OBSERVATIONS OF THE SUSPECTED RR LYR STARS NSV 14172 AND NSV 14264

J.F. Le Borgne[1,2,3]

[1] GEOS (Groupe Européen d'Observations Stellaires), http://geos.upv.es

[2] IRAP; OMP; Université de Toulouse; 14, avenue Edouard Belin, F-31400 Toulouse, France

[3] LAM, Laboratoire d'Astrophysique de Marseille, 38 Rue Frédéric Joliot Curie, F-13013 Marseille, France

Abstract

NSV 14264 and NSV 14172 are suspected to be variable stars of RR Lyr type (Brun, 1964). They were observed during three nights in October 2018 with a 25cm diameter telescope. These observations completed by ASAS-SN survey data bring to the conclusion that these two stars are not RR Lyraes but constant stars in the limit of the precision of the present photometry. The analysis of GAIA data allows to say that NSV 14264 is a main sequence dwarf similar to the Sun but that NSV 14172 is a yellow giant star located in the HR diagram at the limit between RR Lyraes and CW cepheids; however, it does not pulsate with significant amplitude.

1 Introduction

NSV 14172 and NSV 14264 were introduced in the suspected variable catalog (Samus et al., 2017) after the publication by A. Brun of a list of variable star candidates (Brun, 1964). These 2 stars were suspected to be of RR Lyr type and have numbers 49 and 59 respectively in Brun (1964). The observations were done by R. Weber between August 1959 and December 1962 using a photographic camera. The range of photographic magnitudes are 12.5 to 13.6 and 12.2 to 13.4 respectively. It is surprising that such bright stars are still suspected and that no publication reporting on their real status is available. In the present paper we report observations of these two stars made on October 3, 4 and 5, 2018 in order to clarify their photometric properties.

2 Observations

The observations were made in J.F. Le Borgne's private observatory (EsO) in Escalquens (Occitania, EU) using a 10 inches diameter newton f/4 telescope (Skywatcher) equipped with a CCD camera (Apogee Alta F9000, KAF-09000) and optical aberration corrector giving a field of $2°\times2°$. A Johnson R filter was used with an exposure time of one minute.
Usual dark and flat-field corrections were done with the use of the software *IRAF* running on a fedora linux system. Astrometry was performed using *imwcs* part of *WCSTools* package[1] and photometry using *SExtractor* program (Bertin & Arnouts, 1996).
NSV 14264 was observed on October 3 and 4, 2018 and NSV 14172 on October 5, 2018 (table 1). Each night, images were continuously acquired during more than 10 hours. The number of images obtained are between 439 and 457 per night. The comparison and check stars for each star are given in table 2 were data from UCAC4 catalog (Zacharias et al., 2013) are given.

[1] http://tdc-www.harvard.edu/wcstools/

The magnitudes of the studied stars are obtained by adding the UCAC4 SDSS r magnitude of comparison star to instrumental magnitude differences.

Date 2018	JD	duration	star	Mean magnitude	standard deviation	Number of measurements
October 3	2458395	10h10mn	NSV 14264	11.459	0.011	439
October 4	2458396	10h32mn	NSV 14264	11.460	0.010	457
October 5	2458397	10h03mn	NSV 14172	12.425	0.013	445

Table 1 – Nightly information about observations.

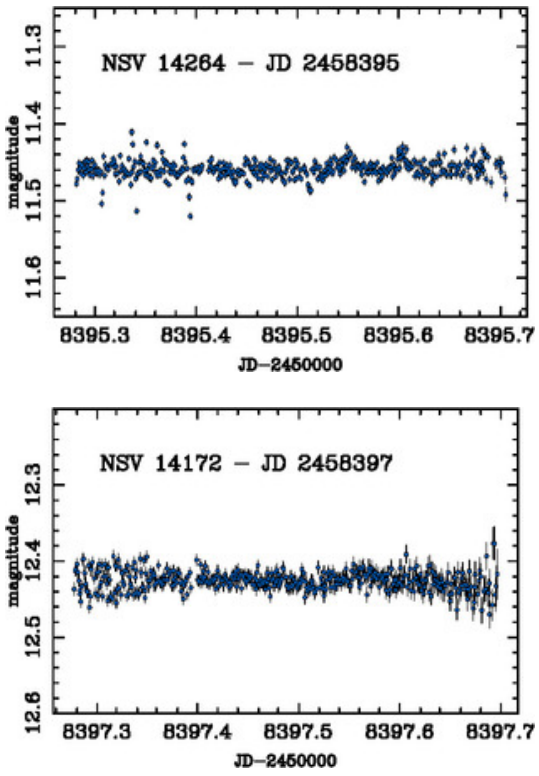
	UCAC4	ra(J2000)	dec(J2000)	B	V	r	B-V
NSV 14172	674-114332	22:28:42.9422	+44:39:42.240	13.411	12.692	12.477	0.719
comp. star	674-114331	22:28:42.6767	+44:45:36.732	13.252	12.678	12.527	0.574
check star	674-114345	22:28:50.5750	+44:38:58.040	13.413	12.857	12.700	0.556
NSV 14264	685-122818	22:39:04.7963	+46:49:57.021	12.949	11.983	11.700	0.966
comp. star	685-122869	22:39:20.9711	+46:48:07.358	11.464	11.362	11.473	0.111
check star	685-122744	22:38:43.9073	+46:54:55.862	11.759	11.458	11.461	0.003

Table 2 – Coordinates (equinox J2000.0) and UCAC4 photometry of NSV 14172, NSV 14264 and their comparison and check stars.

3 Light curves

In figure 1 the light curves of the two stars are drawn for the three nights. All three graphs have a full scale of 0.4 magnitudes in ordinate. The light curves show no significant variation for the three nights and the two stars. Since all time series cover about 10 hours (duration of the order of magnitude of the period of RR Lyr stars), it can be said that these stars cannot be RR Lyraes. Table 1 gives the mean magnitudes per night and standard deviations. The standard deviations are of the order of 0.01 magnitude. Table 3 gives the mean magnitude and standard deviations for the whole run.

In order to confirm these findings, we analyzed the data from the survey ASAS-SN (Shappee et al., 2014) of both stars. This survey takes only a couple of measurements per night but the data cover several years. Two filters are available, V and g. V filter (2014-2018) and g filter (2018-2023) have only 7 months of in common from April to November 2018. The light curves in V and g are plotted in figure 2 (as in figure 1, the ordinate full scale is 0.4 magnitudes). The mean values and standard deviations are shown in table 3. The ASAS-SN data confirm that these stars have no significant light variation within a range of a couple of hundredths of magnitude ($3\sigma \sim 0.07$ mag.) for each filter and over the time interval of four years. The data from ASAS-SN used for the present statistics were cleaned for internal error greater than 0.02 magnitudes in g and 0.03 in V for NSV 14172, 0.03 in g and V for NSV 14264. Only data from camera "bC" were used for NSV 14172 and NSV 14264 for



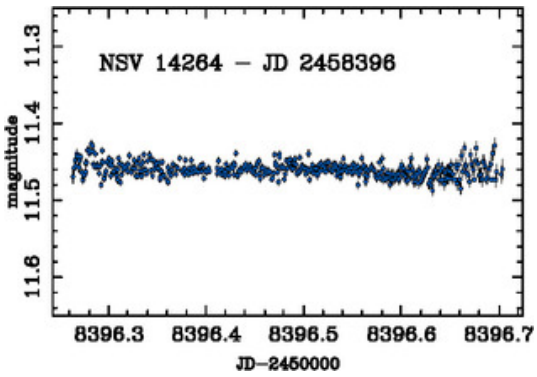


Figure 1 – R light curves of NSV 14264 and NSV 14172 on October 3, 4 and 5, 2018. Time scales are heliocentric julian days.

	UCAC4	filter (observatory)	number of meas. (of nights)	Mean magnitude	Standard deviation
NSV 14172	674-114332	R (EsO)	445 (1)	12.425	0.013
check star	674-114345	R (EsO)	445 (1)	12.703	0.014
NSV 14172	674-114332	V (ASAS-SN)	627 (226)	12.593	0.019
NSV 14172	674-114332	g (ASAS-SN)	792 (252)	12.928	0.026
NSV 14264	685-122818	R (EsO)	896 (2)	11.459	0.011
check star	685-122744	R (EsO)	896 (2)	11.407	0.013
NSV 14264	685-122818	V (ASAS-SN)	628 (226)	11.966	0.013
NSV 14264	685-122818	g (ASAS-SN)	814 (260)	12.430	0.015

Table 3 – Mean magnitudes of NSV 14172, NSV 14264 and their check stars.

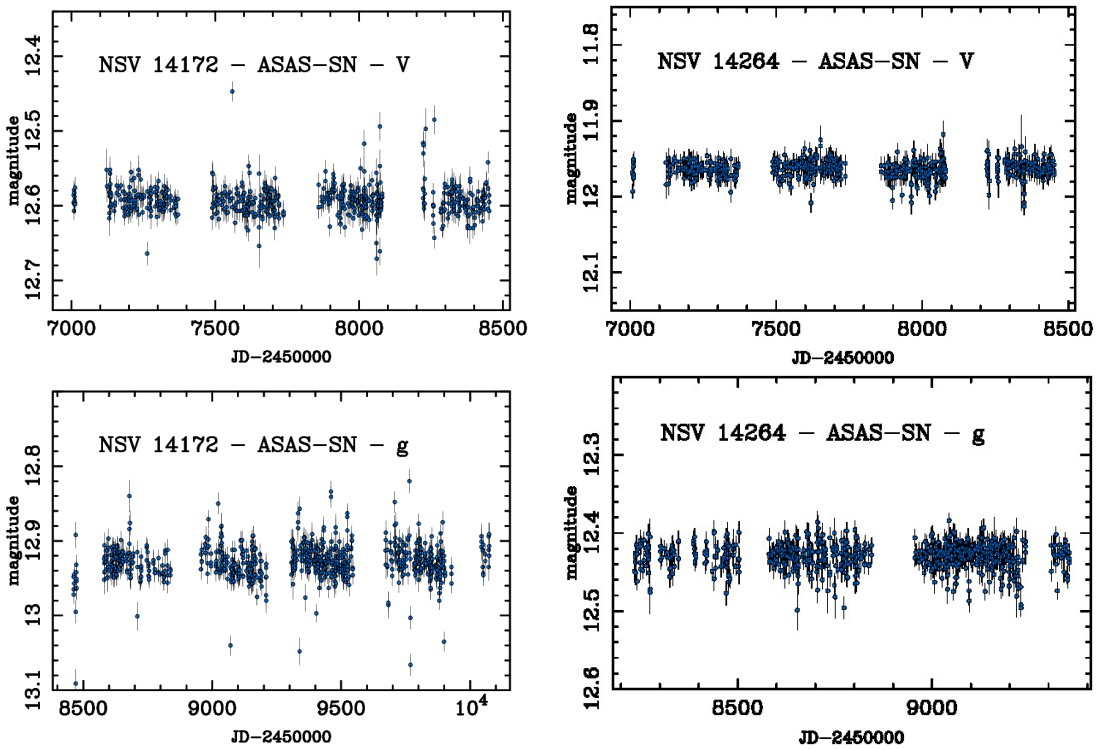


Figure 2 – V and g light curves of NSV 14172 and NSV 14264 from ASAS-SN. Time scales are heliocentric julian days.

filter g. Data from camera "bs", though contemporary to camera "bC", were more dispersed. The camera used for both stars in V is "bc" only.

4 Characterizing UCAC4 674-114332 and UCAC4 685-122818

Table 4 summarizes the values of physical parameters of NSV 14172, NSV 14264 as deduced from GAIA observations, DR2 and DR3, published by the Gaia Coll. (2018, 2022) and consequent papers. It appears that the two stars are very different. NSV 14172 is a dwarf quite similar to the Sun with an effective temperature of 5400 – 5900 K, a stellar radius of about 1.1 $R_\odot$ and a mass of 1 $M_\odot$, slightly less luminous than the Sun (0.8-0.9 $L_\odot$). NSV 14264, on the other hand, is a yellow giant star 24 times more luminous than the Sun and a radius of 7.38 or 7.818 $R_\odot$. Its effective temperature is about 4900 K. This difference of class, since their magnitudes are quite close to each other, is reflected in their distances: 320 pc for NSV 14172, 1228-1274 pc for NSV 14264, in accordance with the measured parallaxes of 3.1063 mas and 0.7504 mas from Gaia DR3. The estimated gravities $log(g)$ are also characteristic of their respective classes.

The G absolute magnitudes published by Anders et al. (2022) are 4.48 for NSV 14172 (Gaia Coll. (2022) gives 4.75) and 1.02 for NSV 14264. These values with a BP-RP value of 0.9427 place NSV 14172 on the main sequence as expected while the BP-RP value of 1.2217 for NSV 14264 places it among the RR Lyraes as can be seen in figure 3 of Gaia Coll. (2019). The published effective temperature is cooler than typical temperatures of RR Lyraes, though, more typical of cepheids. However, NSV 14264 does not pulsate with expected amplitude.

UCAC4 685-122818 (NSV 14724) was investigated by Cantat-Gaudin et al. (2018) as possibly belonging to the open cluster ASCC 124 also known as Alessi 37 (Kharchenko et al., 2005) They estimated the probability of stars to belong to clusters from GAIA DR1 data. The result was that UCAC4 685-122818 does not belong to ASCC 124 / Alessi 37.

Parameter	**NSV 14172**	**NSV 14264**	**Source**
plx (mas)	3.1063±0.0132	0.7504±0.0128	Gaia Coll. (2022)
dist. (pc)	310.577 (307.7-313.5)	1228.878	Bailer-Jones et al. (2018)
	310.5780±2.883	1274.9399±47.820	Stassun et al. (2019)
	320.136 (318.6-321.5)	1271.854	Bailer-Jones et al. (2021)
	320.7386		Gaia Coll. (2022)
	320.462	1283.0	Anders et al. (2022)
T_{eff} (K)	5374.33	4937.93	Gaia Coll. (2018)
	5377.6		Gaia Coll. (2022)
	5735±154	5155±175	Bai et al. (2019)
	5907.41	4843.02	Anders et al. (2022)
log(g) (cm/s2)	4.3143		Gaia Coll. (2022)
	4.4087	2.7795	Anders et al. (2022)
$[Fe/H]$	-0.7598		Gaia Coll. (2022)
	-0.0396	-0.1154	Anders et al. (2022)
Radius ($R_\odot$)	1.05	7.38	Gaia Coll. (2018)
	1.1332		Gaia Coll. (2022)
	1.018	7.818	Stassun et al. (2019)
Luminosity ($L_\odot$)	0.826	29.159	Gaia Coll. (2018)
	0.9659		Gaia Coll. (2022)
Mass ($M_\odot$)	0.901		Gaia Coll. (2022)
	0.996		Stassun et al. (2019)
	0.999	1.376	Anders et al. (2022)
class	dwarf	giant	Stassun et al. (2019)
G Abs. mag.	4.7556		Gaia Coll. (2022)
	4.4833	1.0264	Anders et al. (2022)
mag G	12.3951±0.0002	11.7418±0.0001	Gaia Coll. (2022)
mag BP	12.7822±0.0005	12.2755±0.0004	”
mag RP	11.8394±0.0003	11.0539±0.0003	”
BP-RP	0.9427	1.2217	”

Table 4 – Physical parameters and photometry (rounded to 0.0001 mag) of NSV 14172 and NSV 14264 deduced from GAIA data.

5 Checking for misidentification

It is quite common that variable stars are misidentified in discovery papers, giving wrong coordinates. Brun (1964) provides finding charts: we have compared these charts with the Digital Sky Survey (DSS) as provided by the European Southern Observatory [2]. We choose to make the comparison with the blue DSS images expecting a better similarity of wavelength response of photographic plates. The comparison is not straightforward, but we can say that the identifications of Brun-49 with UCAC4 674-114332 and Brun-59 with UCAC4 685-122818 is good with a reasonable confidence.
Since the misidentification could have been done on the drawing of the finding charts, we have examined the light curves of the stars in the field obtained at EsO. We have drawn the light curves of about a thousand stars in the fields of UCAC4 674-114332 and of UCAC4 685-122818. None of them shows light variations characteristic of RR Lyraes. The selection criteria was that they were brighter than 15 and fainter than 12 in V filter, and with B-V less than 0.9 in UCAC4 catalog (Zacharias et al., 2013).

6 Conclusion

We have examined the possible light variation of two RR Lyrae candidates included in the list of Brun (1964). None of them were proved to vary as noticed from our own observations and from ASAS-SN archive data. From GAIA data we can say that NSV 14172 is a bona fide one solar mass main sequence star while NSV 14264 is a yellow giant. However, NSV 14264 luminosity and effective temperature are typical of a star located in the pulsating star instability strip.

7 Acknowledgements

The present study makes use of the following facilities:
- The GEOS database of RR Lyr stars hosted at Institut de Recherche en Astrophysique et Planétologie, Toulouse, France http://rr-lyr.irap.omp.eu/dbrr/
- The SIMBAD database, operated at CDS, Strasbourg,France (Wenger et al., 2000), of the VizieR catalogue access tool also at CDS. The original description of the VizieR service was published in A&A, Supp. 143, 23, http://vizier.u-strasbg.fr/viz-bin/VizieR and of "Aladin sky atlas" developed at CDS, Strasbourg Observatory, France (Bonnarel et al., 2000; Boch & Fernique, 2014)
- The International Variable Star Index (VSX) database, operated at AAVSO, Cambridge, Massachusetts, USA
- Data products from the AAVSO Photometric All Sky Survey (APASS). Funded by the Robert Martin Ayers Sciences Fund and the National Science Foundation.

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