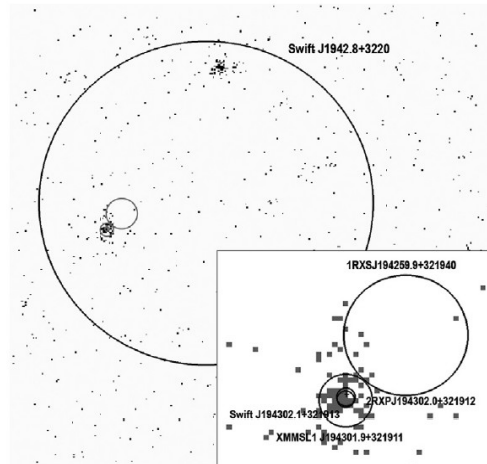


Multi-frequency Evolution of V2491 Cyg (Nova Cyg 2008 No. 2)

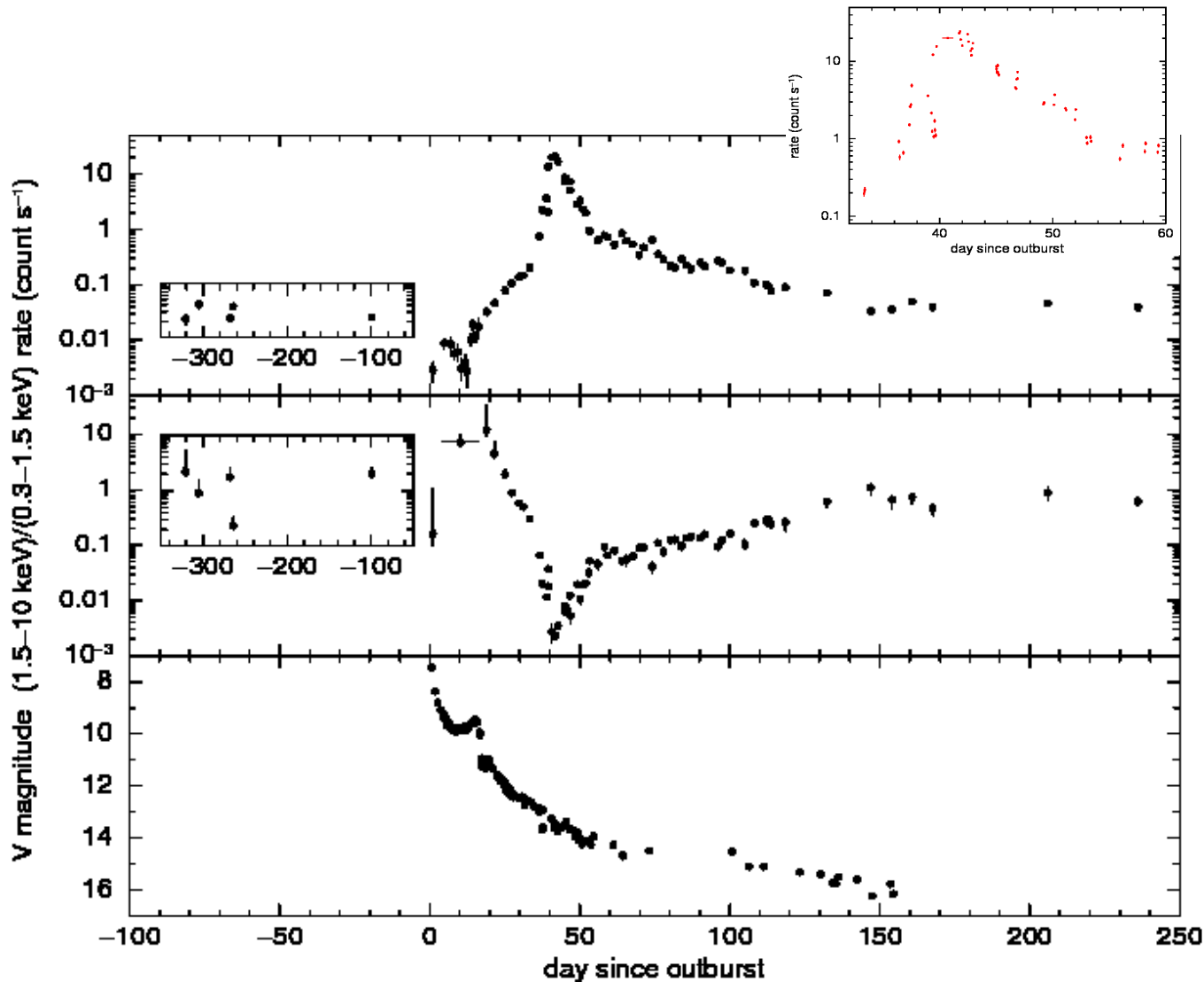
Kim Page

Page et al., 2010, MNRAS, 401, 121
Ibarra et al., 2009, A&A, 497, L5
Ness et al., 2011, ApJ, 733, 70

- ★ V2491 Cyg was detected in nova outburst on 10th April 2008.
- ★ Swift observations started less than a day after the announcement of the outburst.
- ★ UVOT was blocked for the first week and then saturated the detector for the following 2 weeks because the source was too bright.
- ★ The optical source rebrightened around 26th April.
- ★ Serendipitous earlier observations had revealed a pre-nova X-ray source, which was persistent but variable (both in brightness and hardness).
- ★ Detected by Suzaku, up to 70 keV (Takei et al. 2009, 2011).
- ★ No sign of dust formation in the NIR.

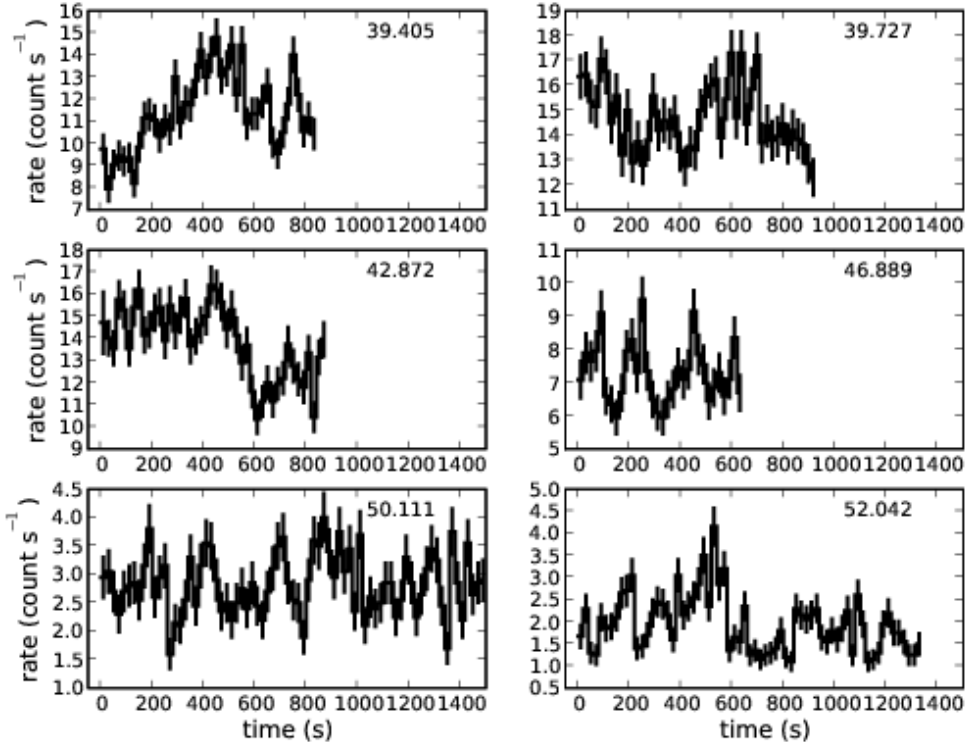


Uncertain whether the BAT detection was V2491 Cyg. Depends on spectral shape and variability.



The X-ray source detected just after outburst was almost an order of magnitude fainter than the serendipitous pre-nova detection.

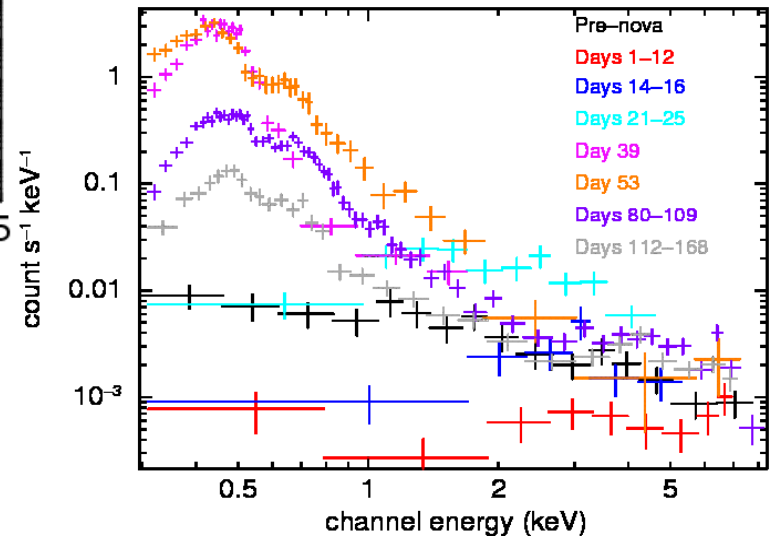
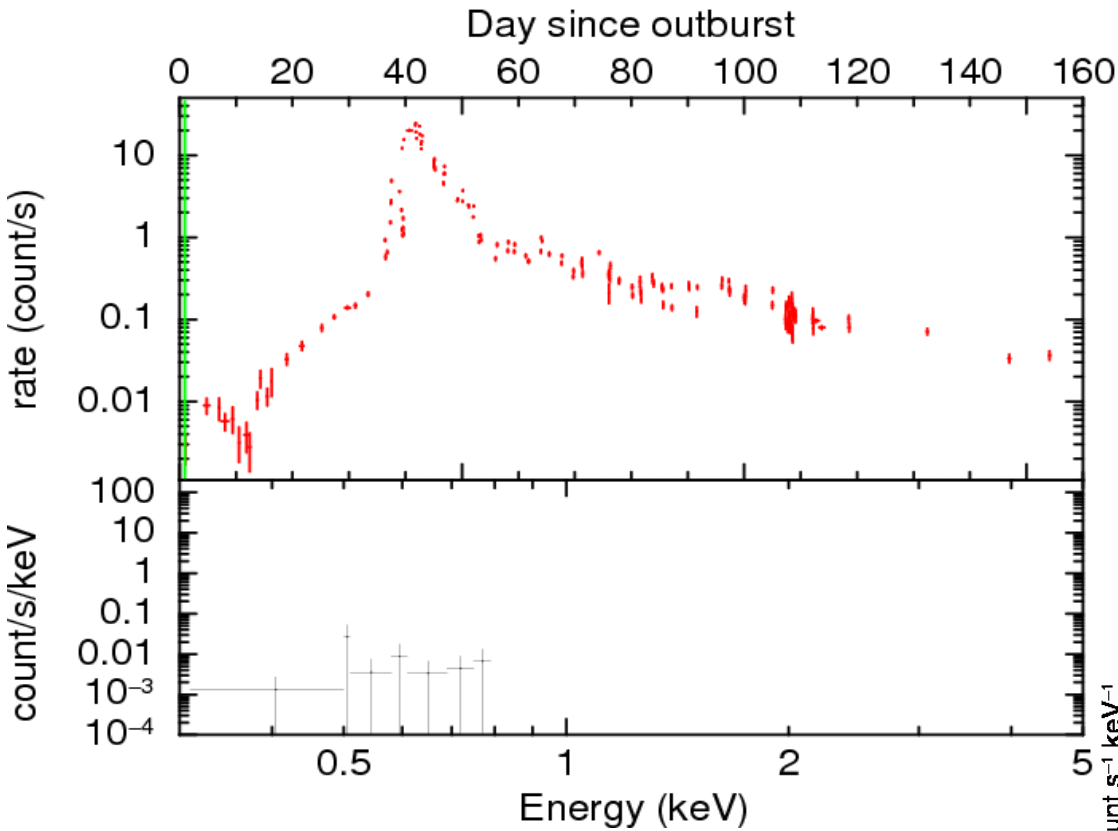
Around day 36 after outburst, the X-ray count rate rapidly increased, with the peak occurring on day 42.

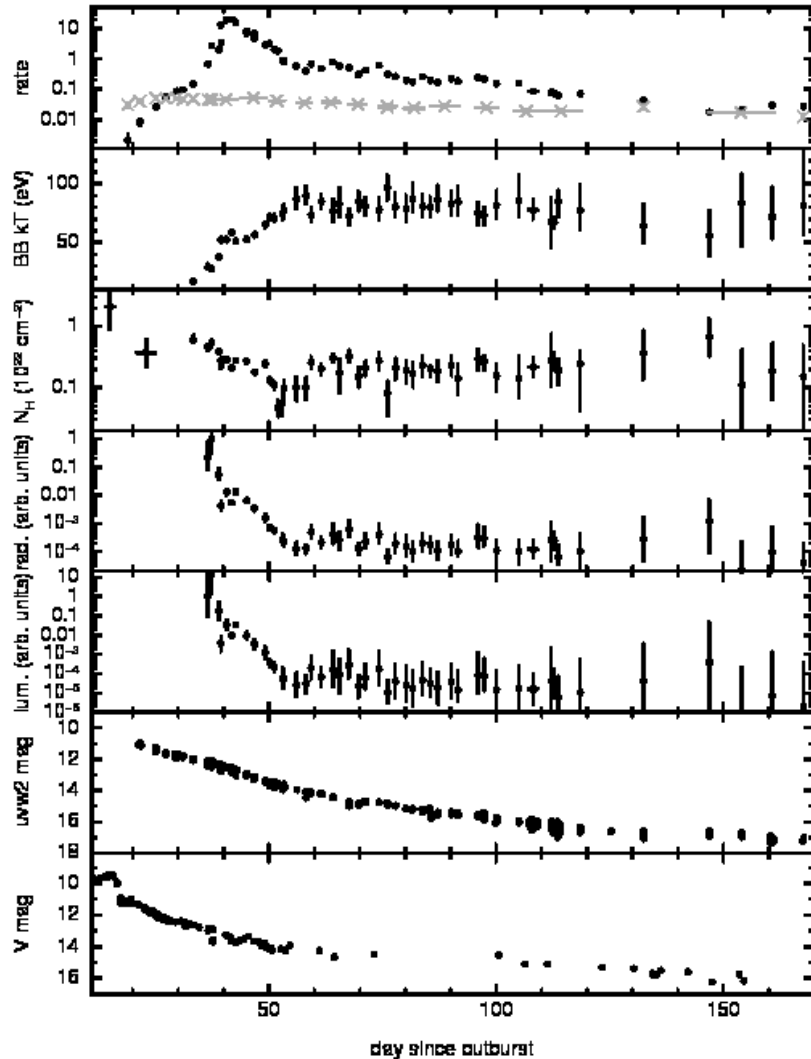


Short-term variability was found in some light-curve segments, but no strict periodicity.

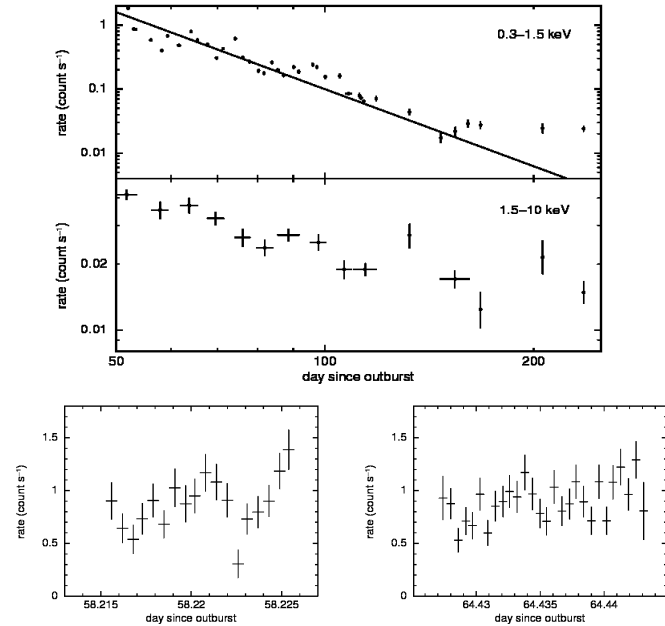


X-ray Spectral Evolution - 1





The hard band (1.5-10 keV; grey crosses) emission does not change much during the SSS outburst.



Flickering (time-scales of a few days and 5-10 minutes) is noticeable in both bands at later time - signature of accretion after around day 57?
See also Suzaku data in Takei et al. (2011)

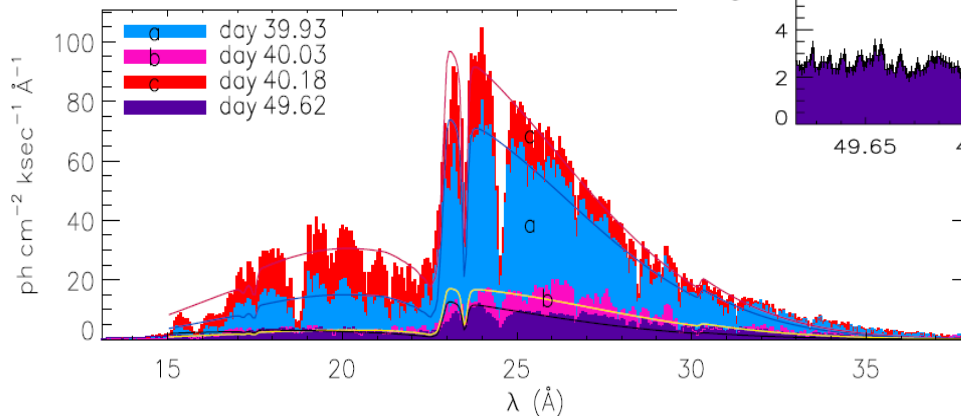
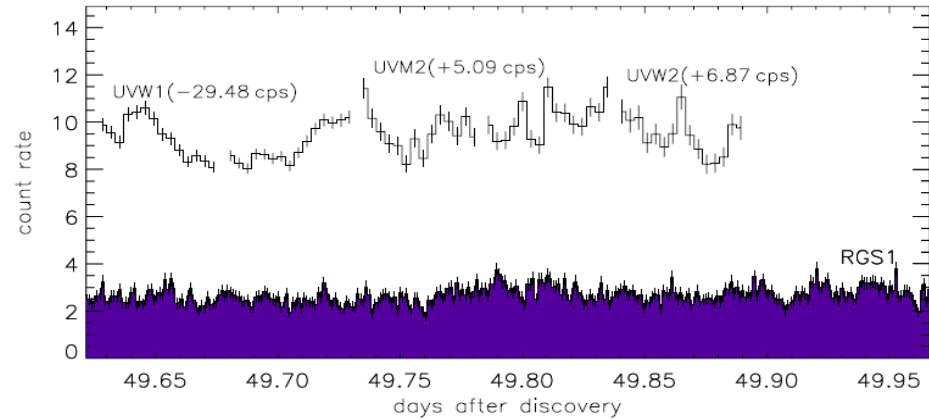
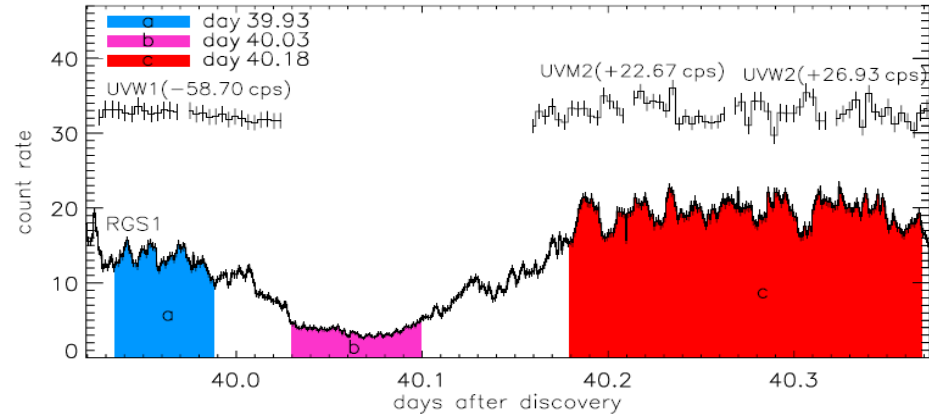


X-ray Spectral Evolution - 3

- ★ Initially, as the X-ray count rate gets higher, BB (or model atmosphere) temperature increases and N_H decreases. Luminosity and radius decrease, too.
 - ★ All level off around day 57, when the lc decay slows
 - ★ The decrease in X-ray CR from days ~42 to 57 is predominantly caused by the (apparent) shrinking of the emitting region; energy released by settling of the cooling envelope and fall-back of mass could contribute to the temperature remaining constant.
 - ★ N_H consistent with the best-fitting value determined from pre-nova data.
 - ★ Some evidence for an iron line at later times; could be seeing reflection as accretion resumes (see, e.g., Done & Osborne 1997).
- ★ UVOT data fade monotonically
 - ★ The decay steepens around the time of the peak X-ray flux (~day 40) and then flattens again at the same time as the X-rays (day 57)
 - ★ The optical data show a slower decay around this later time, too.

Two XMM observations were obtained, just before the peak in the X-ray light-curve and then part way through the steep decline.

The spectra are BB-like with deep absorption features superimposed.

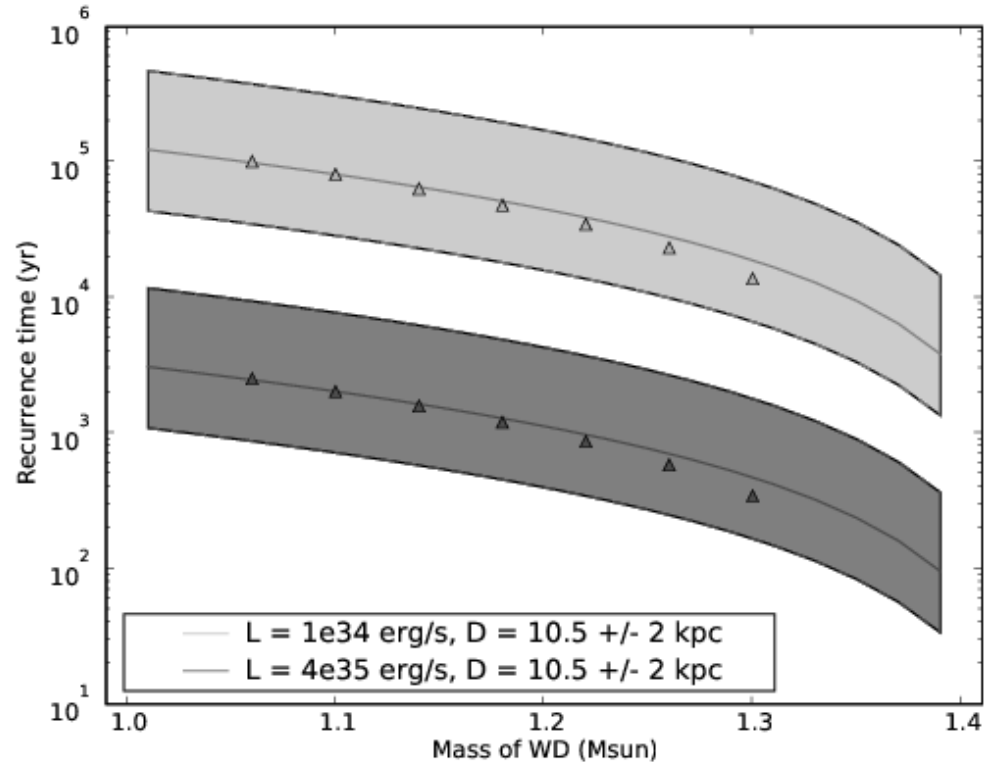


5.9×10^5 K, 6.3×10^5 K, 6.3×10^5 K,
 8.0×10^5 K

A recurrent nova?

- ★ V2491 Cyg is a fast nova
 - ★ High expansion velocities and rapid optical fading.
- ★ X-ray source was detected pre-outburst
 - ★ Implies high accretion rate
 - ★ V2487 Oph was also detected pre-outburst and has since been identified as a RN.

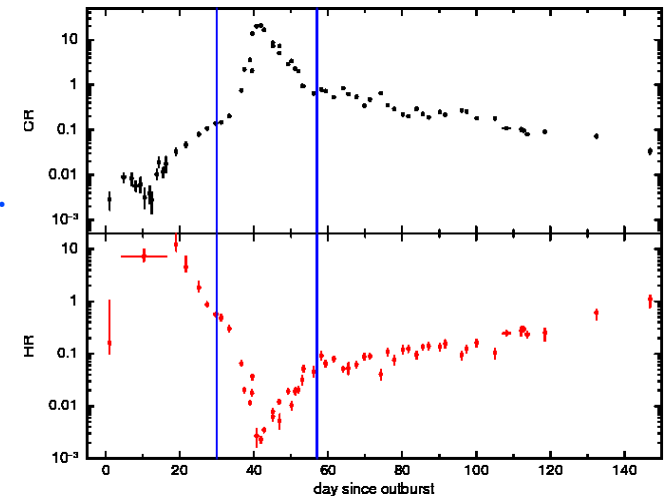
★ Similarities with RN U Sco and V394 CrA in line profiles, lack of forbidden lines and the He/N classification (Tomov et al., ATel 1485)



Plot created using the WD mass-radius relation of Nauenberg (1972; solid curves) and Althaus et al. (2005; triangles).

High M_{WD} means V2491 Cyg could recur over decades, but this hasn't been observed.

- ★ The X-ray emission shows at least 3 separate phases:
 - ★ Early, hard X-ray emission - interpreted as shock emission caused by components within the ejecta having different velocities. The faintness of the earliest detections may be partly due to absorption by the ejected nova shell. As this expands and the ejecta thin, the X-ray emission brightens and the N_H drops.
 - ★ Supersoft source phase - nuclear burning on the surface of the WD. BB temperature rises (due to increasing transparency of photosphere?) and column thins. Contrary to other Swift-monitored novae, there is only a short interval of ~constant count rate: V2491 Cyg turned off very quickly.
 - ★ Decline of the SSS - the hard component fades less rapidly and thus becomes more prominent again. After ~day 150, the decline in X-rays has almost ceased.



- ★ *Something* happens across multi-wavelengths on days 40 (peak in X-rays; “blip” in BB temperature; UV decay steepening) and 57 (decline slows in both X-ray and UV; BB and N_H level off) - but what??