

## Unidentified emission features in the RCB star V854 Cen

Ostrum, Ochsendorf, Kaper, and Tielens, submitted to A&amp;A

## Abstract &amp; Introduction

During its 2012 decline the R Coronae Borealis star (RCB) V854 Cen was spectroscopically monitored with X-shooter on the ESO *Very Large Telescope*. The obscured optical and near-infrared spectrum exhibits many narrow and several broad emission features, as previously observed. The envelope is spatially resolved along the slit and allows for a detailed study of the circumstellar material. In this *Letter* we report on the properties of a number of unidentified emission features (UFs), including the detection of a new one at 8692 Å. These UFs have been observed in the Red Rectangle, but their chemical and physical nature is still a mystery. The previously known UFs behave similarly in the Red Rectangle and V854 Cen, but are not detected in six other observed RCBs. Possibly the presence of some hydrogen is required for the formation of their carrier(s). The  $\lambda 8692$  UF is present in all RCBs. Its carrier is likely of a carbonaceous molecular nature, presumably different from that of the other UFs.

**Key words.** circumstellar matter – stars: individual: V854 Cen

- **R CrB stars:** 突発的な質量放出 & ダスト形成より day-scale で 7-10 等級減光する星 (進化パス未解明).
- **V854 Cen:** R CrB stars の中でも水素輝線および PAH 放射が検出された特異な天体.
- **Red Rectangle (RR):** post-asymptotic giant branch stars のひとつ (R CrB stars とは無関係).
- **Extended Red Emission (ERE):** RR の nebula で検出された可視光放射 (Unidentified Features, UFs).

V854 Cen の減光期のスペクトルには ERE に似た放射バンド (UFs) があることが知られている。

この放射バンドは他の R CrB stars では検出されていない。

V854 Cen は比較的水素が豊富な R CrB star であり異なるダスト化学進化が期待できる？

V854 Cen の減光期に VLT/X-shooter で観測  $\rightarrow$  未同定バンド放射 (UFs) と新たに 8692Å のバンド放射を発見。

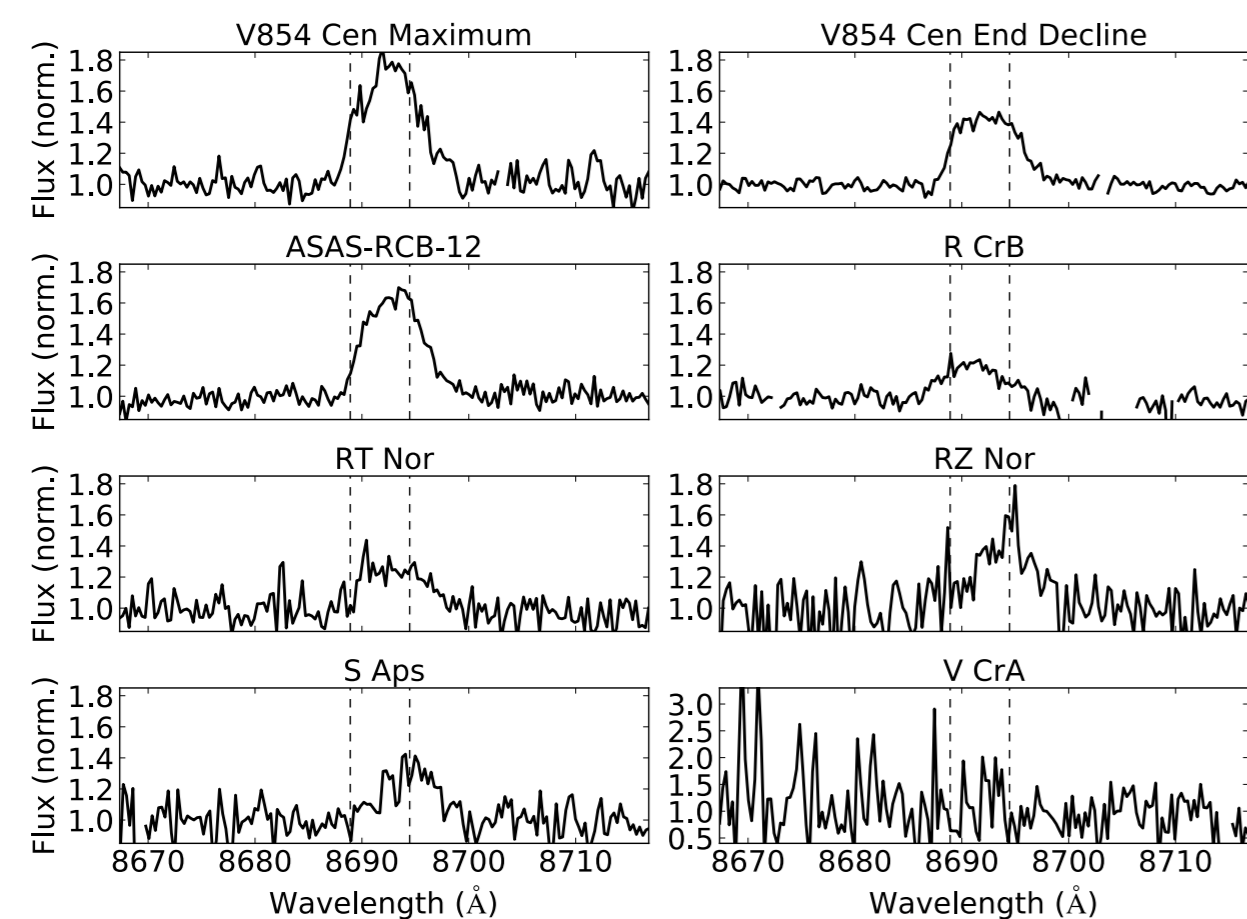
V854 Cen のスペクトルからは 4/7 の UFs を検出 ( $\lambda 5800$ , 5827, 5854, and 6617).

どのバンドも Western(+) 側で卓越,  $\sim 5800\text{\AA}$  のバンドは距離によって blue shifted.

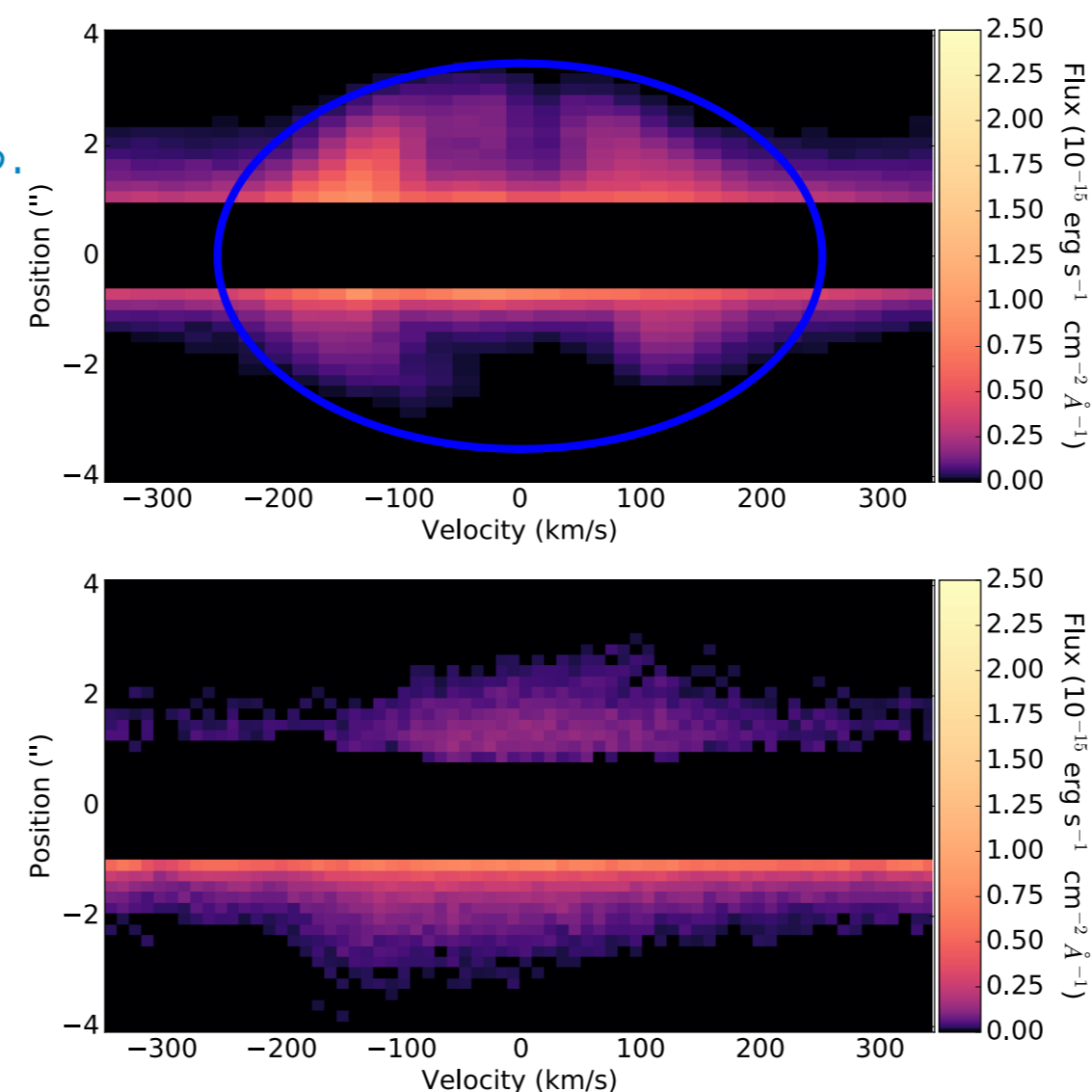
新発見のバンド (8692Å) は他の R CrB stars でも観測したら見えた。

8692Å band は波長シフトの傾向も違う (bipolar outflow?).

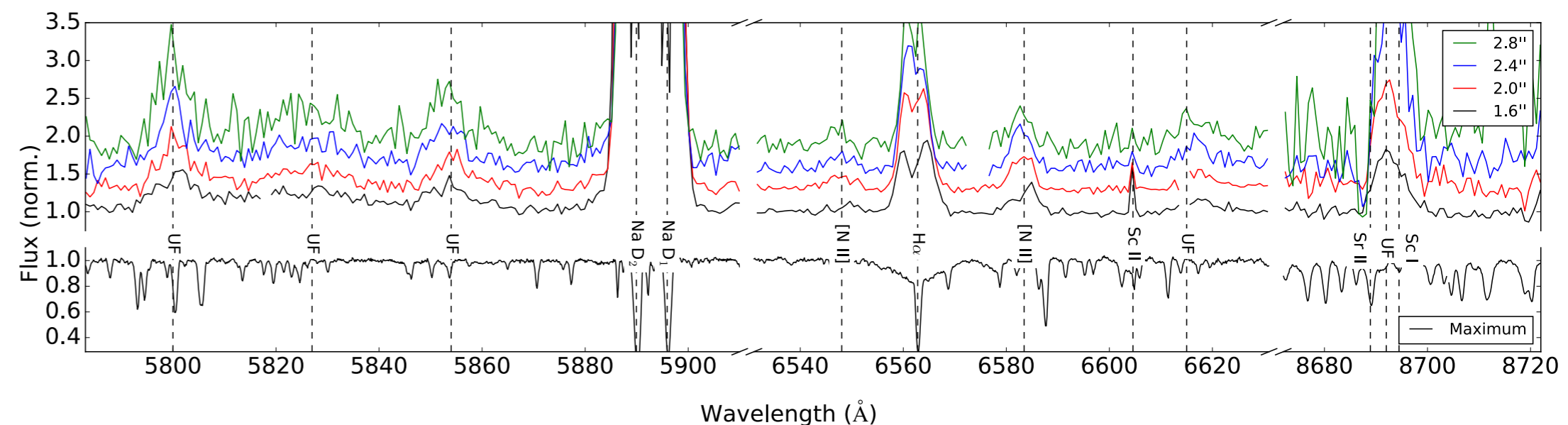
8692Å band は carbonaceous dust によるものだが UFs とは carrier が違うだろう。



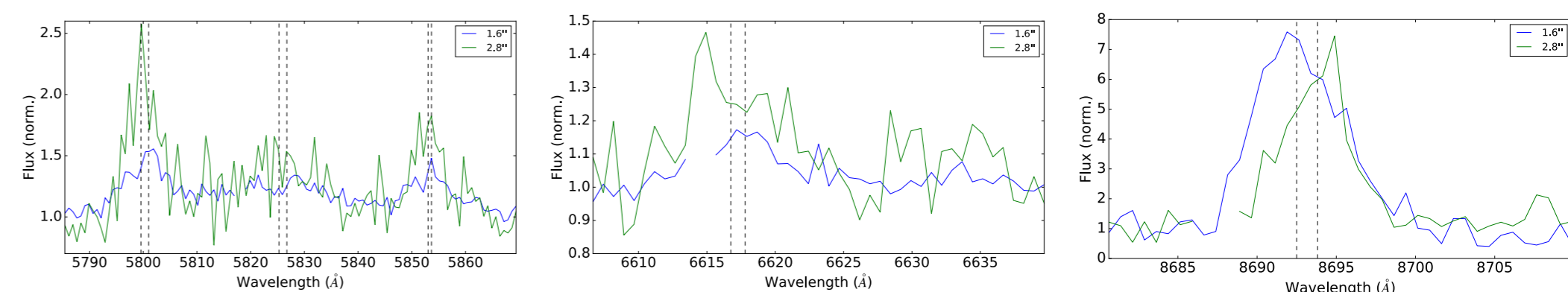
**Fig. 2.** The  $\lambda 8692$  UF in all observed RCBs. The two dashed lines indicate the position of the Sr II  $\lambda 8689$  and Sc I  $\lambda 8694$  photospheric lines. The UF is detected in all except V CrA. The position and intensity of the feature clearly vary between objects. In V854 Cen the feature is also detected during maximum light.



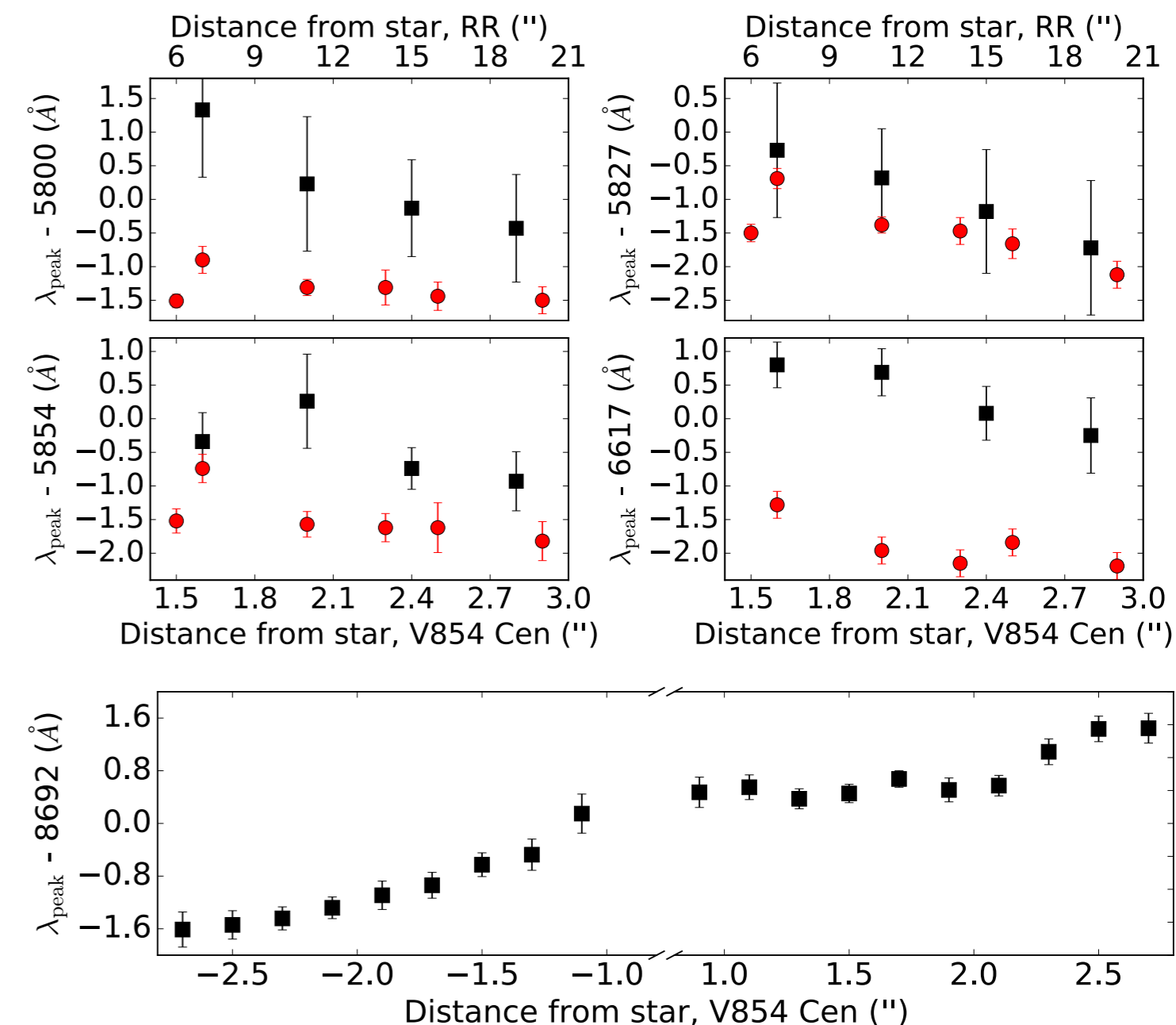
**Fig. 3.** Position along the spectrograph slit (vertical direction) against radial velocity for the Ca II K resonance line (*top*) and UF at 8692 Å (*bottom*) in V854 Cen. The continuum flux has been subtracted and all flux within 0.7'' of the central object has been set to zero to enhance the visibility of these extended features. The thick blue line shows the expected maximum radial velocity at each position for a spherical shell of radius 3.5'' and expanding with a velocity of 250 km s<sup>-1</sup>. One sees that the unidentified feature at 8692 Å is spatially extended as well.



**Fig. 1.** V854 Cen decline spectra at different offsets from the central object (*see inset*) and at maximum light (*bottom spectrum*). During a decline, the absorption spectrum converts into an emission spectrum, the strongest emission lines being the Na I D doublet. Additionally, a sequence of unidentified emission features (UFs) is clearly detected between 5800 and 5860 Å, at 6617 Å, and at 8692 Å. The narrow Y II  $\lambda 6614$  emission line has been removed from the 1.6'' and 2.0'' offset spectra for plotting purposes. The absorption lines near 5800 Å and 5854 Å are due to C I and Ba II, respectively.



**Fig. B.1.** Spectra at 1.6'' and 2.4'' from the central object for all unidentified features. Dashed lines indicate the best-fit peak position for each feature. *Top left:*  $\lambda 5800$ , 5827, and 5854. *Top right:*  $\lambda 6617$ . *Bottom left:*  $\lambda 8692$ . In all features except  $\lambda 8692$ , a blueshift with increasing distance from the central object is observed. The  $\lambda 8692$  feature shifts toward longer wavelengths in the spectra shown here, but it shifts toward shorter wavelengths on the other side of the star. The 1.6'' spectrum of  $\lambda 8692$  has been stretched by a factor 8 for displaying purposes.



**Fig. 4.** Band positions of the unidentified features as function of distance to the central object for V854 Cen (black squares) and the Red Rectangle (red circles). There is no measurement of the  $\lambda 6617$  feature at 6''. Error bars reflect 1 $\sigma$  errors. All RR bands are blueshifted with respect to the corresponding bands in V854 Cen. The  $\lambda 8692$  band is only covered in V854 Cen and is detected on both sides of the star.