

## **NSV 07212 and NSV 07329: Two Probable RCB Stars**

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Working on identifications of objects from the NSV catalog, we found that NSV 07212 and NSV 07329 were two probable variables of the rare RCB type. Both stars enter the ASAS-3 variable-star catalog as “MISC” variables (i.e. those lacking a reliable variable-star classification), with spurious periods. We present the results we obtained for the two variables, mainly from our analysis of the ASAS-3 photometry. NSV 07212, a known carbon star, is a variable with an amplitude as large as 7<sup>m</sup>. Though, in this case, the RCB classification is rather certain, spectroscopy of both stars is needed.

## **1 Introduction**

In the course of our work on new Name-Lists of the General Catalogue of Variable Stars (GCVS), we are undertaking attempts to find stars of the New Catalogue of Suspected Variables (the NSV catalog; Kukarkin et al. 1982) that had no reliable identifications and no accurate coordinates till now. Many stars found in this process have already obtained their permanent GCVS names in the recent Name-Lists (Kazarovets et al. 2008, 2011): after successful identification, it was possible to study them using observations from large CCD surveys of the sky available in the Internet. A part of the results from such studies were published separately, in several papers since 2009 (e.g., Kazarovets and Pastukhova 2011ab); other stars successfully found and studied just enter the Name-Lists with a reference to an unpublished study by the compilers.

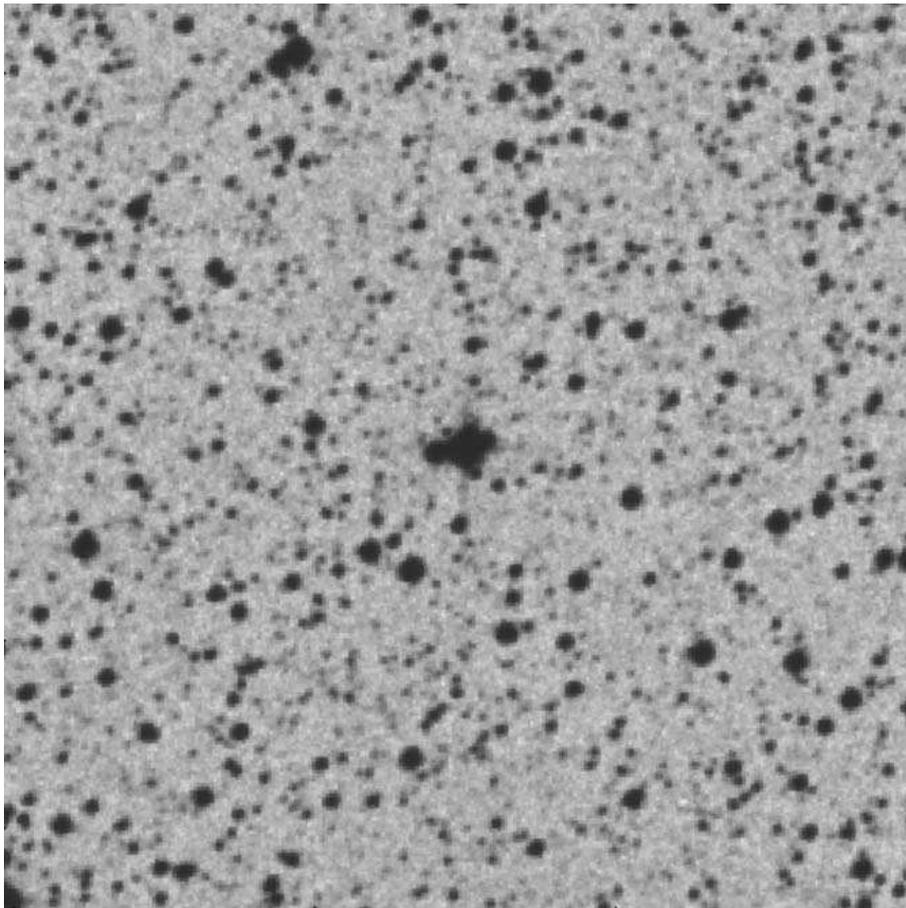
From time to time, this process reveals especially interesting variable stars, deserving further detailed studies. In this paper, we announce two variables probably belonging to the rare RCB stars.

R Coronae Borealis (RCB) stars, named after their prototype, are evolved stars with hydrogen-deficient, carbon-rich atmospheres. From time to time, they exhibit deep fadings, sometimes as deep as 8–9 magnitudes. The deepest fadings can last for hundreds of days. Thus, the prototype star, R CrB, an object of the sixth visual magnitude at maximum light, is currently only beginning to emerge from a fading to 15<sup>m</sup> that already lasts for more than four years. Such fadings are usually interpreted as the result of light absorption by dust produced by the star. Dust production must be related to chemical peculiarities of these stars’ atmospheres. Dust-related are also infrared excesses observed for typical RCB stars. Besides, variables of this type often exhibit pulsations, their periods being of the order of a month.

## 2 NSV 07212

This variable was announced by Luyten (1935) as AN 409.1935 Nor; its provisional Harvard designation is HV 8772. According to Luyten, the star varied between  $13.5^m$  and  $17.2^m$  (photographic magnitudes). Later it entered several catalogs of suspected variable stars (Prager 3952, CSV 2421, NSV 07212) but did not get a permanent variable-star name because no particulars on the character of variations and no finding chart had ever been published.

We identify the variable with the star GSC 08308-01266 ( $11^m4$ ) = IRAS 15407-5035, located in  $1'.5$  to the east of the position published by Luyten. This is the only star around Luyten's position that obviously varies. The difference between our coordinates and those published by Luyten is within typical positional uncertainties of Luyten's publications, as follows from our many-year experience of search for his variables. The 2MASS J2000.0 coordinates of our variable star are  $15^h44^m25^s.077$ ,  $-50^\circ45'01''.21$ , and its 2MASS magnitudes,  $J = 8.832$ ,  $H = 7.695$ ,  $K_s = 6.584$ , suggest an infrared excess. The finding chart is presented in Fig. 1. The star is contained in the General Catalog of Galactic Carbon Stars (Alksnis et al. 2001) as CGCS 3628; the spectral type R quoted there is from unpublished data by C.B. Stephenson.

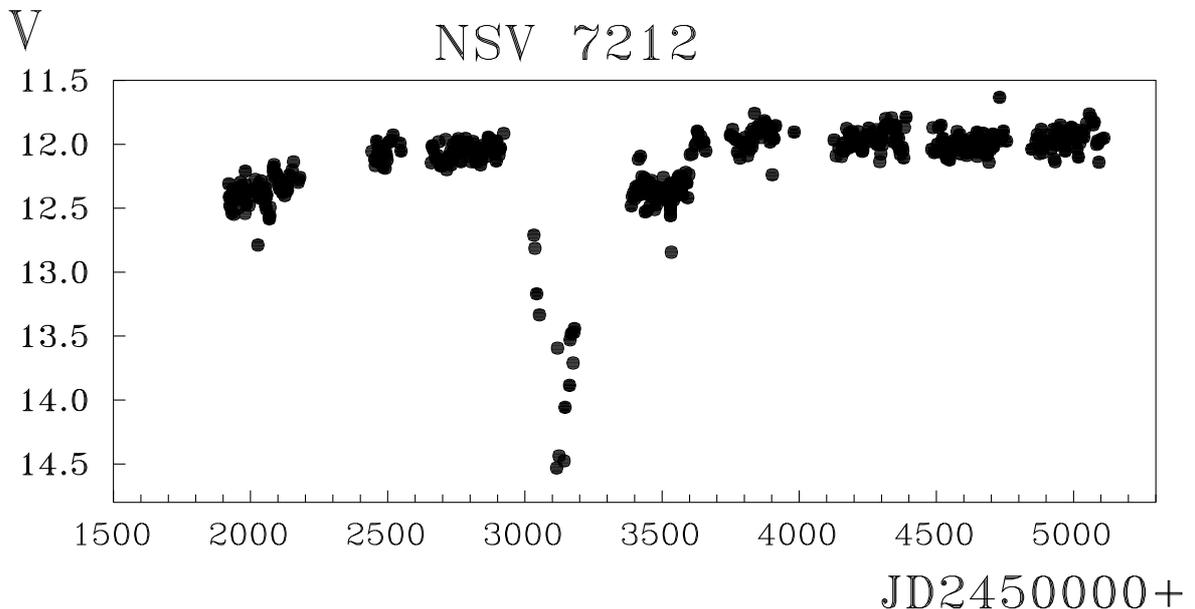


**Figure 1.** The finding chart of NSV 07212 (the bright star in the middle of the blend at the center) from a red USNO Image and Catalog Archive image. North is on top, east is to the west, the side of the square is about  $5'$ .

The star enters the variable-star catalog of the ASAS-3 survey (Pojmanski 2002) as

ASAS 154425–5045.1. It is listed as a MISC (miscellaneous) variable, i.e. an object with a somewhat indefinite variable-star classification; the period tabulated for it is 141.4 days. An inspection of the ASAS-3 light curve folded with this period shows that it is unable to satisfactorily reproduce the observations.

The light curve of the star, based on the ASAS-3 observations available by mid-August, 2011 and covering the time range between JD 2451920 and 2455110, is shown in Fig. 2. It is quite typical of RCB variables. At maximum, the star is about  $11^m8$ – $11^m9V$ . A single deep and broad minimum started between JD 2452922, when the star had been still at  $11^m9V$ , and JD 2453032, already at  $12^m7V$ . At minimum, the star was fainter than  $14^mV$ ; its actual brightness at that time is unknown because of the presence of companions (see below). After JD 2453180 ( $13^m4V$ ), there is a gap in observations till JD 2453387 ( $12^m5V$ ), and it seems that the recovery from the minimum lasted till about JD 2453600.



**Figure 2.** The  $V$ -band light curve of NSV 07212, from ASAS-3 data.

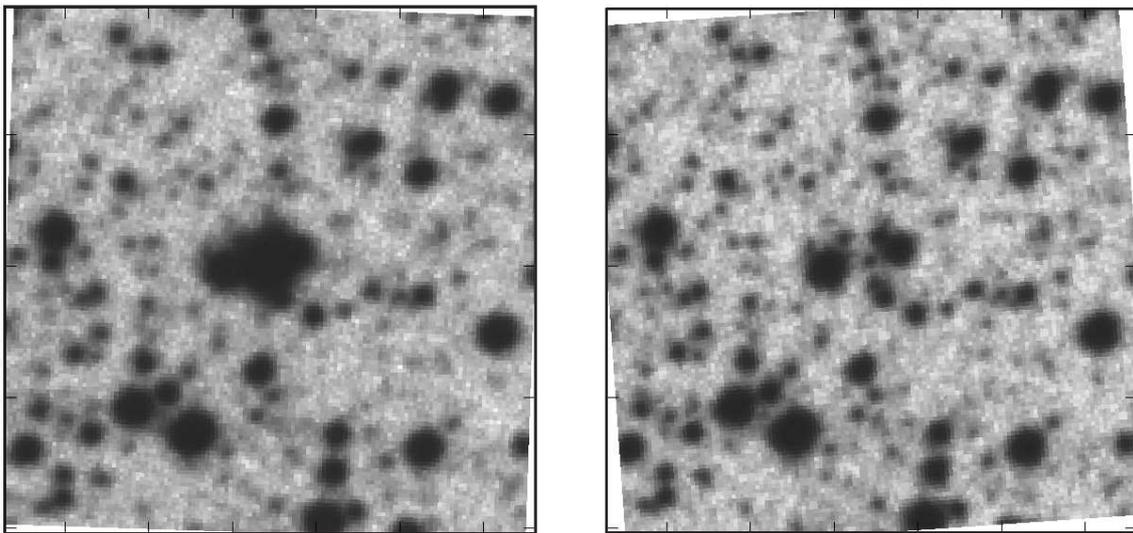
Outside the minimum, there are also variations with an amplitude of several tenths of a magnitude. We were not able to represent these variations with a reliable period, but their timescale seems to be usual for RCB pulsations.

ASAS-3 magnitudes result from CCD photometry with a pixel size of about  $15''$ . The images of the field available from the Aladin Sky Atlas reveal the presence of at least two companions to the star. The brighter of them ( $14^m35V$  in the GSC 2.3 catalog) is in  $10''$  from the variable, at the position angle of  $100^\circ$ . The fainter one is probably at  $15^m$ ; its distance from the variable is  $7''$  and its position angle,  $292^\circ$ . Thus, the variable's magnitude at minimum brightness is seriously influenced, mainly by the brighter companion. However, the fading and brightening rates suggest that the minimum was not *much* fainter than  $14^m$ .

The USNO Image and Catalog Archive (<http://www.nofs.navy.mil/data/FchPix/>) provides five images of the field taken with Schmidt telescopes in 1976–1995, two of them in a broad blue band (J plates) and three, in a red band (IIIaF plates). The first four plates show the variable bright. The fifth plate, AO16588 ( $R$  band, emulsion Kodak IIIaF,

filter OG590), with the epoch 1995.2402, corresponding to JD 2452808, shows the star extremely faint, probably as faint as  $19^m$   $R$ , from a comparison to surrounding USNO-A2.0 stars. We compare this image to the plate AO15068 (epoch 1992.5599) in Fig. 3.

## NSV 7212



**Figure 3.** Two red-band images of NSV 07212 from the USNO Image and Catalog Archive. North is on top, east is to the west, both images have the side of the square about  $2'$ . Left: plate AO15068 (1992.5599); right: plate AO16558 (1995.2402).

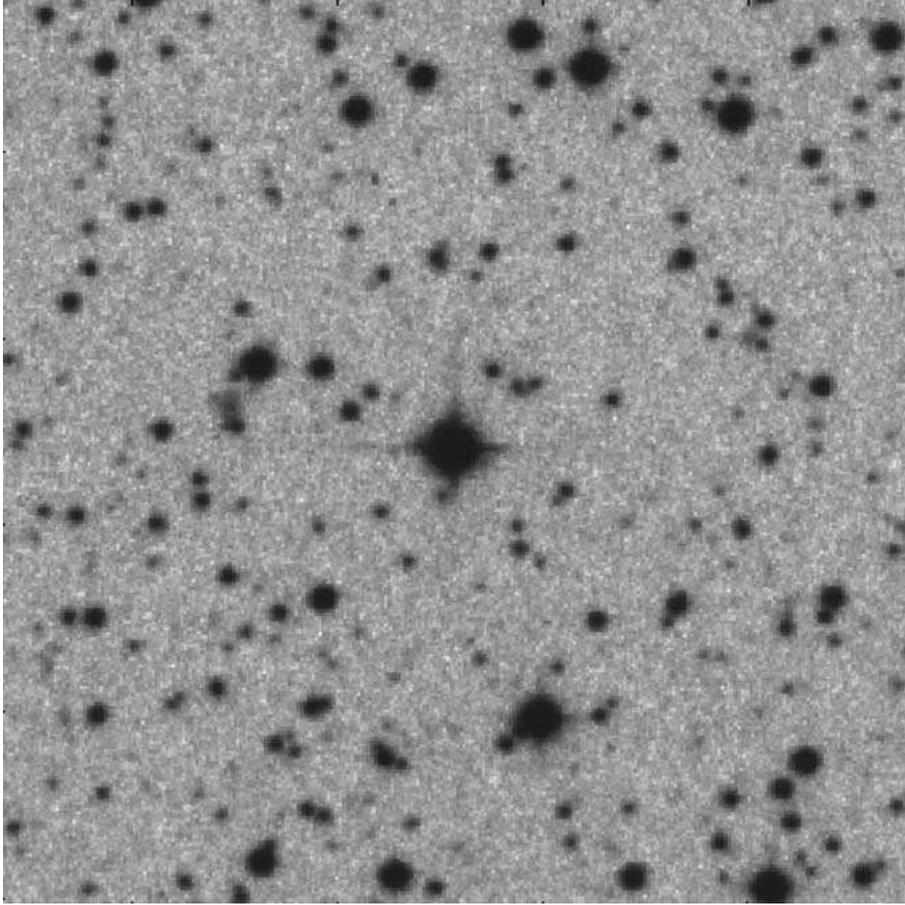
Though additional spectroscopy is desirable in order to check the hydrogen-deficient character of the star's spectrum, we conclude from the existing evidence that NSV 07212 is a *bona fide* large-amplitude RCB variable.

### 3 NSV 07329

NSV 07329 (AN 61.1914 Sco, Zinner 1171, CSV 2497) was announced, among 49 variables, by Lampland (1914). His photographic observations showed the star at  $14^m$  on June 25, 1913 and fainter than  $15^m$  on June 28, 1913. Though Lampland promised to prepare and publish finding charts for his stars, this was never done. The coordinates he published for the new variables are rough, and their reliable identification is a problem. If a certain variable star is found within several arcminutes from Lampland's position, it is usually identified with Lampland's star. In 2008, we adopted the identification of NSV 07329 with the variable star ASAS 155517–2924.6 (approximately in  $4'$  from Lampland's position) in the online version of the NSV catalog. This is the only star in the ASAS variable-star catalog in wide surroundings of the coordinates published by Lampland (1914). Our checks of a number of other stars in the field has not revealed any additional good candidates.

In the ASAS variable-star catalog (Pojmanski 2002), the star ASAS 155517–2924.6 is listed among MISC variables. Its 2MASS coordinates are  $15^h55^m17^s.080$ ,  $-29^\circ24'37''.04$

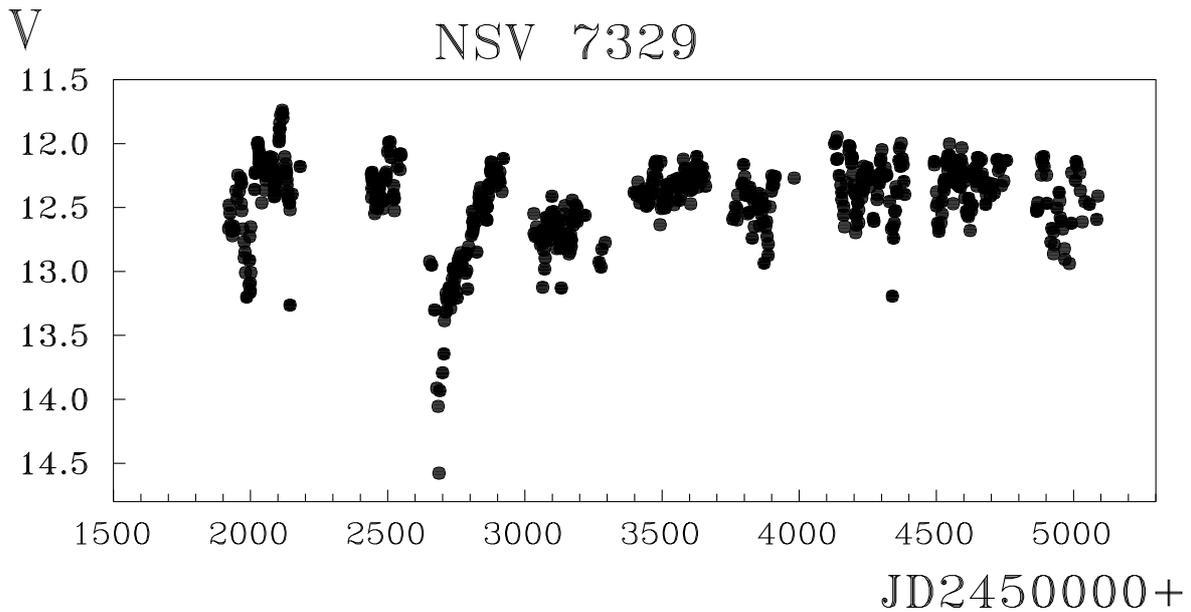
(J2000.0), and, like for NSV 07212, its 2MASS magnitudes ( $J = 7.012$ ,  $H = 6.145$ ,  $Ks = 5.802$ ) suggest an infrared excess. The field is comparatively uncrowded. The finding chart is displayed in Fig. 4.



**Figure 4.** The finding chart of NSV 07329 (the central bright star) from a red USNO Image and Catalog Archive image. North is on top, east is to the west, the side of the square is about  $5'$ .

The ASAS period for ASAS 155517–2924.6,  $435^{\text{d}}1$ , does not provide a satisfactory representation of the ASAS-3 photometry. The light curve from the ASAS-3 survey (Fig. 5) shows variations in the  $11^{\text{m}}8$ –( $14^{\text{m}}V$  range. It reveals a single deep minimum that began between JD 24522548 ( $12^{\text{m}}1V$ ) and 2452652 ( $12^{\text{m}}9V$ ), reached a magnitude below  $14^{\text{m}}V$  at about 2452686, with a subsequent ascent to about  $12^{\text{m}}2V$  by JD 2452900. Oscillations with a rather large amplitude were observed outside this minimum. After JD 2454100, a pronounced cycle of  $58^{\text{d}}4$  can be derived, with a peak-to-peak amplitude up to  $0^{\text{m}}7$ .

We are not aware of any publication concerning the spectral type of NSV 07329. The photometric information available suggests an RCB classification. The star could also belong to a subtype of young variable stars with deep fadings, but the field seems quite free of any nebulae. Spectroscopy of the star is very desirable.



**Figure 5.** The  $V$ -band light curve of NSV 07329, from ASAS-3 data.

#### 4 Conclusions

We have identified the known carbon star NSV 07212 as an almost certain RCB variable with a large variation amplitude, from  $11^m8V$  to about  $19^mR$ . Two deep minima of the star have been recorded so far.

NSV 07329 is a possible RCB variable, varying from  $11^m8V$  to fainter than  $14^mV$ . Only one deep minimum has been detected so far.

High-quality spectroscopy is needed to finally establish the nature of these two interesting variable stars.

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