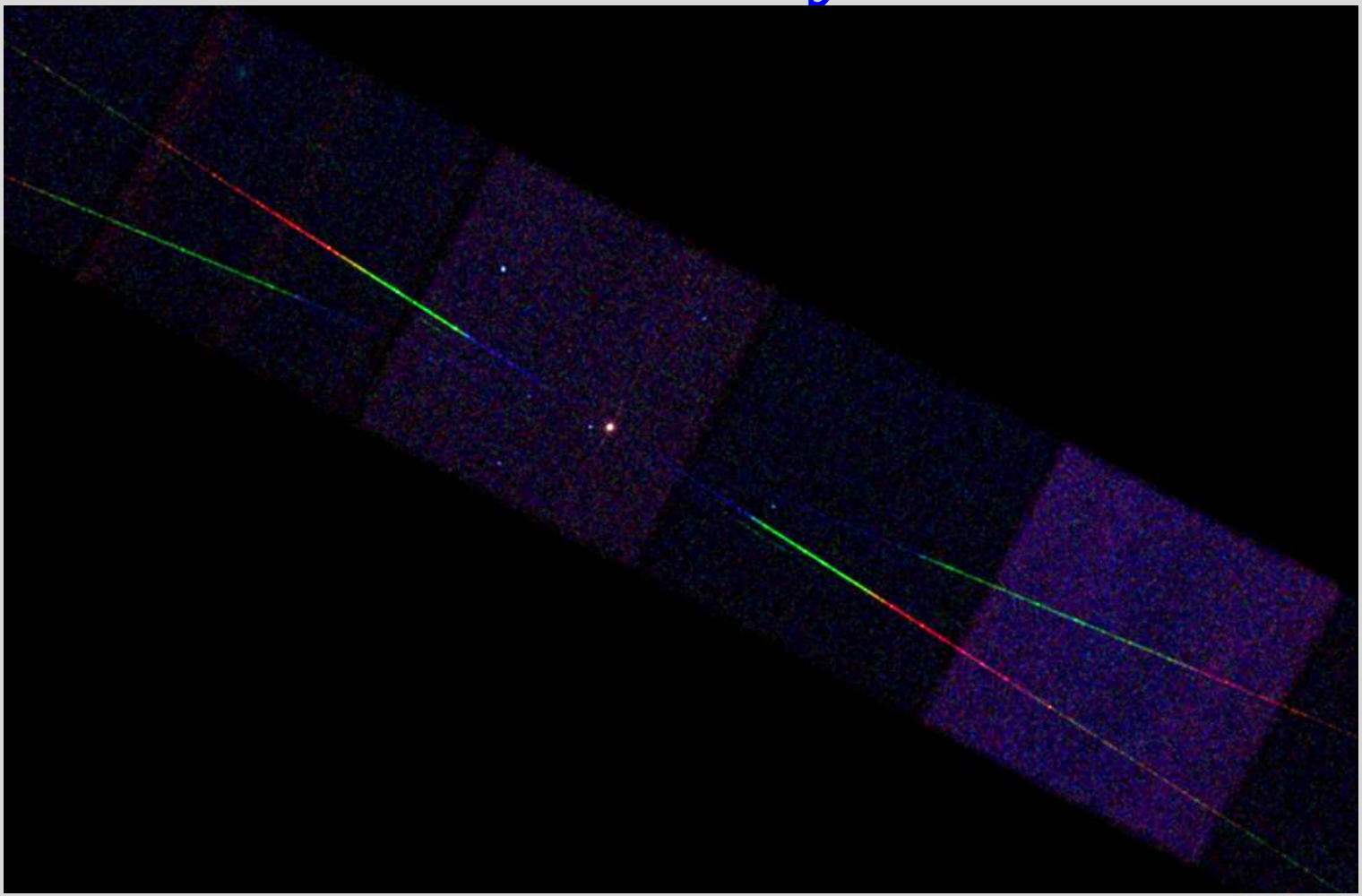
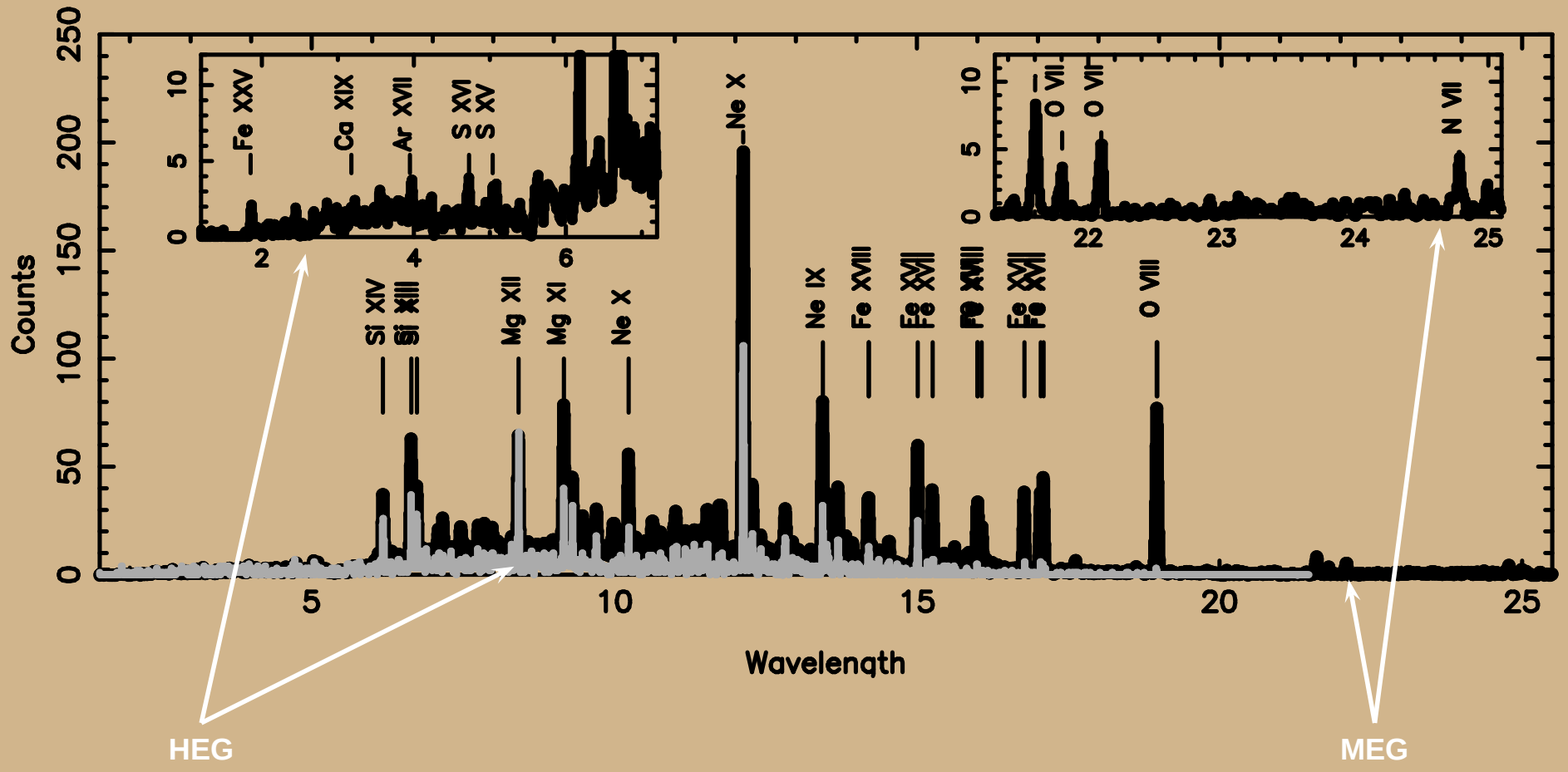
Determining Coronal Structure in Active Binary Stars



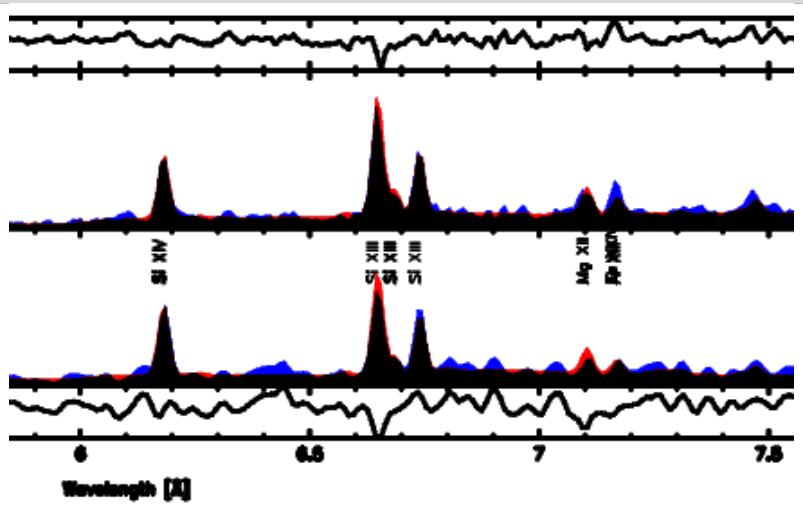
David P. Huenemoerder (MIT)

VW Cep Spectrum (120ks)

$P = 0.28$ day; W-type W UMa binary



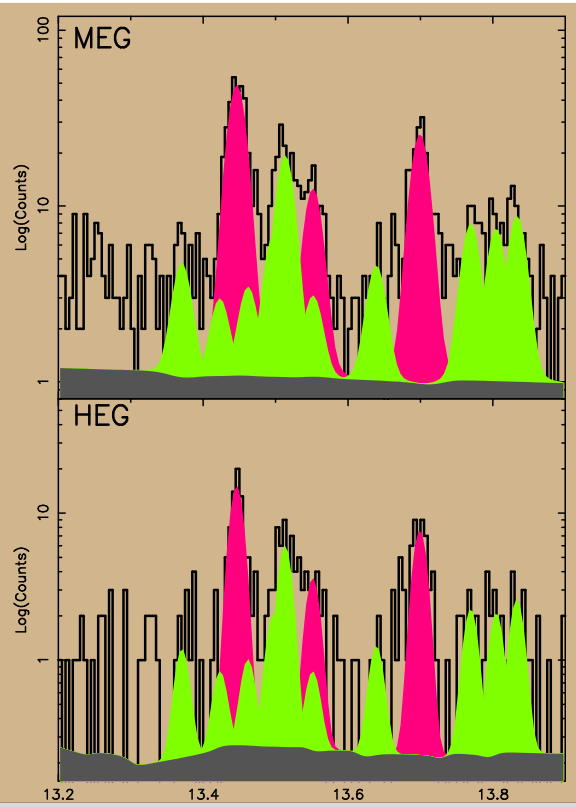
Plasma Volume, Density, & Geometry



Ne IX

Fe XIX-XX

Continuum



Fit Line Fluxes: $\rightarrow$

Emission measure

$N_e^2 \times Volume$

$(\sim 5 \times 10^{52} \mathrm{cm}^{-3})$

Fit Line Ratios:

Helium-like lines

(O VII, Ne IX, Mg XI)

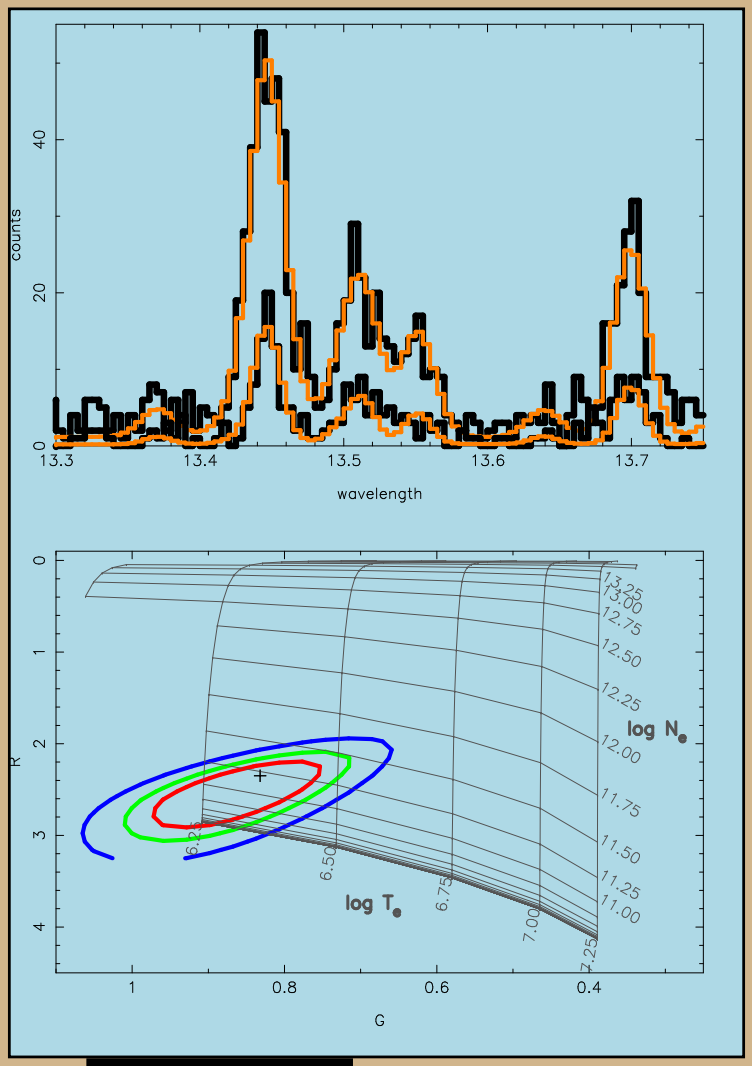
$\rightarrow N_e$

$(\sim 3 - 18 \times 10^{10}\,\mathrm{cm}^{-3})$

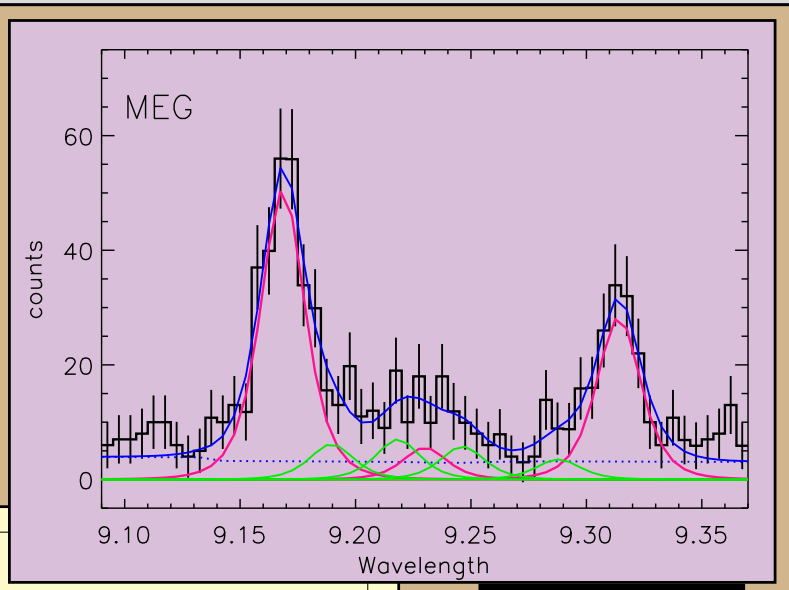
Geometry: $(N_e, V) \rightarrow$

$R(corona)/R_\star < 0.2$

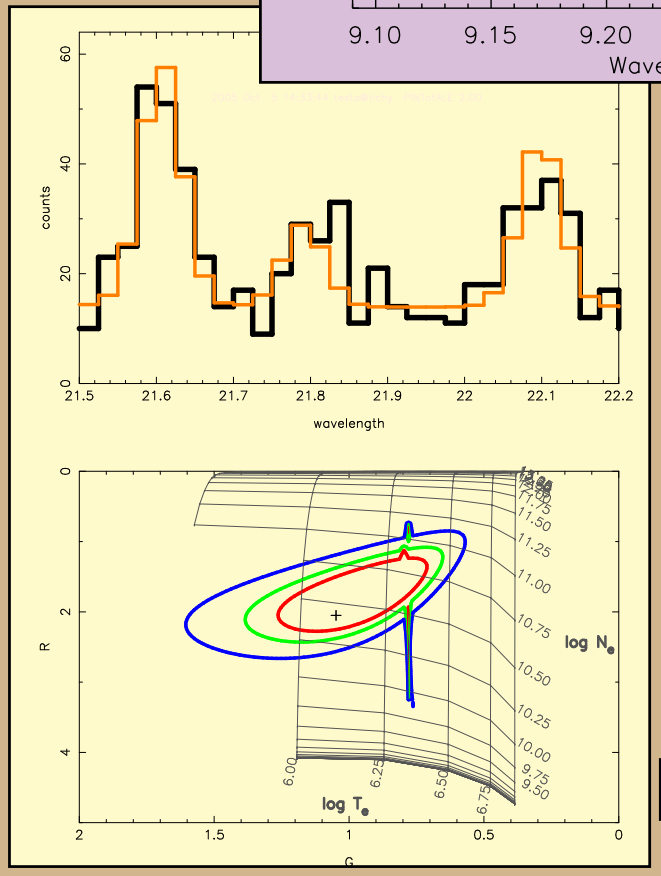
He-like Line Ratio Fits



HEG Ne IX

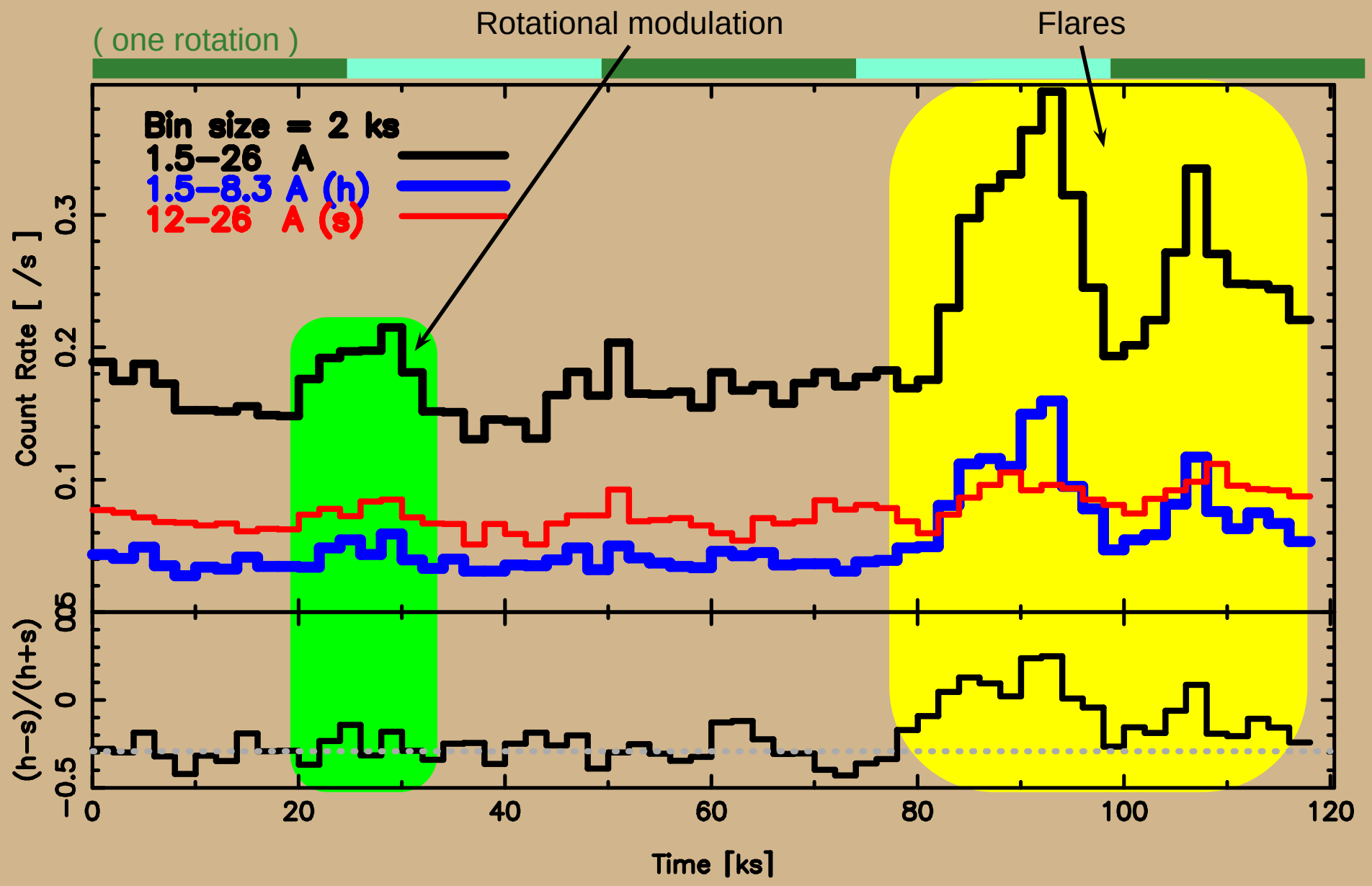


MEG Mg XI

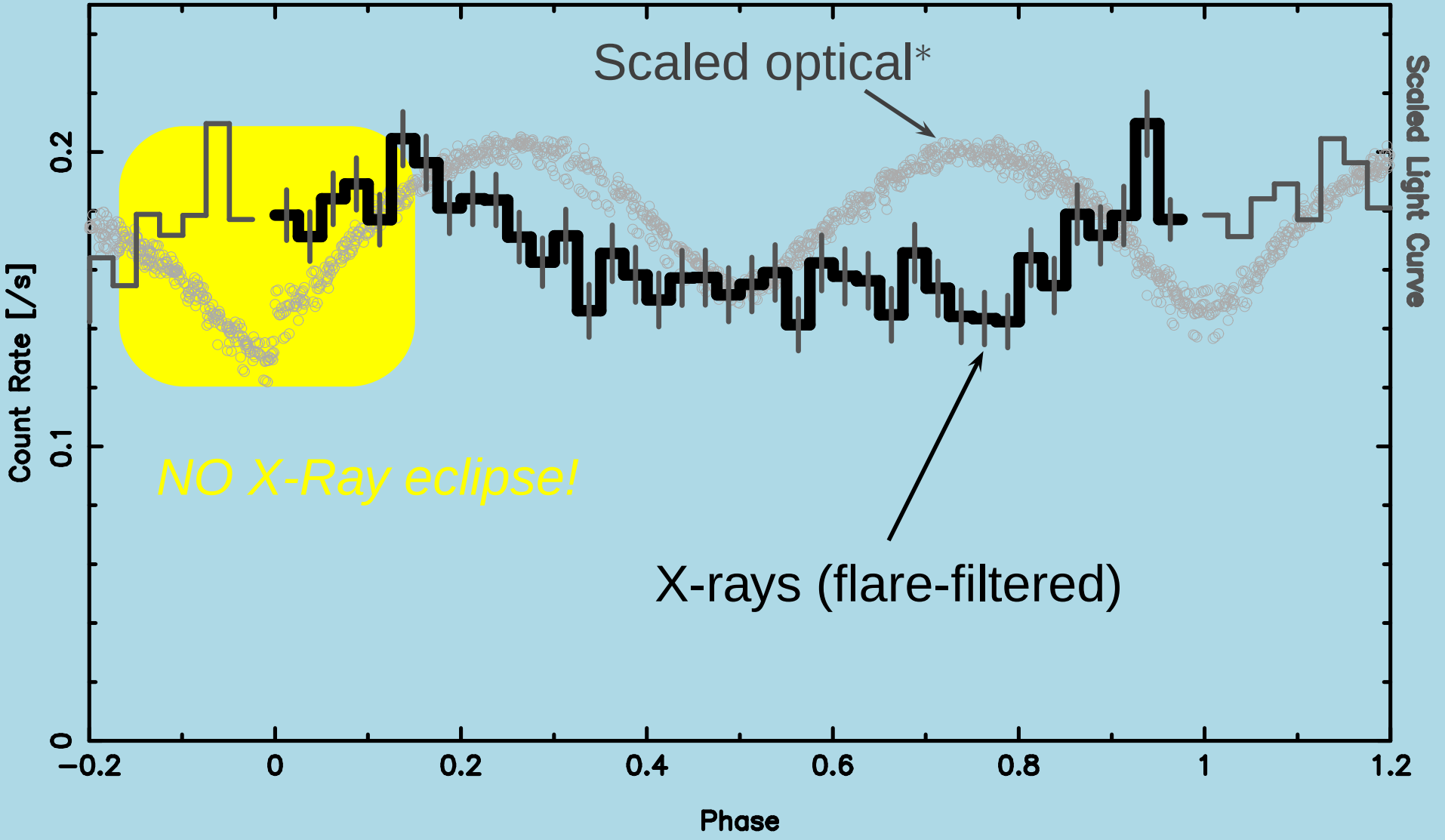


LETGS O VIII

VW Cep X-ray Light Curve

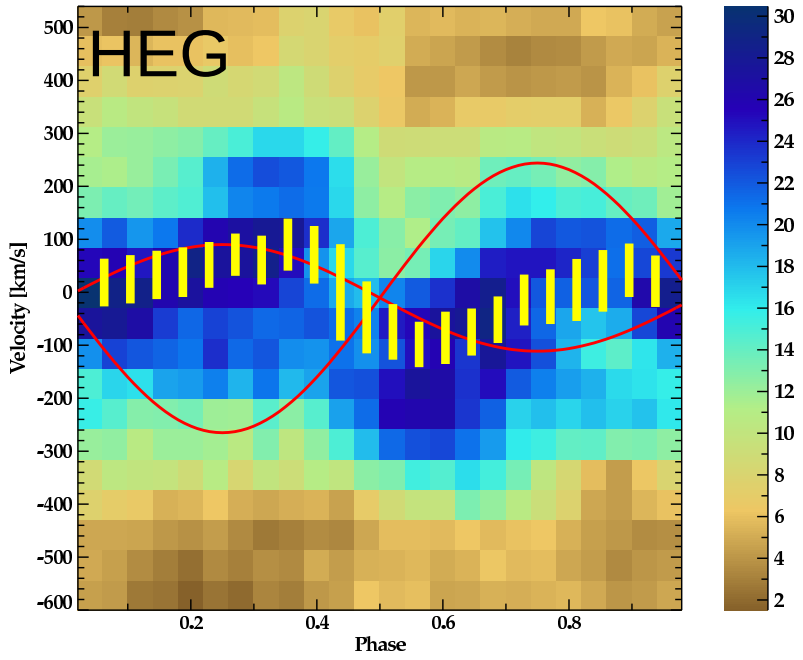


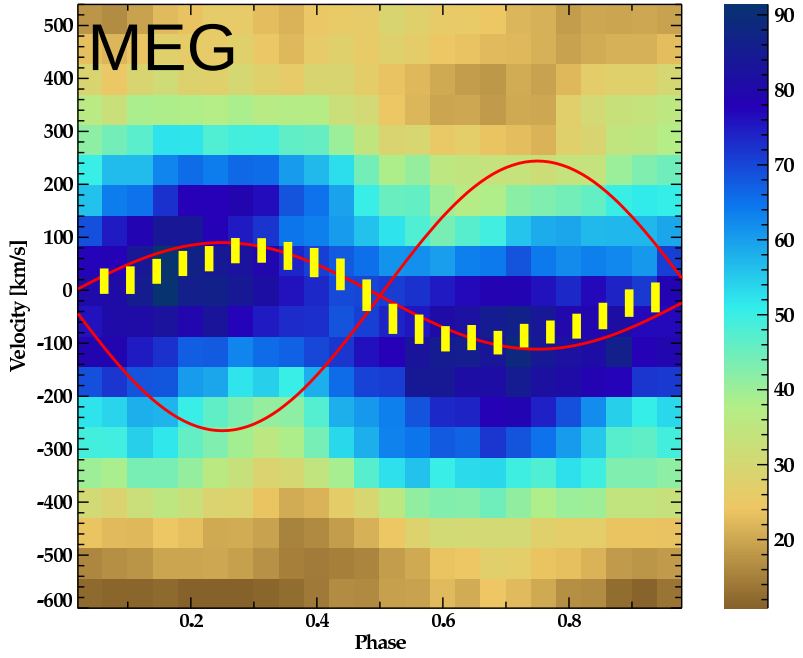
VW Cep Phased X-ray Light Curve



*Pribulla; http://www.astro.sk/~pribulla/lc.html

Velocity Modulation

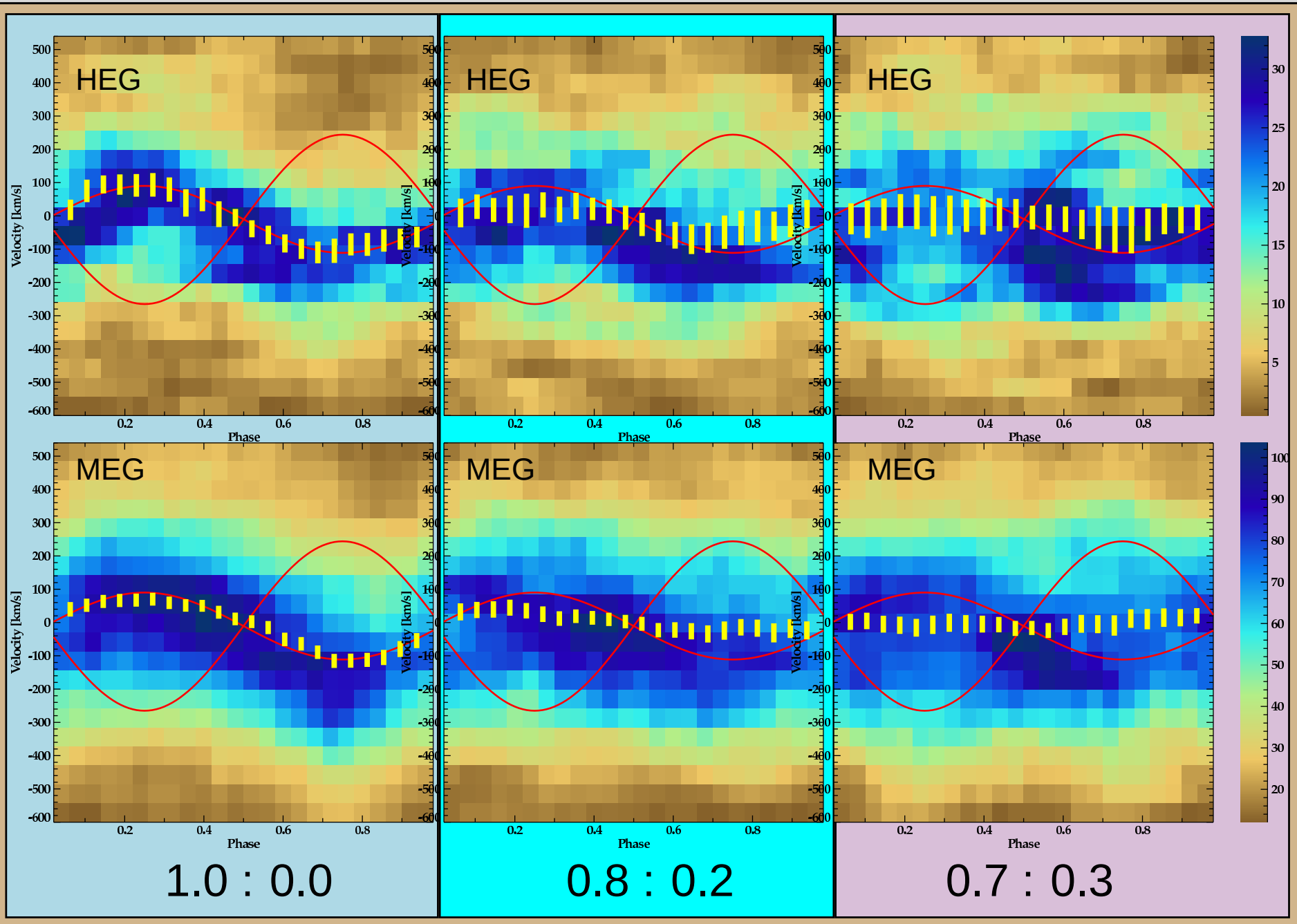




Composite Line Profile: In each phase bin, transform several lines to velocity scale and sum. Measure centroid of core.

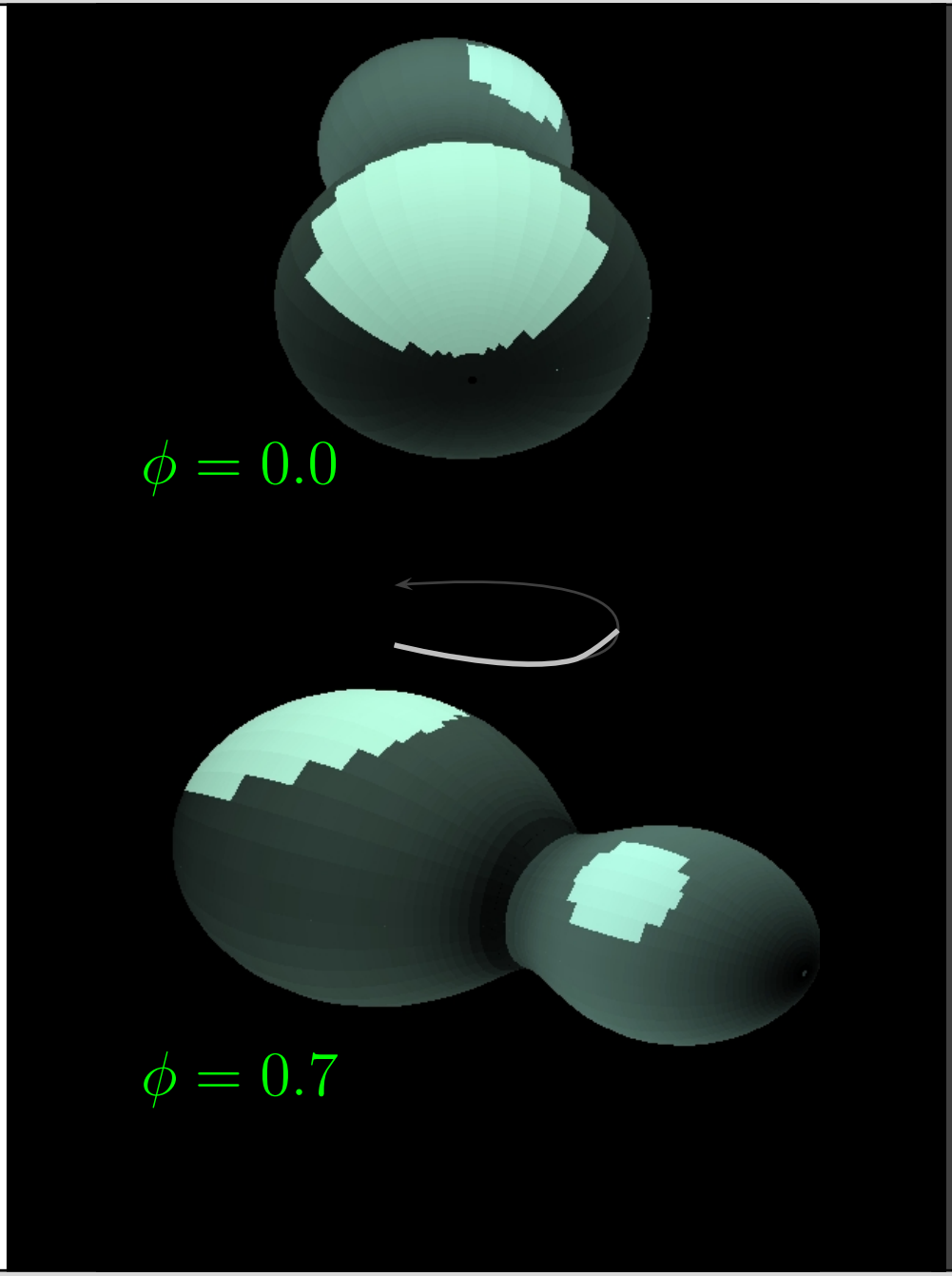
The Primary Dominates; Simulations imply $\leq 20\%$ of the flux from the secondary at some phases (0.7–0.9).

Composite Profile Simulations



Primary/Secondary weights

A Consistent View



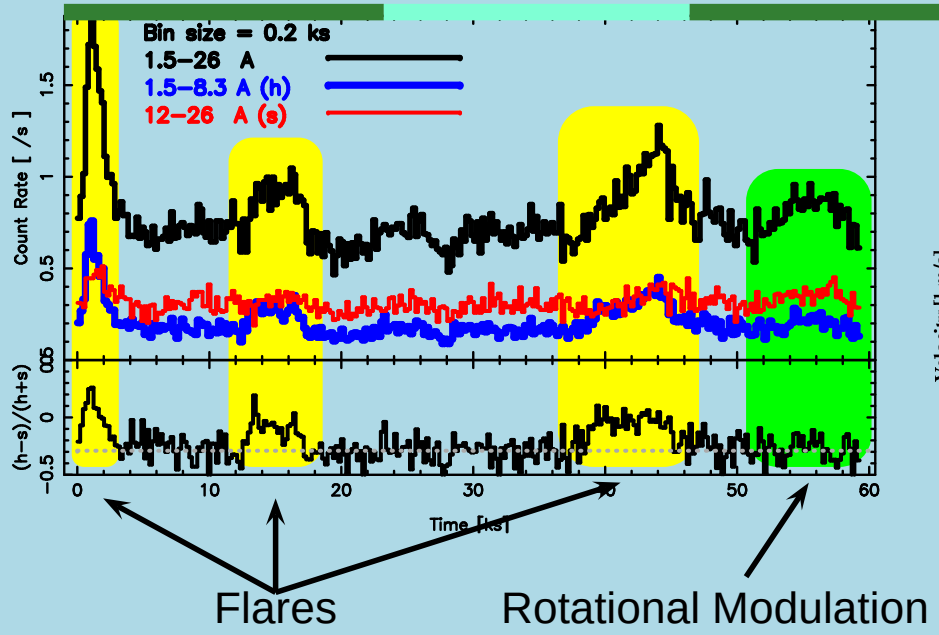
Polar/asymmetric corona: no eclipses;

Compact corona: some modulation; density & volume arguments;

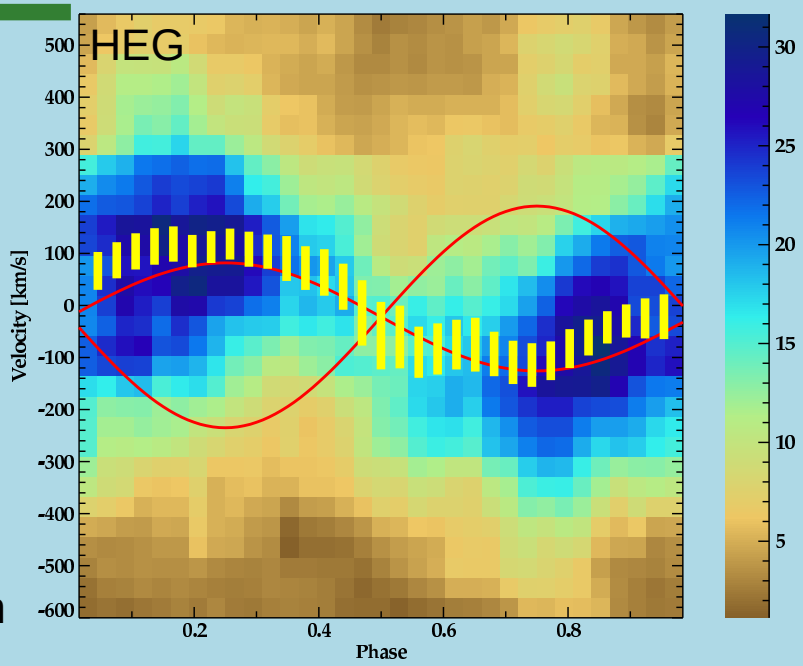
Primary Star Dominates: velocity+ light curves

The corona has compact, near polar, and few coronal emitting regions (*why* is TBD).

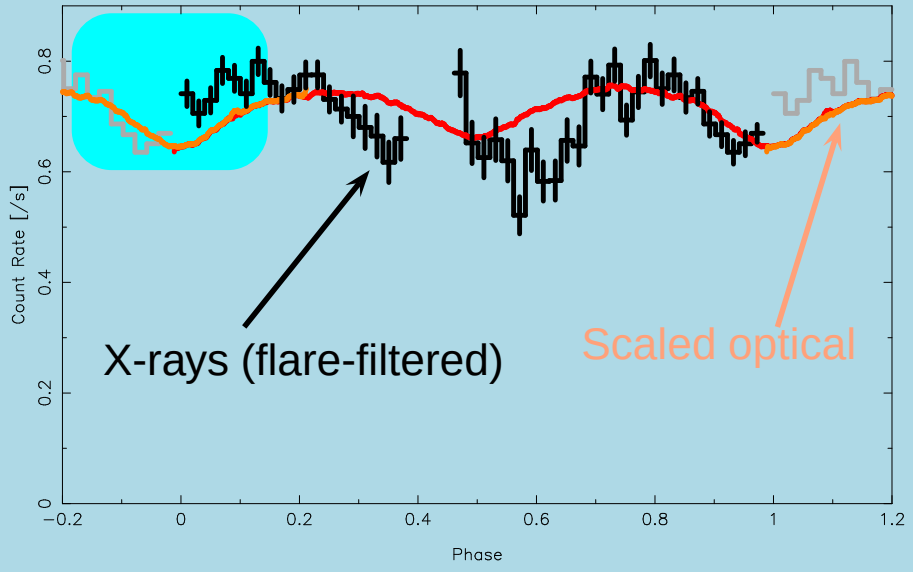
Another W UMa Case: 44 Boo

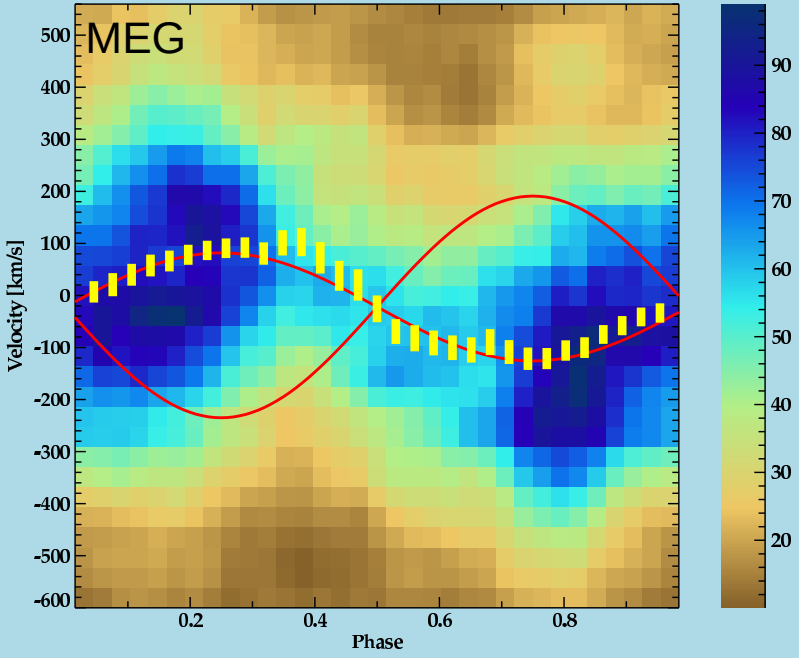


$$P = 0.27 \text{ d}$$

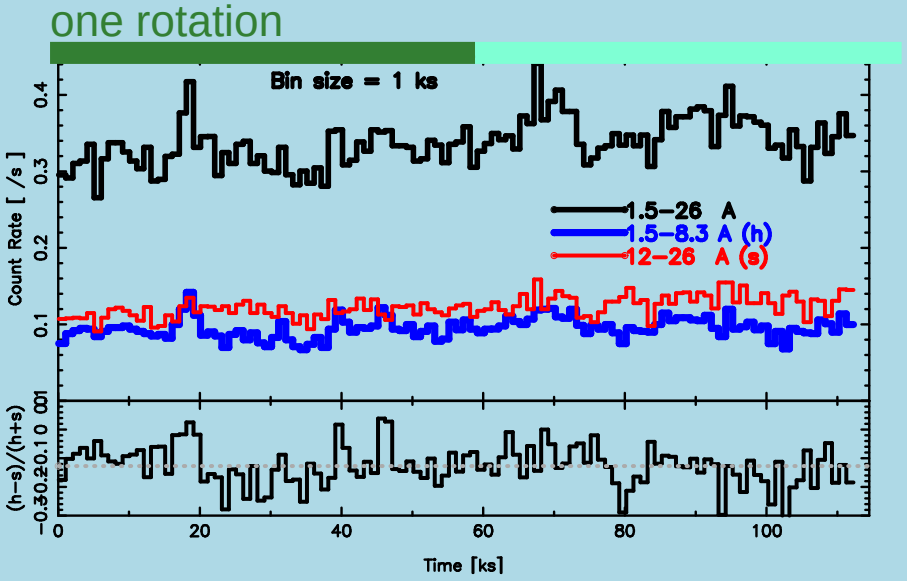


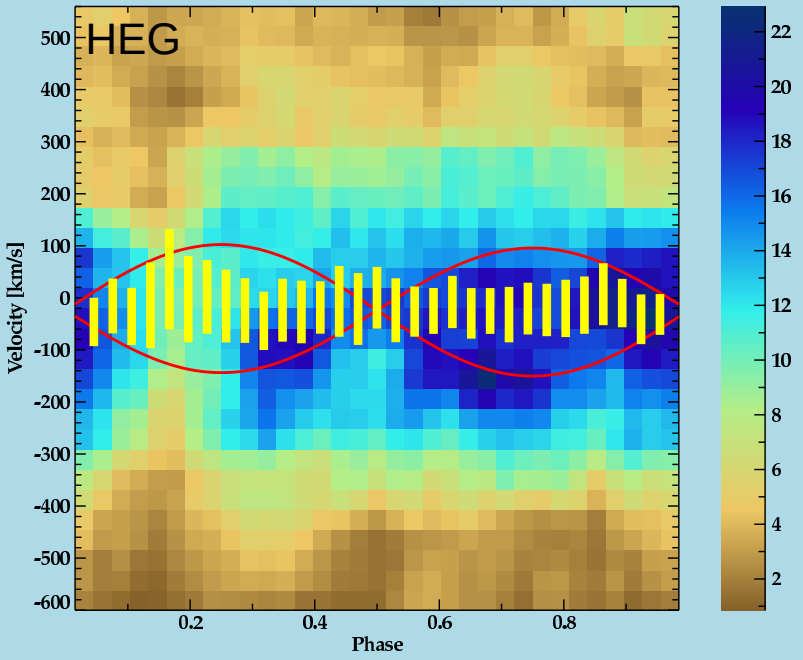
X-Ray eclipse!

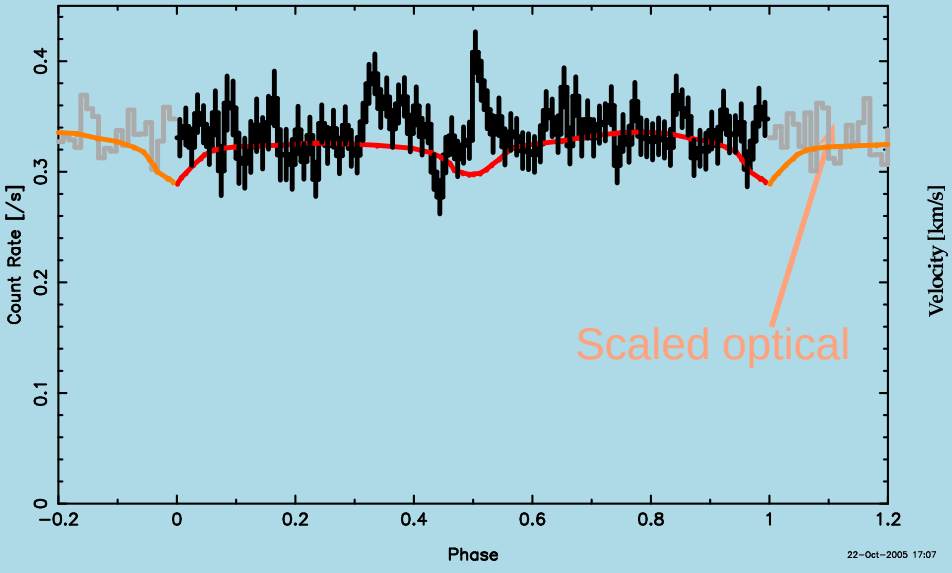


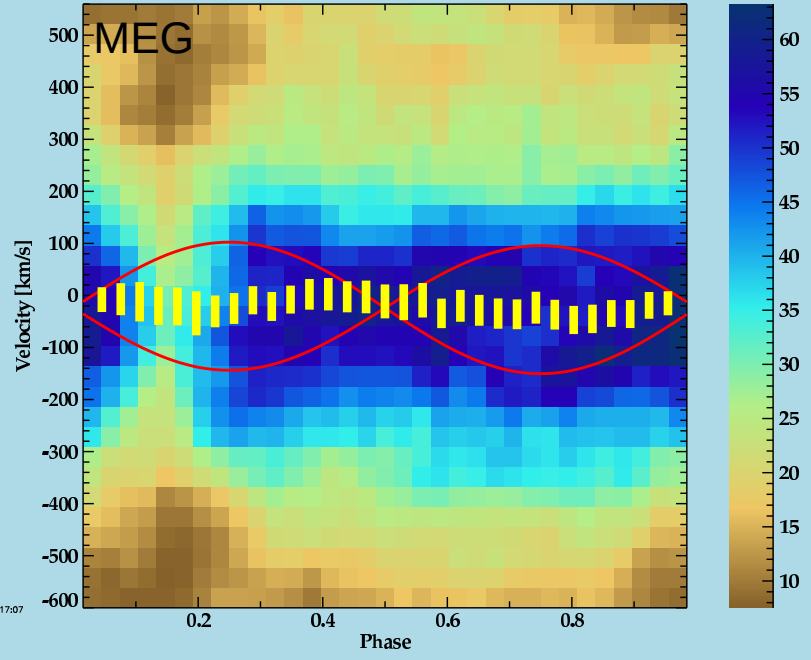


ER Vul (detached, eclipsing $P = 0.69$ d)



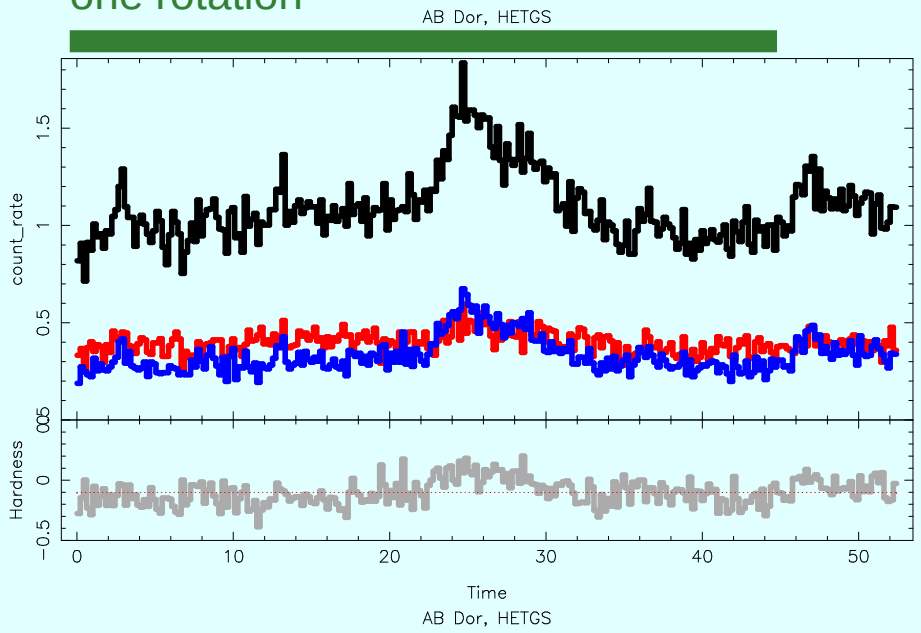


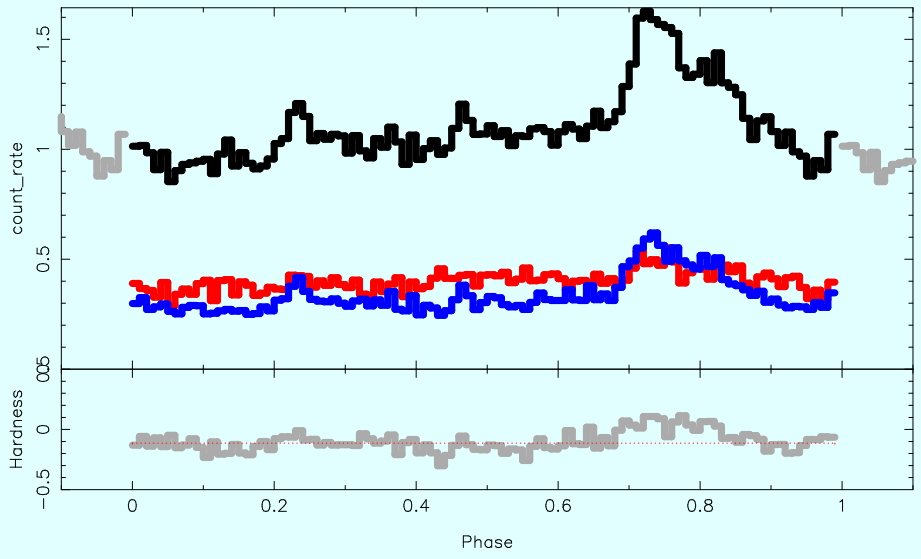


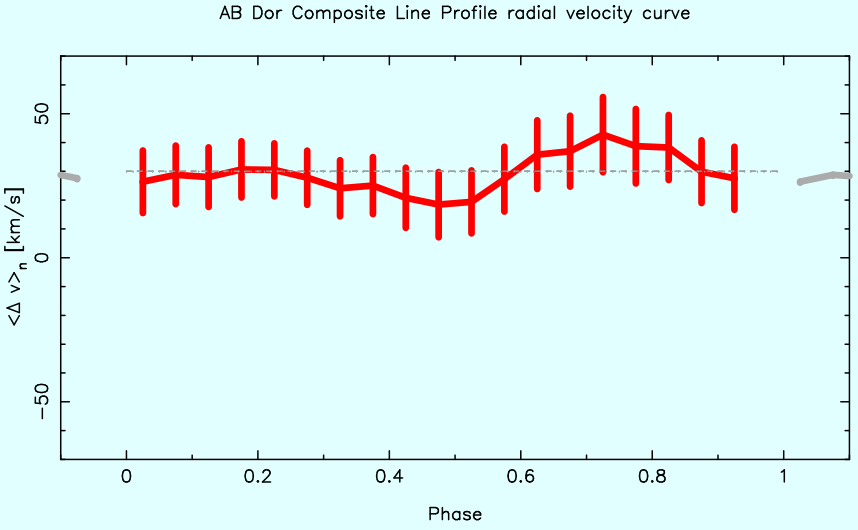


AB Dor (single, $P = 0.51$ d)

one rotation

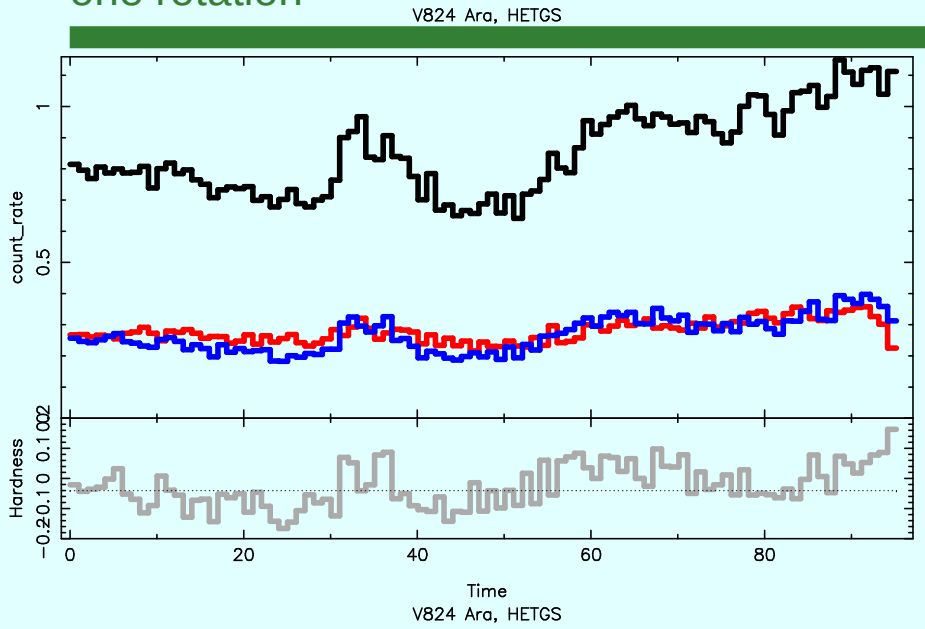


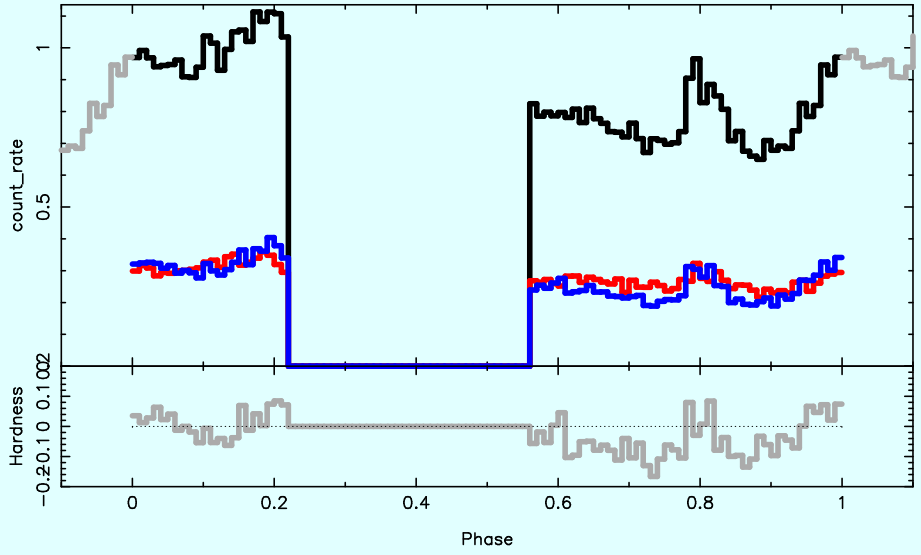


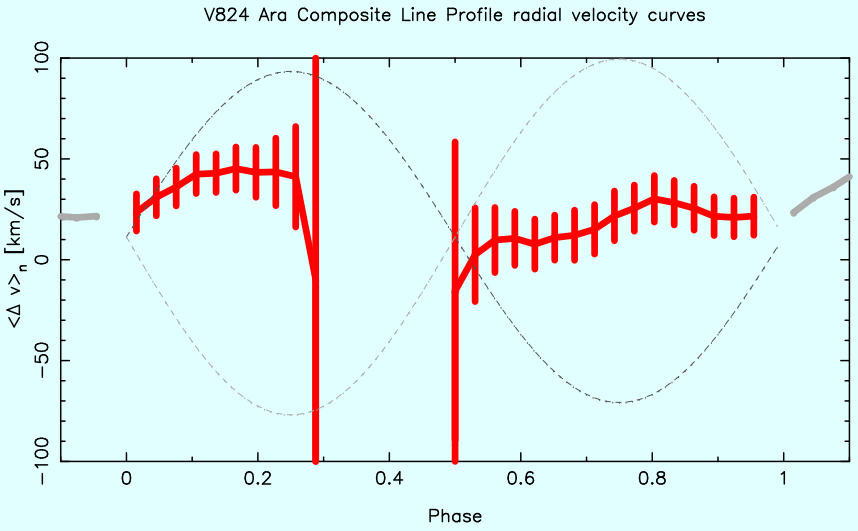


V824 Ara (HD 155555; $P = 1.68$ d)

one rotation

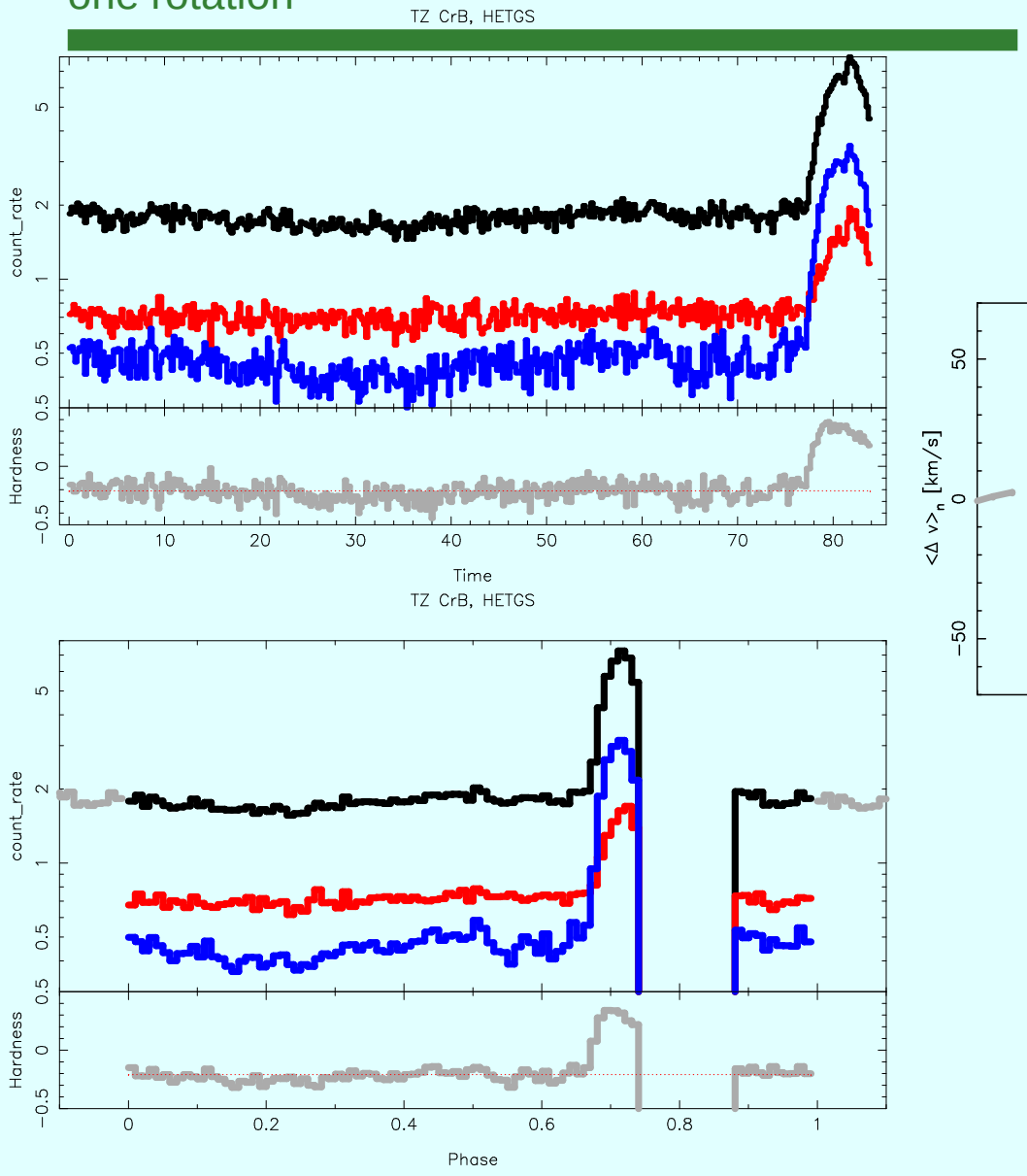


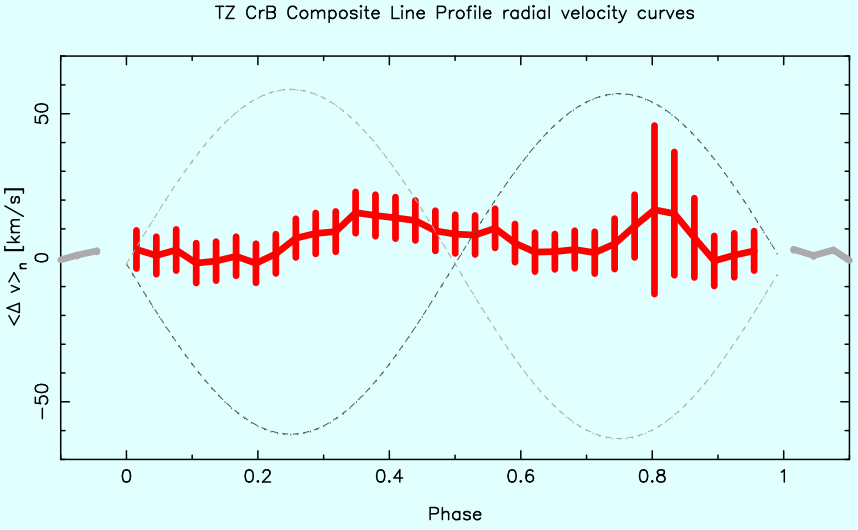




TZ CrB (σ^2 CrB; $P = 1.14$ d)

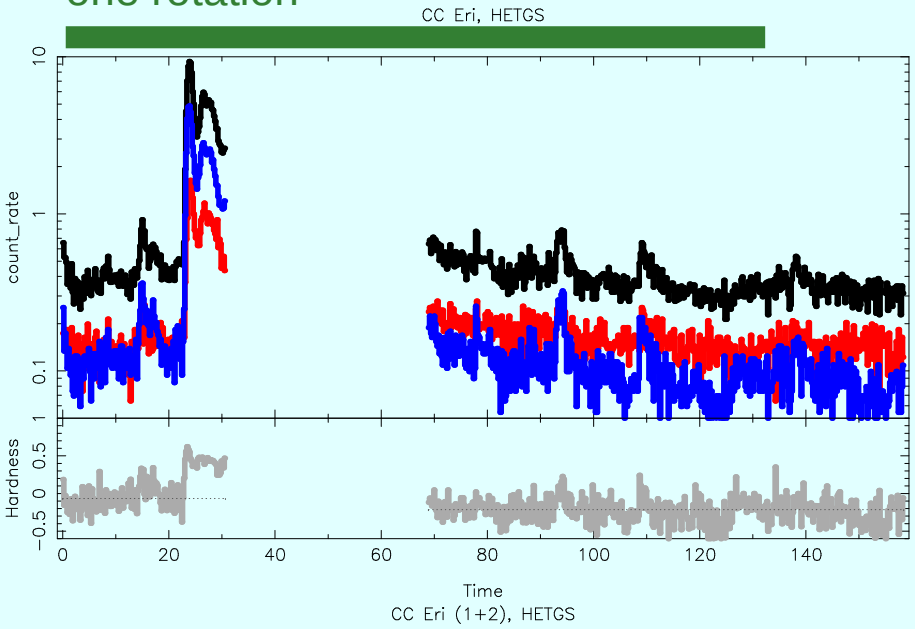
one rotation

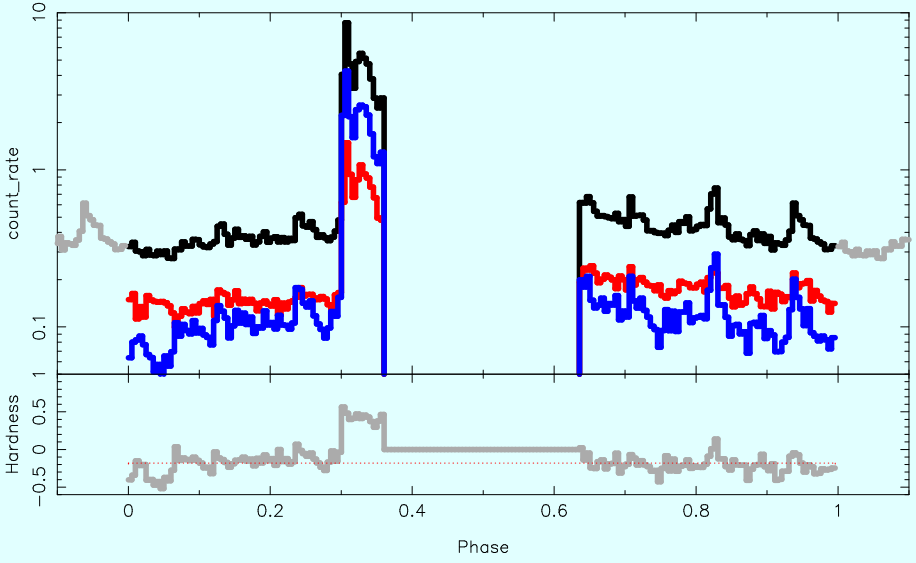


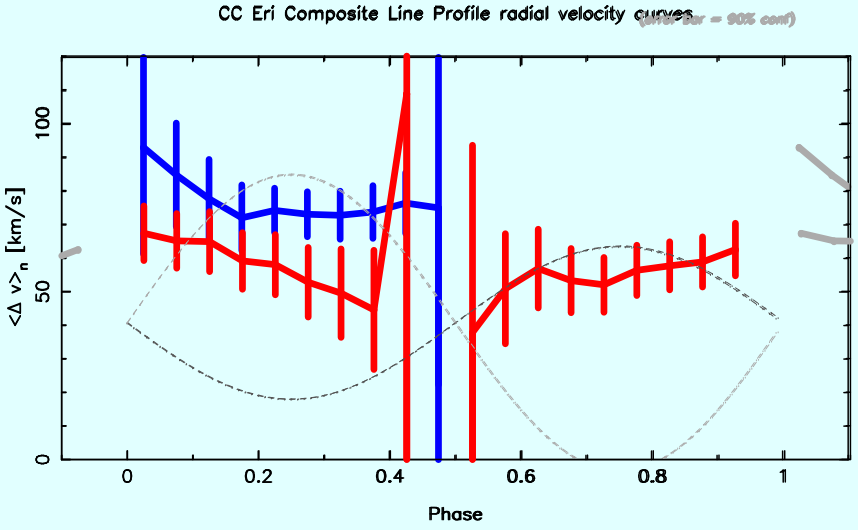


CC Eri (BY Dra type; $P = 1.56$ d)

one rotation







Summary

Selected Short-Period Stellar HETGS Observations

Star	P[d] ([ks])	$t_{\rm exp}$[ks]	$t_{\rm exp}/P$	v-variable?
VW Cep	0.28 (24.2)	117	4.8	yes
44 Boo	0.27 (23.2)	59	2.6	yes
AB Dor	0.51 (44.5)	52	1.2	maybe
ER Vul	0.69 (59.6)	112	1.9	no
TZ CrB	1.14 (98.5)	84	0.8	maybe
CC Eri	1.56 (34.8)	120	0.9	maybe
V824 Ara	1.68 (145.3)	94	0.6	maybe

X-ray line velocities can be used for coronal mapping for some short period/high velocity systems.

Exposure times have been too short to provide necessary redundancy or signal.

Ask for more time! Approve more time!