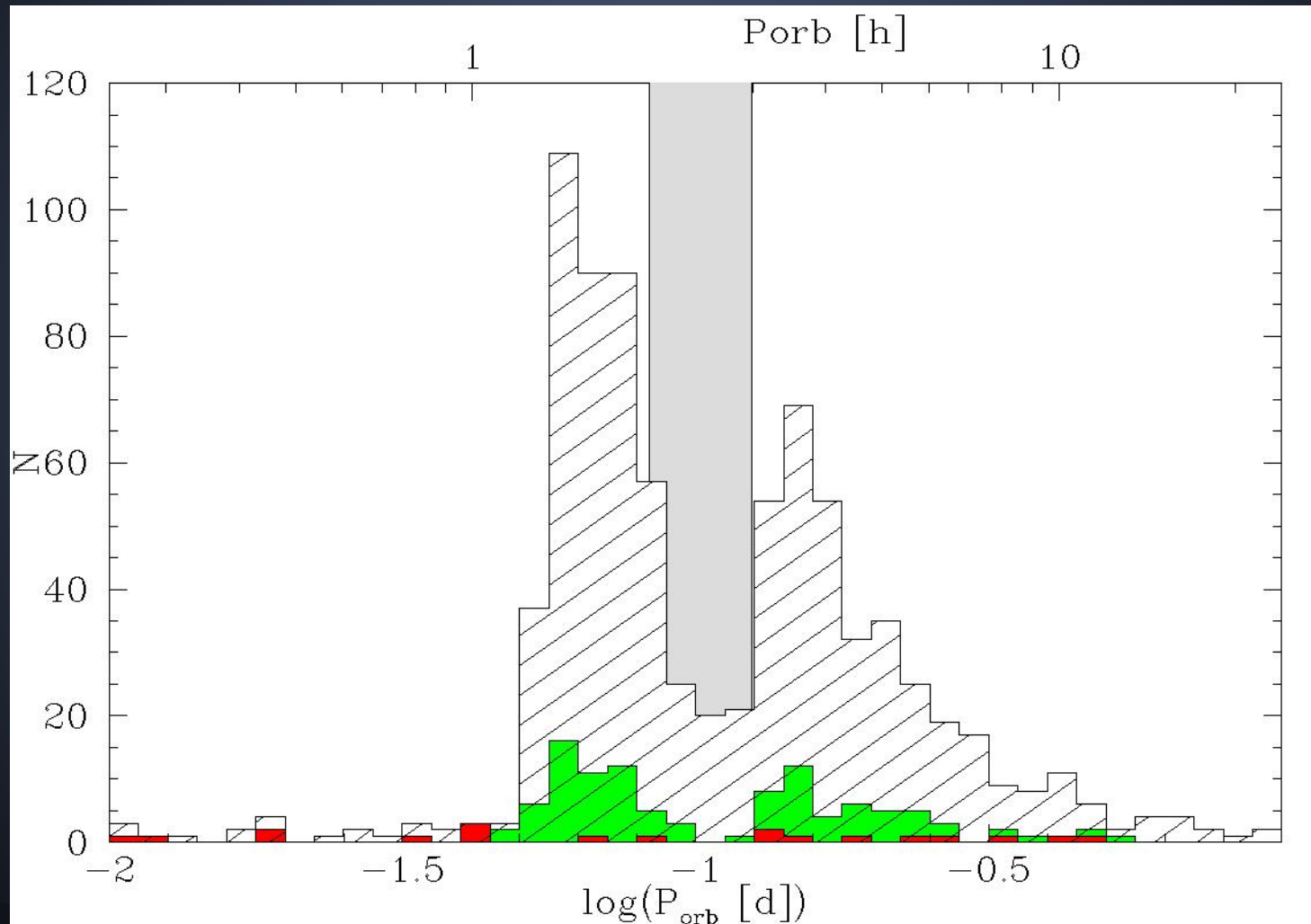
Also in other (longer period) CVs



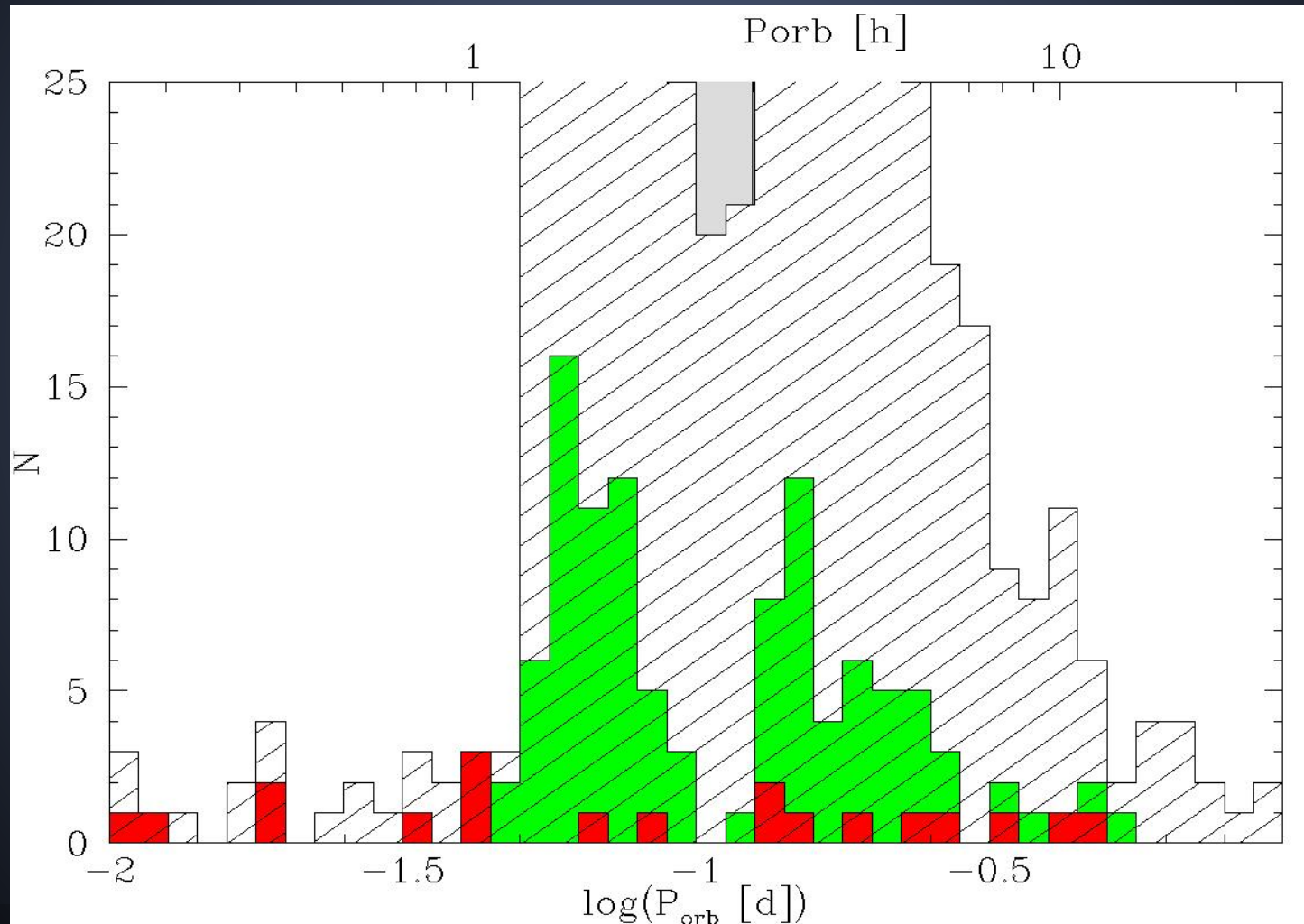
UV line flux ratios



Found at all orbital periods



Found at all orbital periods



Does this channel produce AM CVn stars?

- * Not all CVs with evolved donors will become AM CVn systems
- * ...but the formation channel produces CVs with a wide range of parameters
- * *At least* one hydrogen-rich with properties of an AM CVn
 - probably a low mass donor
- * *Only* one hydrogen-rich with properties of an AM CVn (so far)
 - not the main AM CVn factory