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Cataclysmic and RCB Type Candidates for Identification of Three Suspected Variables

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I report the discovery of two cataclismic variable stars as probable candidates for identification of the Luyten's variable HV 9251 (NSV 10231) and Wolfs' object AN 115.1905 (NSV 12542). I also suggest the possible RCB variability type for Hoffmeister's star S 9384 (NSV 11988).

1 Introduction

This paper deals with three stars from the NSV catalog: NSV 10231, NSV 11988, and NSV 12542. The first of them, without a published finding chart and with rough coordinates only, was virtually lost for decades. The second one, though easier to identify, remained poorly studied. The third star could be selected from three stars, close to each other, in the position marked on the finding chart.

In the course of my systematic work on identification of NSV stars, I have been able to find that these three stars probably belong to comparatively rare and rather interesting types of stellar variability.

2 NSV 10231 and NSV 12542

The first variable, HV 9251 = NSV 10231, was reported by Luyten (1935). Its photographic variability range was announced as 17.0 – < 18. A finding chart was never published, and, the coordinates provided by Luyten being only rough, its actual location remained unknown. The discoverer presented no information on the star's variability type.

In the course of our work on new electronic version of the NSV catalog (Kholopov et al. 1982), I determine, in particular, accurate positions of the stars and aspire to recover all suspected variables lacking published finding charts. Looking for an identification candidate for the Luyten's variable HV 9251, I noticed the star USNO-A2.0 0375-34430892 = USNO-B1.0 0430-0752563 = GSC 2.3 SA03005977 ($18^{\rm h}08^{\rm m}41^{\rm s}.419$, $-46°54'47''.79$, J2000, epoch 1992.555, from the GSC 2.3 catalog) showing strong variability between the red DSS images of two different epochs.

The variable was at its high stage ($R \sim 15.9$) on the 1985 July 15 plate (ESO.R-MAMA) and at its low stage ($R \sim 17.8$), on the 1992 July 22 plate (AAO.R-DSS2) from the Aladin Sky Atlas. The R magnitudes were estimated using red magnitudes of comparison stars from the A2.0 catalog. The star is also at its quiescence level on several DSS plates in different bands (two V, three R, and two infrared plates) from the STScI

Archive. The corresponding epochs are: 1987 September 13 and 17 (V); 1993 April 18, 1996 August 24, and 1998 July 16 (R); 1981 April 26 and 1987 July 4 (IR). The $5' \times 5'$ fragments of the 1985 and 1992 red plates are shown in Fig. 1.

Individual magnitudes from catalogs are the following. USNO-A2.0: $B = 18.9$, $R = 15.9$; USNO-B1.0: $R1 = 16.18$, $R2 = 18.05$, $B2 = 19.58$, $I = 17.86$; GSC 2.3: $F = 18.05$, $Bj = 16.42$, $V = 16.99$, $N = 17.40$. The epoch of the USNO-A2.0 red plate is 1980.075, but, unfortunately, we could not find access to the epochs of USNO-B1.0 and GSC 2.3 observations. It is possible to suppose that another outburst was detected at the USNO-A2.0 epoch, and maybe also at least at one of the unknown USNO-B1.0 and GSC 2.3 plate epochs. (The epoch of the star's coordinates given in the GSC 2.3 catalog is 1992.555, coinciding with that of the red plate in the right panel of Fig. 1, where the star is faint; the mean epoch of observation quoted in the USNO-B1.0 catalog, 1985.0, does not coincide exactly with those for any of the plates listed above.)

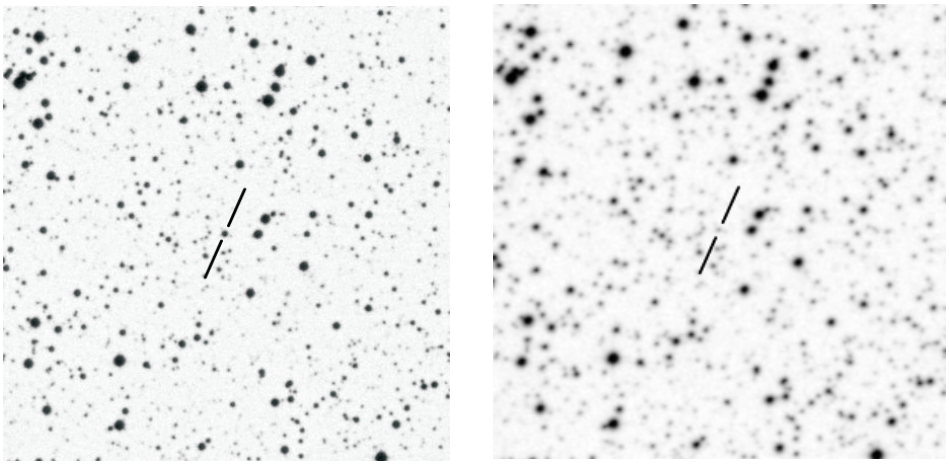

Figure 1.
USNO-A2.0 0375-34430892 on the red DSS plates. Left: 1985 July 15; right: 1992 July 22. The field is $5' \times 5'$; north is on top, east is to the left.

The star is not contained in the 2MASS catalog, thus it is not strongly colored. Its very low brightness on two DSS IR plates seems to rule out the possibility of its being a red flare star. Use of publicly available electronic archive of CCD observations of the Catalina Sky Survey (Drake et al. 2009) for our southern star was excluded, there being no data in the Milky Way zone. The star is too faint ($V > 15.0$) for CCD observations of the ASAS-3 project (Pojmanski 2002). The object does not enter the photometric and spectroscopic catalog of the Sloan Digital Sky Survey III (Ahn et al. 2012). Also, the field is not in any X-ray catalogs.

However, our variable is the UV source GALEX J180841.4-465447 (nuv = 18.14). Therefore I believe that the object in question is a cataclysmic variable, likely a dwarf nova of the UG type.

Returning to the identification problem for the Luyten's variable, the cataclismic variable is 1.′4 to N–NW from the position published by Luyten. This is a usual error for Luyten's measurements of coordinates for his stars, as it follows from our many-year experience of searching for his variables. The photographic brightness and variability range for HV 9251 (see above) are in a very good agreement with the range of variability and

brightness we find for our probable cataclysmic star. I find no other variable stars in the $10' \times 10'$ field around Luyten's position. Based on these findings, I suggest to consider that USNO-A2.0 0375-34430892 and HV 9251 are the same object.

The second candidate cataclysmic variable, NSV 12542, featured a stronger outburst than the first one. I discovered it and identified with USNO-A2.0 0975-17056159 = USNO-B1.0 0989-00509811, with the coordinates $19^{\rm h}54^{\rm m}33\overset{\rm s}{.}035$, $+08^\circ54'17\overset{''}{.}44$ (J2000, epoch 1971.5) from the USNO-B1.0 catalog. I believe that this is the star whose outburst was discovered by Wolf & Wolf (1905). They reported the star AN 115.1905 to be bright on a single plate (1905 September 18), while it was invisible on three other plates taken in 1901, 1903, 1904. A finding chart was published. In the NSV catalog, the star is numbered NSV 12542; its variability range is given as $15- < 17$ pg.

When identifying the variable discovered by Wolfs using their finding chart, I found that the circle on the finding chart that marks the variable covers three faint stars; they form a triangle with $4''-5''$ sides. It seemed improbable to positively identify the variable with one of the three candidates.

Like in the previous case, I compared images from the Aladin Sky Atlas: fragments of the POSS I plates (red and blue, 1950 July 11) and of the POSS II plates (red, 1991 July 17, and blue, 1990 July 27). The faintest star of the triangle was found unusually bright on the two POSS I plates from the same night. Its brightness estimates made with similar use of comparison stars are: $B \sim 19.6$ (POSS II, J), $B \sim 15.0$ (POSS I, O), $R \sim 18.8$ (POSS II, F), $R \sim 15.1$ (POSS I, E). The object is faint in quiescence and located in the Milky Way band, and thus, for one or both of these reasons, is not contained in the 2MASS, GSC 2.3, GALEX, SDSS, X-ray catalogs or in the ASAS-3, Catalina sky surveys. Individual estimates, without clearly indicated observation epochs, can be found in the USNO-B1.0 catalog: $B1 = 15.32$, $B2 = 20.38$, $R1 = 18.49$, $R2 = 19.01$. The brightness estimates from the USNO-A2.0 catalog ($B = 14.9$, $R = 14.5$) are based on the POSS I plates (1950) and have the same epoch as our POSS I estimates. However, moderate angular resolution results in noticeable influence from nearby faint neighbor stars in A2.0 magnitudes. We can assume that the bright USNO-B1.0 B-band estimate is based on the first Palomar survey.

Figure 2 displays $2' \times 2'$ fragments of the 1950 and 1990 blue plates.

The STScI archive contains, besides the four above-mentioned images of the sky region in question, two more blue (1953 September 5 and 1990 August 13), two V-band (both taken on 1982 June 24), two R-band (1953 September 5 and 1991 July 13), and two infrared (1994 June 3 and 1995 July 22) plates. The star's brightness is at the minimum level on all of them. Thus, judging from brightness estimates at maximum (from the same observing night!), we can assume that the star is not strongly colored and maybe even bluish. Two outbursts by $5^{\rm m}$ recorded, presumably for the same object, in half a century suggest that, by its nature, the star is a cataclysmic, UG-type variable.

3 NSV 11988

The third variable, S 9384 = NSV 11988, was announced by Hoffmeister (1966), who also published a finding chart. According to him, the star slowly varies between 13.5 and 14 (pg) and is moderately red.

I identify this variable with the star GSC 03929–01166 (12.3) = IRAS F19222+5655. The coordinates from the 2MASS catalog are $19^{\rm h}23^{\rm m}13\overset{\rm s}{.}104$, $+57^\circ00'55\overset{''}{.}58$ (J2000, epoch

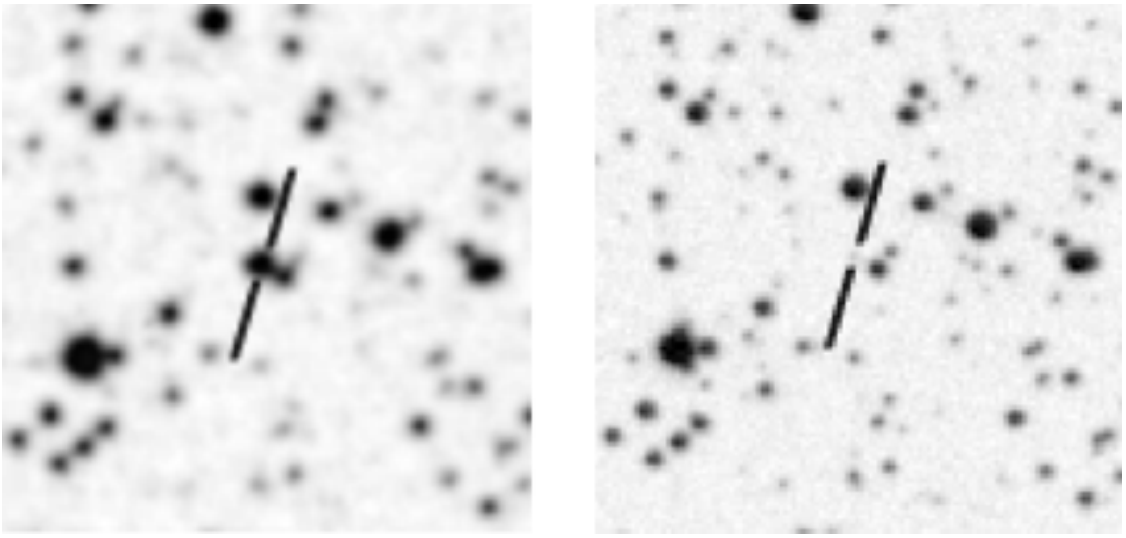

Figure 2.
USNO-A2.0 0975-17056159 on the blue DSS plates. Left: 1950 July 11; right: 1990 July 27. The field is $2' \times 2'$; north is on top, east is to the left.

2000.340), and the magnitudes $J = 7.927$, $H = 7.039$, $K = 6.759$ suggest an infrared excess.

A $5' \times 5'$ finding chart for this variable is shown in Fig. 3.

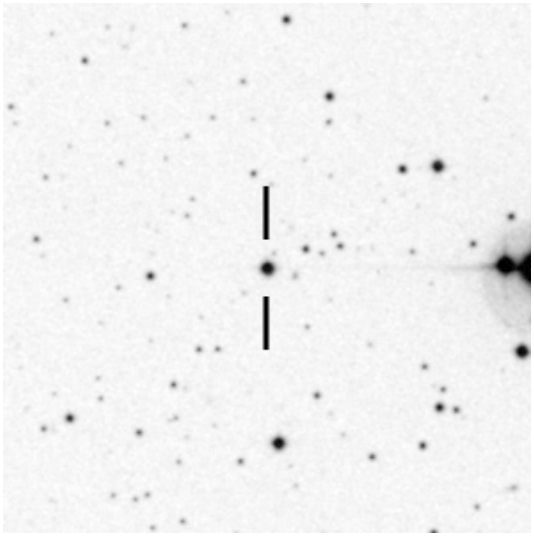

Figure 3.
The finding chart of NSV 11988 from a blue STScI DSS Archive image. The field is $5' \times 5'$; north is on top, east is to the left.

The authors of the ROTSE1/NSVS project (Woźniak et al. 2004) suggest the variability type L: and period of $374^{\rm d}$ for this variable. The light curve of the star, based on the observations of the NSVS object ID 3070388, is shown in Fig. 4. These unfiltered broad-band (450–1000 nm) CCD observations (called $R1$) cover the time range between JD 2451274 and 2451633. The light curve shows variations between 10.8 and 11.6 ($R1$). At maximum, the star is 10.8–11.0 ($R1$). A single deep minimum began after JD 2451452

and reached the bottom in 40 days. Then, we see a gradual brightness increase, nearly to the maximum at the end of the observational interval. Oscillations with a small amplitude were observed outside this minimum, the cycle being about $59^{\rm d}.0$. I am not aware of any publications concerning the spectral type of NSV 11988; however, the photometric data suggest that it is a quite typical RCB variable. Spectroscopy of the star is urgently needed.

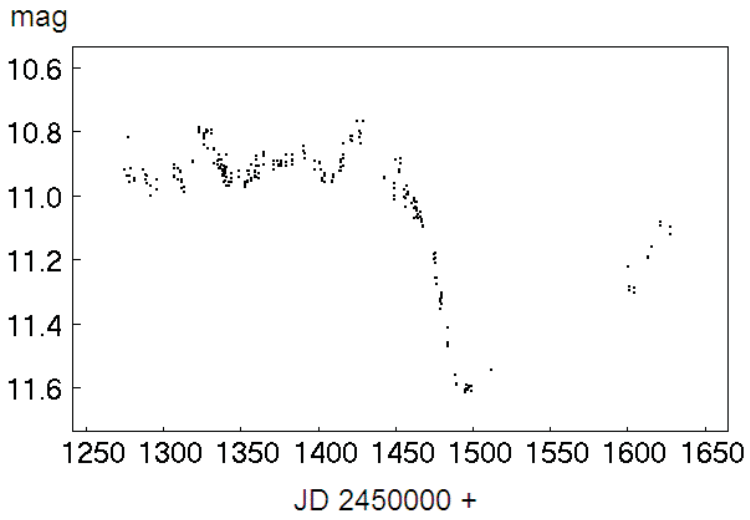

Figure 4.
The unfiltered light curve of NSV 11988 from ROTSE1/NSVS data (260 good points).

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