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First light elements for the RR Lyr star NSV 7366

ABSTRACT:

From visual then photoelectric and CCD observations performed by GEOS members, the nature of the star NSV 7366 came to light. This pulsating star of RR Lyr type with a period of 0.66542 d. was also observed by the robotic telescope ROTSE. Its light curve characteristics seem to confirm a low metallicity for that high galactic latitude star. Our observations are compared with the Tycho2 catalogue. The CCD images were also used to determine one timing of maximum of a fainter pulsating star in the vicinity of NSV 7366.

RÉSUMÉ:

A partir d'observations visuelles puis photoélectriques et CCD de la part des membres du GEOS, la nature de l'étoile NSV 7366 s'est révélée. De type RR Lyr, cette pulsante de 0.66542 j. de période a également été suivie par le télescope automatique ROTSE. Les caractéristiques de sa courbe de lumière semblent confirmer une composition pauvre en métaux pour cette étoile de haute latitude galactique. Nos observations sont également comparées aux données du catalogue Tycho2. Les images CCD ont également permis de déterminer un instant de maximum d'une autre pulsante faible et proche de NSV 7366.

RIASSUNTO:

Da osservazioni visuali e, successivamente, fotoelettriche e CCD da parte di membri del GEOS, è stato possibile rivelare la natura della stella NSV 7366. Del tipo RR Lyr, questa pulsante di 0.66542 g. di periodo è stata misurata anche dal telescopio automatico ROTSE. Le caratteristice della curve di luce sembrano confermare un basso livello di metallicità nella composizione chimica di questo oggetto di alta latitudine galattica. Le osservazioni sono state confrontate anche con i dati del catalogo Tycho2. Inoltre, le immagini CCD hanno permesso di determinare un istante di massimo per un'altra debole variabile pulsante nello stesso campo.

RESUMEN:

A partir de observaciones visuales, y posteriormente fotoeléctricas y CCD, realizadas por miembros del GEOS, ha sido posible revelar la naturaleza de la estrella NSV 7366. Del tipo RR Lyr, esta pulsante de 0,66542 d. de período ha sido también seguida por el telescopio automático ROTSE. Las características de su curva de luz parecen confirmar una composición pobre en metales para esta estrella de alta latitud galáctica. Las observaciones han sido asimismo comparadas con los datos del catálogo Tycho2. Las imágenes CCD han permitido también determinar un instante de máximo de otra pulsante débil próxima a NSV 7366.

I) INTRODUCTION

NSV 7366 was discovered variable by Weber (1962), who considered it as a rapid irregular variable with spectral type G0.

II) VISUAL OBSERVATIONS

First visual observations has been performed in 1983. It soon appeared that NSV 7366 was a variable of the RR Lyr type. The star remains at the same brightness when observed every two days. The probable period was around 2d/n. A period search, from 57 maxima determined from GEOS visual observations (see table 1), clearly shows a value around 0.6654 d. (Boninsegna, 1988).

III) PHOTOELECTRIC OBSERVATIONS

From 1985, different teams of GEOS members performed 141 measurements in B and V in almost 15 years. A period search with the photoelectric data shows a 0.66542 d period (see Fig 3). The light curves confirmed the RR Lyr nature. The photoelectric V magnitudes are in the 11.78--12.73 range and the B-V curve (from 0.14 to 0.43) mimics the V one, strongly supporting the pulsating nature. The light curve is very asymmetrical (the M-m value is 0.14 period).

IV) CCD OBSERVATIONS

During the 2001 and 2002 seasons, Massimiliano Martignoni (MRT) using his 20-cm telescope, carried out 236 CCD unfiltered measurements; GSC 02040-01197 has been used as comparison star, GSC 02040-1562 served as check star (see Fig. 4).

V) FIRST OFFICIAL PERIOD

Finally, 57 visual, 2 photoelectric and 3 CCD times of maxima were available. The computation using all the visual times weighted three times less than the photoelectric and CCD ones, gave a first ephemeris (see table 2, stage 0). But, as the IBVS publication does not allow visual observations to be published, only the CCD and photoelectric maxima are to be listed. In that case, the O-C values of the five maxima look rather strange: all five positives (0.0018, 0.0153, 0.0113, 0.0144, 0.0153)!
Jacqueline Vandenbroere (VBR) noticed that the times of the most active observer on that star was often credited with a negative O-C value. In order to improve the quality of the ephemeris, several checks were performed (see table 2, stages 1 to 7).
The comparison between the electronic and visual observations, to check each value of the ephemeris, shows a too slight difference to reject the visual observations (see table 2, stages 1 and 2). Gathering all the maxima and giving to the electronic ones a weight ten times more important than the visual ones, gave the ephemeris shown in stage 3. Therefrom, all the maxima beyond twice the standard deviation of the population were rejected. A new ephemeris was calculated and again, a new iteration was undertaken (see table 2, stages 4 to 7). Finally, the ephemeris of stage 7 was adopted, but a more realistic error band has to be taken in account (see table 2, stage 8). Table 3 lists all the maxima used for the final ephemeris below.
All the 22 times of maxima rejected had negative values, except for the oldest two. These two maxima (2446119.5906, 2446175.4928) were observed ten years before the first maxima listed in table 3. Could the large O-C positives values (around 0.025d) of these maxima be the effect of a period variation?

Max = HJD 2450724.980 + 0.665426 x E
± 0.002 ± 0.000002

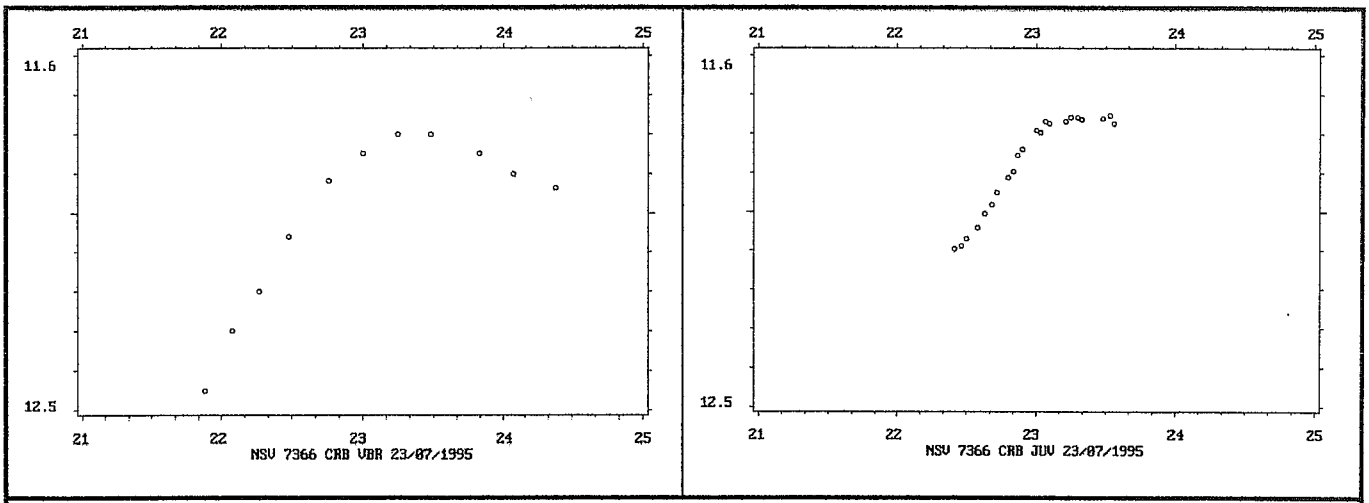

Fig. 1: Visual versus photoelectric observations: Vandenbroere J. - Jungfraujoch V (1995 July 23).

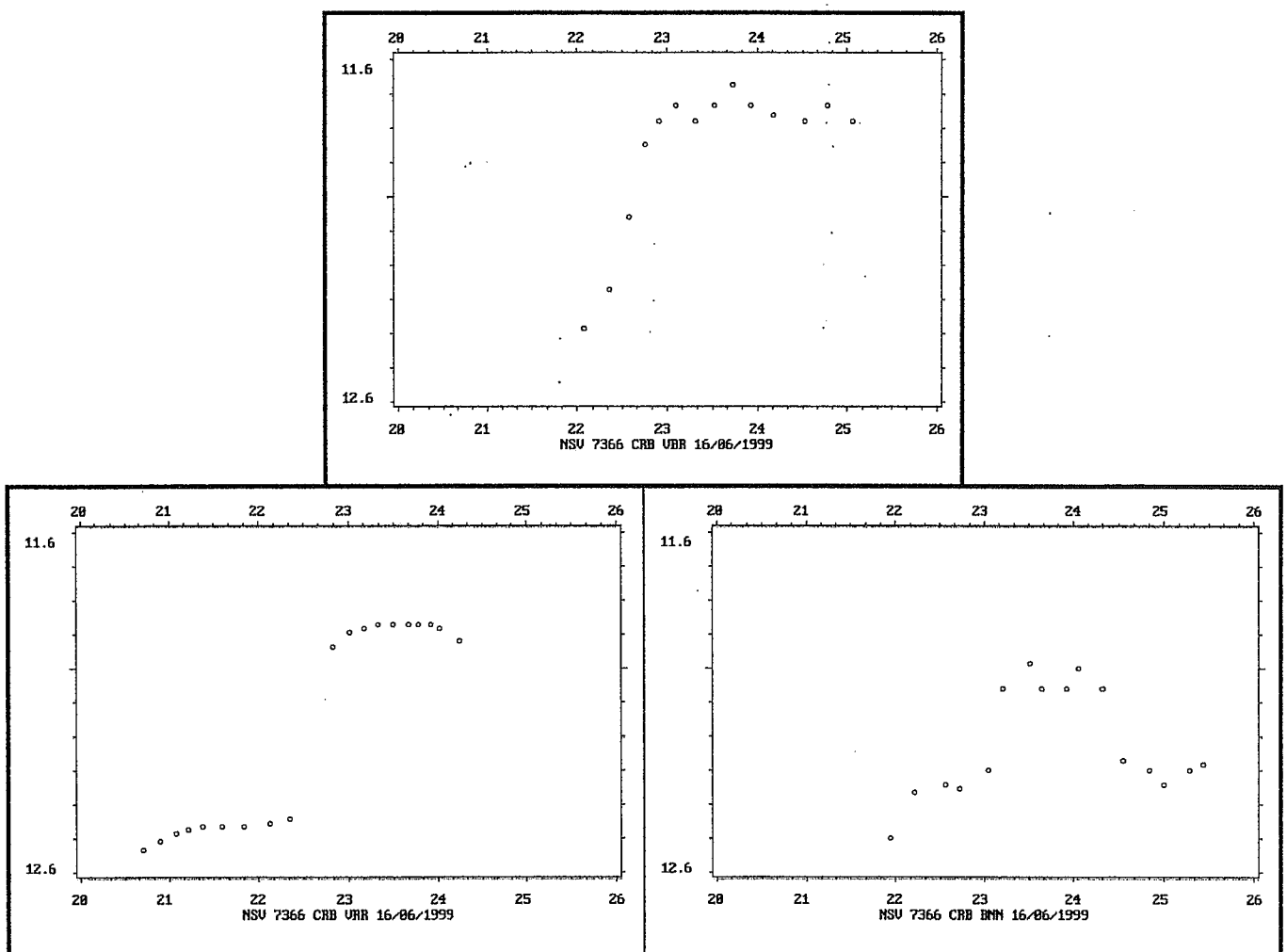

Fig. 2: Comparison between three independant visual observations: J.Vandenbroere, J.-P. Verrot, R. Boninsegna (1999 June 16).

Verrot J.-P.	VRR	32
Vandenbroere J.	VBR	16
Boninsegna R.	BNN	6
Paris B.	PAR	2
Manna A.	MAA	1

Table 1: List of the visual observers and number of maxima collected.

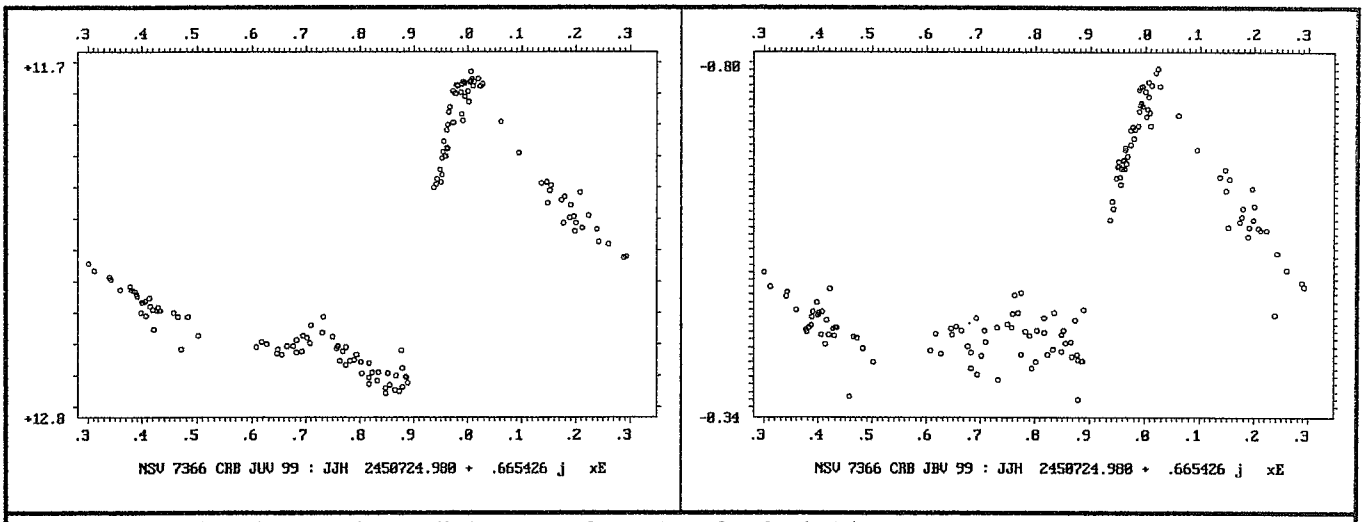

Fig. 3: Photoelectric V and B-V light curve from Jungfraujoch Observatory. The B-V index presented is the one used by Geneva photometric system. In the text, the data of this system were transformed into the Johnson's and Morgan's system (Meylan G. et al., 1981).

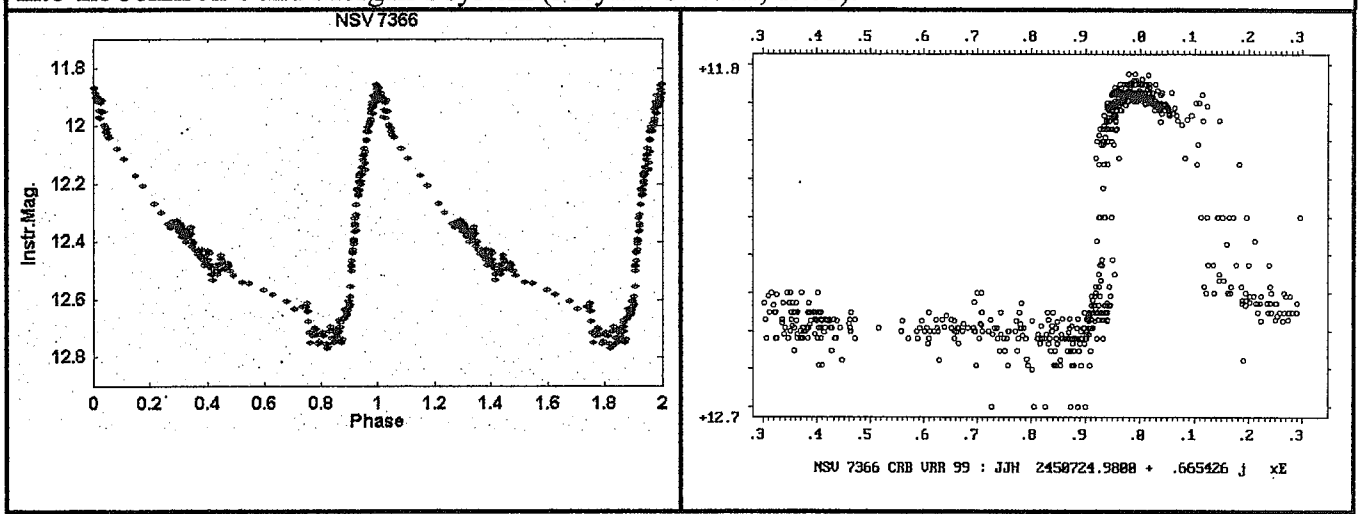

Fig. 4: left, CCD unfiltered light curve from Martignoni M. (MRT) and right, composite visual light curve from Verrot J.-P. (VRR).

	HJD 2400000+	Period (d)	O-C std dev.	nb.eli.	maxima taken into account
0.	50724.977	0.665424			57 visual + (3 x (2 ppe + 3 CCD))
	± 0.003	± 0.000002			
1.	50724.983	0.665425	0.0049		2 ppe + 3 CCD
	± 0.008	± 0.000005			
2.	50724.977	0.665421	0.0114		57 visual
	± 0.003	± 0.000002			
3.	50724.976	0.665425	0.0117	5	57 visual + (10 x (2 ppe + 3 CCD))
	± 0.002	± 0.000001			
4.	50724.977	0.665425	0.0104	6	52 visual + (10 x (2 ppe + 3 CCD))
	± 0.002	± 0.000001			
5.	50724.977	0.665426	0.0090	5	46 visual + (10 x (2 ppe + 3 CCD))
	± 0.002	± 0.000001			
6.	50724.979	0.665426	0.0079	6	41 visual + (10 x (2 ppe + 3 CCD))
	± 0.002	± 0.000001			
7.	50724.980	0.665426	0.0066		35 visual + (10 x (2 ppe + 3 CCD))
	± 0.001	± 0.000001			
8.	50724.977	0.665427	0.0073		35 visual + 2 ppe + 3 CCD
	± 0.002	± 0.000002			

Table 2: Steps for the quality improvement of NSV 7366 ephemeris.

N	JJH 2400000 +	E	O - C	Obs.
1.	49896.51880	-1245	-0.0016	VBR
2.	49898.51400	-1242	-0.0027	VBR
3.	49922.47420	-1206	0.0021	JUV PPE
4.	49922.47650	-1206	0.0044	VBR
5.	49924.46510	-1203	-0.0033	VBR
6.	49946.44300	-1170	0.0156	JUV PPE
7.	50250.53140	-713	0.0039	BNN
8.	50276.47210	-674	-0.0070	VBR
9.	50282.46760	-665	-0.0003	VBR
10.	50546.64270	-268	0.0003	BNN
11.	50556.61360	-253	-0.0102	VBR
12.	50570.60870	-232	0.0110	VBR
13.	50578.58050	-220	-0.0024	VBR
14.	50600.55420	-187	0.0123	VBR
15.	50628.50130	-145	0.0114	VBR
16.	50656.43580	-103	-0.0020	VRR
17.	50664.42190	-91	-0.0010	VRR
18.	50668.40820	-85	-0.0073	VRR
19.	50670.41030	-82	-0.0014	MAA
20.	50690.36280	-52	-0.0117	VRR
21.	50726.29620	2	-0.0114	VRR
22.	50932.59380	312	0.0039	VBR
23.	50984.48770	390	-0.0055	PAR
24.	51010.43630	429	-0.0085	VRR
25.	51012.43560	432	-0.0055	VRR
26.	51014.44260	435	0.0052	VBR
27.	51040.38170	474	-0.0073	VRR
28.	51078.32190	531	0.0036	VRR
29.	51346.49420	934	0.0089	BNN
30.	51346.48880	934	0.0035	VBR
31.	51346.49170	934	0.0064	VRR
32.	51362.45830	958	0.0027	BNN
33.	51368.45130	967	0.0069	VBR
34.	51398.39610	1012	0.0075	VBR
35.	51420.34080	1045	-0.0069	VRR
36.	51422.33400	1048	-0.0100	VRR
37.	51430.31840	1060	-0.0107	VRR
38.	52080.45210	2037	0.0011	MRTccd
39.	52424.47920	2554	0.0025	MRTccd
40.	52436.45770	2572	0.0034	MRTccd

Table 3: List of visual, photoelectric and CCD maxima.

WR 103	CSV 7254	NSV 7366
GSC 2040 1369	ROTSE1 J155731.78+283800.4	
α: 15h 57 min 32s	J 2000	δ: + 28° 38.0'

Table 4: Cross identifications and position of NSV 7366

VI) MORE OBSERVATIONS

A SIMBAD query revealed that the coordinates of NSV 7366 are very similar to those of ROTSE1 J155731.78+283800.4, a variable discovered by the robotic telescope ROTSE. Akerlof et al. (2000) reports a period value of 0.66539 ± 0.00006 d.
The two periods are coincident within error bars, but our determination is one order of magnitude more accurate than ROTSE one. Therefore, we can infer that ROTSE1 J155731.78+283800.4 and NSV 7366 are the same star and that our analysis provides the first accurate ephemeris on its light variability. The star is also known as GSC 02040-1369. See table 4 for cross-identifications and position of the star.
The star is also present in the Tycho-2 catalogue. However, the Tycho mean V and B-V values are not in agreement with ours: 12.11 versus 12.41 and 0.77 versus 0.21 respectively, well outside the Tycho standard error.

The galactic latitude of NSV 7366 is quite high (50°), so the colour excess due to interstellar reddening is small (E/ B-V=0.03 mag). Considering a mean apparent magnitude V=12.20 and an absolute magnitude V=0.60, the NSV 7366 distance would be about 2.1 Kpc. As shown by Poretti (2001), the light curves of RRab stars split into three tails in the Fourier parameter space after P=0.50~d. Comparing Fig.3 and 4 with Fig.13 (right panels) in Poretti (2001), we infer that NSV 7366 is belonging to the lower tail, characterized by a low metallicity, as expected for stars at such galactic latitudes.

The CCD images were also used to obtain photometric data on GSC 02040-01409=ROTSE J155733.60+283225.0, a fainter RRc variable located close to NSV 7366. One timing of maximum light (HJD 2452409.4568 ± 0.0035) has been determined.

V) CONCLUSION

Visual, photoelectric and CCD measurements defined the RRab nature of NSV7366=GSC 2040 1369. The first ephemeris is also given.
Only occasional observations will be needed for that star in order to confirm the constancy of the period. We cannot list all the observers who have contributed to the observations as well visual as electronics ones. We thank them all.

V) REFERENCES

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