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Discovery of the spectroscopic binary nature of the classical Cepheids FN Aql and V1344 Aql

L. Szabados[1], B. Cseh[2,3], J. Kovács[2], B. Csák[2], Á. Dózsa[2], Gy. M. Szabó[1,2], A. E. Simon[1,2], T. Borkovits[1,2,4], L. L. Kiss[1,2,5], I. Jankovics[2], Gy. Mező[1]

[1]*Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, H-1121 Budapest, Konkoly Thege Miklós út 15-17, Hungary*
[2]*ELTE Gothard-Lendület Research Group, H-9704 Szombathely, Szent Imre herceg u. 112., Hungary*
[3]*Department of Astronomy, Loránd Eötvös University, H-1117 Budapest, Pázmány P. sétány, Hungary*
[4]*Baja Astronomical Observatory, H-6500 Baja, Szegedi út, Kt. 766, Hungary*
[5]*Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia*

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ABSTRACT
We present the analysis of photometric and spectroscopic data of two classical Cepheids, FN Aquilae and V1344 Aquilae. Based on the joint treatment of the new and earlier radial velocity data, both Galactic Cepheids have been found to be a member in a spectroscopic binary system.

To match the phases of the earlier radial velocity data correctly with the new ones, we also determined the temporal behaviour of the pulsation period of these Cepheids based on all available photometric data. The $O-C$ graph covering about half century shows slight changes in the pulsation period due to stellar evolution for both Cepheids.

Key words: binaries: spectroscopic – stars: variables: Cepheids – stars: individual: FN Aquilae – stars: individual: V1344 Aquilae

1 INTRODUCTION

Classical Cepheid variable stars are well known primary distance indicators owing to the famous period–luminosity (P-L) relationship. Companions to Cepheids may complicate and at the same time facilitate the applicability of using the P-L relationship for distance determination. On the one hand, the photometric contribution of the secondary star has to be taken into account when determining the brightness and colours of the Cepheid component in optical photometric bands, otherwise the companion may falsify the luminosity value determined for the Cepheid (Szabados & Klagyivik 2012). On the other hand, Cepheids in binary systems serve as reliable calibrators of the P-L relationship (Evans 1992). The frequency of binaries among bright Cepheids exceeds 50%, while among the fainter ones an observational selection effect encumbers revealing binarity (Szabados 2003b).

In the case of pulsating variables, like Cepheids, spectroscopic binarity (SB) manifests itself in a periodic variation of the γ-velocity (i.e. the radial velocity, RV, of the mass centre of the Cepheid). In practice, the orbital RV variation of the Cepheid component is superimposed on the pulsational RV variations. An unrevealed orbital motion increases the scatter of the pulsational RV curve, and has an adverse effect on estimating the distance (therefore on the calibration of the P-L relationship) via the use of the Baade–Wesselink method.

The orbital period of binaries involving a supergiant Cepheid component cannot be shorter than about a year. SBs involving a Cepheid component with orbital periods longer than a decade are also known (see the on-line data base on binaries among Galactic Cepheids: http://www.konkoly.hu/CEP/orbit.html). Therefore, a first epoch RV curve, especially based on data obtained in a single observational season, is usually insufficient for pointing out an orbital effect superimposed on the RV changes due to pulsation.

In this paper we point out SB of two bright Galactic Cepheids, FN Aquilae (FN Aql) and V1344 Aquilae (V1344 Aql) by analysing RV data. Basic information on these Cepheids is found in Table 1. The new RV data and the observational circumstances are described in Section 2, then Sections 3 and 4 are devoted to the results on each new SB Cepheid, while Section 5 contains our conclusions.

2 NEW RADIAL VELOCITIES

Both Cepheids were observed among the targets of a RV survey of Galactic classical Cepheids initiated in 2012, using the 0.5 m RC telescope of ELTE Gothard Astrophysical Observatory, Szombathely and the 1 m RCC telescope of Piszkéstető Mountain Station of the Konkoly Observatory of the Research Centre for Astronomy and Earth Sciences of the Hungarian Academy of Sci-

Table 1. Basic data of the programme stars and the number of spectra.

Cepheid	$\langle V\rangle$ mag	P (d)	Mode of pulsation	Number of nights	Number of spectra
FN Aql	8.40	9.482	Fundamental	17	22
V1344 Aql	7.77	7.477	First overtone	38	73

ences. The spectrograph was the same fibre-fed instrument at both locations, the eShel system of the French Shelyak Instruments (Thizy & Cochard 2011). The detailed description of the instrument, methods and the observing programme is given in Csák et al. (2014).

The exposure times were typically 900 sec, the observing sequence was ThAr-object-object-ThAr. In most cases two consecutive spectra were recorded, which were averaged at the end of reduction process.

All spectra were reduced with standard tasks in IRAF[1], including bias, dark and flat-field corrections, aperture extraction, wavelength calibration, and continuum normalization. We checked the consistency of wavelength calibrations via RV standard star observations, which proved the stability of the system.

RV values were determined by cross-correlating object spectra and $\mathrm{R} = 11500$ synthetic spectra chosen from the Munari et al. (2005) library using the FXCOR task of IRAF. Correlations were calculated between 4870 and 6550 Å, excluding Balmer lines, NaD and telluric regions.

Barycentric Julian dates and velocity corrections for mid-exposures were calculated using the BARCOR code of Hrudková (2006). This method resulted in a 100-200 $\mathrm{m\,s^{-1}}$ uncertainty in the individual RV values, while further tests have shown that our absolute velocity frame was stable to within $\pm$200-300 $\mathrm{m\,s^{-1}}$.

The individual RV values are listed in Tables 2 and 3, respectively.

Table 2. New RV values of FN Aql

$\mathrm{JD}_\odot$ 2 400 000 +	v_{rad} ($\mathrm{km\,s^{-1}}$)	σ ($\mathrm{km\,s^{-1}}$)
56463.4765	18.78	0.12
56464.4777	26.97	0.83
56465.5075	31.13	0.11
56467.4097	10.18	0.12
56490.4477	5.26	0.28
56491.4815	14.09	0.48
56505.4206	9.57	0.23
56506.4062	7.71	0.35
56516.4299	5.85	0.16
56519.5152	10.85	0.61
56520.3778	18.96	0.15
56521.4576	27.81	0.10
56522.3047	31.66	0.12
56523.3108	21.95	0.15
56524.3069	9.95	0.11
56570.3523	27.77	0.21
56582.3024	7.42	0.26

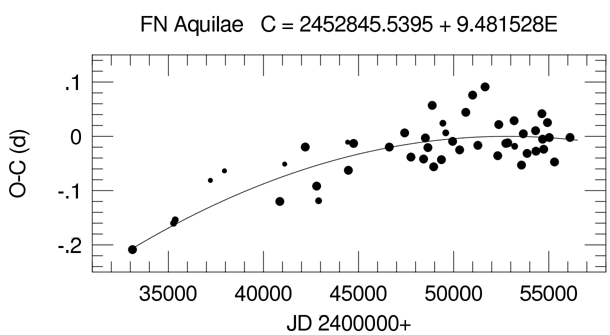

Figure 1. $O-C$ diagram (for the median brightness on the ascending branch) of FN Aql based on the values listed in Table 4. The pulsation period is subjected to a secular decrease.

3 RESULTS FOR FN AQUILAE

3.1 Accurate value of the pulsation period

Variability of FN Aql was discovered by Cerasskaya in 1929 (Blažko 1929). The Cepheid nature of the brightness variations and the pulsation period of about 9.5 d was established by Lause (Prager 1931). Cepheids pulsating with such a period have moderate amplitudes and a bump near the phase of maximum brightness, and their oscillation corresponds to the fundamental mode.

To separate the orbital and pulsational effects in the RV variations, knowledge of the accurate value of the pulsation period is essential, especially when comparing RV data obtained at widely differing epochs. Use of the accurate pulsation period obtained from the photometric data is a guarantee for the correct phase matching of the (usually less precise) RV data. Therefore, the pulsation period and its variations have been determined with the method of the $O-C$ diagram (Sterken 2005).

Visual and photographic observations have not been taken into account in the present study of the pulsation period. Photoelectric data have been available from the 1950s.

In the case of Cepheids pulsating with such a low amplitude, the $O-C$ diagram constructed for the median brightness is more reliable than that based on the moments of photometric maxima (Derekas et al. 2012). Therefore we determined the accurate value of the pulsation period by constructing an $O-C$ diagram for the moments of median brightness (the mid-point between the faintest and the brightest states) on the ascending branch of light curve since it is this phase when the brightness variations are steepest during the whole pulsational cycle.

All published photoelectric and CCD photometric observations of FN Aql covering more than 60 years were analysed in a homogeneous manner to determine seasonal moments of the chosen light-curve feature.

The relevant data listed in Table 4 are as follows.
Column 1: heliocentric moment of the median brightness on the ascending branch;
Col. 2: epoch number, E, as calculated from equation (1):

$$C_{\mathrm{med}} = 2\,452\,845.5395 + 9.481\,528\times E - 4.77\times 10^{-8} E^2 \quad (1)$$
$$\pm\,0.0037 \pm 0.000\,012 \qquad \pm\,0.75\times 10^{-8}$$

(this ephemeris has been obtained by the weighted least-squares fit to the tabulated $O-C$ differences, where $E=0$ is selected arbitrarily and corresponds to the most reliable subset of data);

[1] IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

Table 3. New RV values of V1344 Aql

JD$_\odot$ 2 400 000 +	$v_{\rm rad}$ (km s^{-1})	σ (km s^{-1})
56053.5336	2.89	0.10
56058.5486	−7.18	0.09
56059.5612	−3.58	0.09
56084.4737	−0.96	0.62
56091.4160	2.19	0.40
56104.4768	−3.27	0.48
56106.5345	1.84	0.20
56119.4578	−3.05	0.17
56122.3520	−5.49	0.10
56149.3418	−3.08	0.17
56151.4488	1.70	0.16
56152.3518	−6.46	0.19
56153.3440	−11.97	0.16
56154.3298	−10.63	0.18
56155.3708	−8.05	0.14
56157.3852	0.18	0.17
56159.4025	−2.07	0.25
56161.4092	−11.42	0.19
56163.3492	−6.85	0.11
56164.3200	−3.41	0.16
56165.3170	1.69	0.12
56172.4338	0.13	0.31
56463.4200	−1.79	0.52
56464.4263	2.89	0.38
56465.4884	2.59	0.12
56467.3852	−10.32	0.30
56490.3670	−9.86	0.30
56491.3978	−7.47	0.29
56504.3974	−9.31	0.15
56505.3915	−9.88	0.18
56506.3783	−7.38	0.17
56516.4160	2.17	0.11
56520.3647	−9.69	0.10
56521.4696	−7.19	0.09
56522.3177	−5.05	0.09
56523.3230	−0.99	0.11
56570.3760	1.56	0.20
56582.3282	−4.14	0.15

Col. 3: the corresponding $O-C$ value as calculated from the constant and linear terms of equation (1);
Col. 4: weight assigned to the $O-C$ value (1, 2, or 3 depending on the quality of the light curve leading to the given difference);
Col. 5: reference to the origin of data.

The plot of $O-C$ values shown in Fig. 1 can be fitted with a parabola implying a minute decrease (-0.3175 s yr^{-1}) in the pulsation period. Previous studies of period variations of FN Aql are also available in the literature. Szabados (1988) approximated the $O-C$ graph with a constant period and a light-time effect superimposed on it (see Sect. 3.2), while Berdnikov & Pastukhova (1994) found a slightly increasing pulsation period. On the contrary, Turner (1998) included FN Aql in the table of Cepheids with decreasing period. The value quoted by Turner was taken from the unpublished study carried out by Duncan (1991), and this value is smaller by 10% than the period shortening derived in this paper.

Table 4. $O-C$ values of FN Aql (see the description in Section 3.1)

JD$_\odot$ 2 400 000 +	E	$O-C$	W	Data source
33114.2710	−2081	−0.2087	3	Eggen (1951)
35276.1080	−1853	−0.1601	2	Irwin (1961)
35361.4481	−1844	−0.1538	2	Walraven et al. (1958)
37210.4186	−1649	−0.0812	1	Mitchell et al. (1964)
37949.9954	−1571	−0.0636	1	Williams (1966)
40860.7681	−1264	−0.1200	3	Pel (1976)
41116.8382	−1237	−0.0512	1	Feltz & McNamara (1980)
42197.7639	−1123	−0.0197	3	Vasil'yanovskaya (1977)
42795.0282	−1060	−0.0917	3	Szabados (1977)
42899.2979	−1049	−0.1187	2	Dean (1977)
44425.9318	−888	−0.0108	1	Berdnikov (2008)
44463.8061	−884	−0.0626	3	Moffett & Barnes (1984)
44738.8200	−855	−0.0131	3	Eggen (1985)
46616.1558	−657	−0.0198	3	Berdnikov (2008)
47422.1118	−572	0.0063	3	Berdnikov (2008)
47753.9208	−537	−0.0382	3	Berdnikov (2008)
48417.6241	−467	−0.0418	3	*Hipparcos* (ESA 1997)
48512.4782	−457	−0.0030	3	Berdnikov (2008)
48645.2018	−443	−0.0208	3	Barnes et al. (1997)
48872.8363	−419	0.0570	3	Berdnikov (2008)
48948.5754	−411	−0.0561	3	Arellano Ferro et al. (1998)
49356.2942	−368	−0.0430	3	Arellano Ferro et al. (1998)
49432.2135	−360	0.0241	2	Barnes et al. (1997)
49583.9003	−344	0.0064	2	Berdnikov (2008)
49944.1826	−306	0.0093	3	Berdnikov (2008)
50313.9465	−267	−0.0250	3	Berdnikov (2008)
50636.3877	−233	0.0442	3	Berdnikov (2008)
50996.7174	−195	0.0759	3	Berdnikov (2008)
51271.5893	−166	−0.0166	3	Berdnikov (2008)
51650.9581	−126	0.0911	3	Berdnikov (2008)
52314.5382	−56	−0.0357	3	ASAS (Pojmanski 2002)
52371.4848	−50	0.0217	3	Berdnikov (2008)
52741.2297	−11	−0.0130	3	*INTEGRAL* OMC
52845.5274	0	−0.0121	3	ASAS (Pojmanski 2002)
53177.4218	35	0.0288	3	ASAS (Pojmanski 2002)
53205.8192	38	−0.0184	2	*INTEGRAL* OMC
53566.0826	76	−0.0530	3	ASAS (Pojmanski 2002)
53660.9556	86	0.0047	3	*INTEGRAL* OMC
53860.0315	107	−0.0315	3	ASAS (Pojmanski 2002)
54305.7052	154	0.0104	3	ASAS (Pojmanski 2002)
54324.6305	156	−0.0274	3	*INTEGRAL* OMC
54637.5900	189	0.0417	3	AAVSO
54675.4691	193	−0.0053	3	ASAS (Pojmanski 2002)
54732.3398	199	−0.0238	3	*INTEGRAL* OMC
54931.5010	220	0.0253	3	*INTEGRAL* OMC
55026.2887	230	−0.0022	3	ASAS (Pojmanski 2002)
55301.2081	259	−0.0472	3	AAVSO
56116.6646	345	−0.0021	3	AAVSO

Table 5. γ-velocities of FN Aql

Mid-JD 2 400 000+	v_γ (km s^{-1})	σ (km s^{-1})	N	Data source
27412	+7.2	2.0	11	Joy (1937)
44916	uncertain	–	2	Barnes et al. (1988)
48741	+12.8	0.1	94	Gorynya et al. (1998)
50488	+13.5	0.1	31	Barnes et al. (2005)
56506	+13.9	0.1	17	Present paper

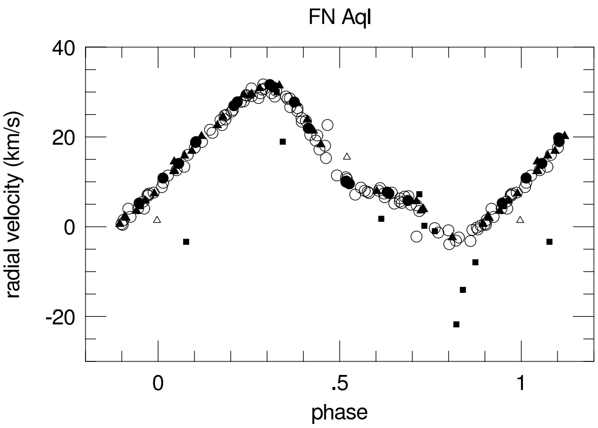

Figure 2. Merged RV phase curve of FN Aql. The filled circles represent our new data, open circles denote values obtained by Gorynya et al. (1998), filled triangles are those obtained by Barnes et al. (2005), open triangles represent values published by Barnes et al. (1988), and Joy's (1937) data are marked as black squares. The RV data have been folded on the pulsation period of 9.481528 d, and the phase shifts due to the parabolic $O-C$ graph (see Fig. 1) have been applied for.

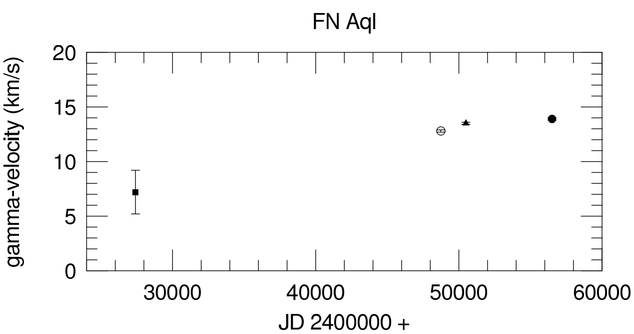

Figure 3. Temporal variation in the γ-velocity of FN Aql. The symbols for the different data sets are the same as in Fig. 2.

3.2 Binarity of FN Aql

A companion can have an observable effect on the colour, amplitude and other phenomenological properties of a Cepheid (Szabados 2003a), even if the two stars are not physically bound and only form optical pairs. Based on their multicolour photometry, Dean (1977) and Pel (1978) suspected a blue companion but two other efficiently used photometric criteria did not indicate any hot companion (Madore 1977; Madore & Fernie 1980). Based on a UV spectrum obtained with the *IUE* satellite, Evans et al. (1990) excluded the presence of a companion hotter than A1V.

Another piece of evidence of binarity is the light-time effect in the $O-C$ diagram of a pulsating variable. Though Szabados (1988) suspected the presence of a light-time effect in the $O-C$ diagram of FN Aql, no wave-like pattern is discernible in the updated $O-C$ diagram in Fig. 1. The suspected light-time effect was mainly due to the inclusion of less reliable photographic data in the analysis of the pulsation period by Szabados (1988).

Nevertheless, there are some peculiarities in the behaviour of FN Aql. On the one hand, Usenko et al. (2001) found a strong carbon deficit and a minor nitrogen overabundance in the spectrum of FN Aql which cannot be explained by the canonical models of stellar evolution. On the other hand, Hurley et al. (2008) pointed out peculiar photometric properties of FN Aql originally observed in the $U-B$ versus $B-V$ diagnostic plane. They explained the correlations between the various colour indices in terms of temporal variations in the circumstellar dust extinction. Fluctuations in the observable stellar wind can be a consequence of the orbital motion in a binary system.

In addition to our own observations, RV data of FN Aql are available from the following sources: Joy (1937), Barnes et al. (1988), Gorynya et al. (1998), and Barnes et al. (2005). Using the accurate pulsation period determined from the $O-C$ diagram (equation 1) and applying the proper phase correction (corresponding to the parabolic $O-C$ graph), the resulting RV phase diagram is shown in Fig. 2. Phase zero is arbitrarily chosen at JD 2 400 000. The meaning of the different symbols is explained in Fig. 2. It is seen that Joy's data are systematically more negative than the more recent RV measurements. Though the seminal paper by Joy (1937) reflects the observational technique and precision of the 1930s, and his method of deriving the RV value might be different from ours, Joy's data are free from any systematic errors in spite of their limited accuracy as documented by Szabados (1996).

The γ-velocities derived from four individual series of RV observations are listed in Table 5 where the standard error of the γ-velocity and the number of the data in the given series (N) is also listed. These data are also plotted in Fig. 3. It is clear that slight variations in the γ-velocity continued in the last two decades and the pattern of data in the diagram implies an orbital period of several decades for this SB system.

4 RESULTS FOR V1344 AQUILAE

4.1 Accurate value of the pulsation period

V1344 Aql pulsates in the first overtone mode, therefore it has a small pulsational amplitude and nearly sinusoidal light and velocity curves. The brightness variability of V1344 Aql was revealed by Kovacs & Szabados (1979). Curiously enough, this star was originally chosen as the check star for the photoelectric observations of the Cepheid FN Aql, in view of their similar brightness and colour, as well as angular proximity.

All published optical photometric observations of V1344 Aql covering 40 years were analysed in a homogeneous manner to determine seasonal moments of the median brightness on the ascending branch of the light curve, similarly to the case of FN Aql. The $O-C$ diagram has been constructed from the V-band data (or nearest to this visual band).

The relevant data for constructing the $O-C$ graph are listed in Table 6 whose structure is similar to Table 4. The ephemeris of the $O-C$ residuals is:

$$C_{\rm med} = 2\,450\,312.6665 + 7.476\,744 \times E + 0.90 \times 10^{-7} E^2 \quad (2)$$
$$\pm\, 0.0106 \pm 0.000\,017 \qquad \pm\, 0.32 \times 10^{-7} E^2$$

as obtained from the second-order least-squares fit to the heliocentric moments of the median brightness on the ascending branch. The tabulated $O-C$ residuals have been obtained by using the constant and linear terms of equation (2).

The plot of $O-C$ values shown in Fig. 4 can be approximated with a parabola implying a minute increase in the pulsation period.

4.2 Binarity of V1344 Aquilae

Due to the belated discovery of brightness variability in V1344 Aql, this Cepheid has not been on the target list of most of the projects aimed at revealing companions to Cepheids from photometric data.

Table 6. $O - C$ values of V1344 Aql (see the description in Section 4.1)

JD$_\odot$ 2 400 000 +	E	$O - C$	W	Data source
42619.4717	−1029	0.3748	2	Kovacs & Szabados (1979)
43501.5128	−911	0.1601	2	Kovacs & Szabados (1979)
44069.6038	−835	0.0185	2	Kovacs & Szabados (1979)
44488.3360	−779	0.0531	3	Fernie & Garrison (1981)
44772.3890	−741	−0.0102	3	Arellano Ferro (1984)
45901.5416	−590	+0.1541	3	Eggen (1985)
48510.7555	−241	−0.0157	3	Berdnikov (2008)
48877.1742	−192	0.0425	3	Berdnikov (2008)
49535.2284	−104	0.0971	3	Berdnikov (2008)
49624.8203	−92	0.0142	3	Berdnikov (2008)
49946.2600	−49	−0.0460	3	Berdnikov (2008)
50312.5890	0	−0.0775	3	Berdnikov (2008)
50649.2110	45	0.0910	2	Berdnikov (2008)
50918.2635	81	−0.0193	3	Ignatova & Vozyakova (2000)
51000.5520	92	0.0251	3	Berdnikov (2008)
51269.6493	128	−0.0404	3	Berdnikov (2008)
51650.9813	179	−0.0224	3	Berdnikov (2008)
52368.7710	275	−0.0001	3	Berdnikov (2008)
52518.4048	295	0.0988	2	ASAS (Pojmanski 2002)
52832.4065	337	0.0773	3	ASAS (Pojmanski 2002)
53123.9522	376	0.0300	3	ASAS (Pojmanski 2002)
53273.4217	396	−0.0354	2	ASAS (Pojmanski 2002)
53774.4264	463	0.0274	3	ASAS (Pojmanski 2002)
53849.1873	473	0.0209	3	ASAS (Pojmanski 2002)
54305.2653	534	0.0175	3	ASAS (Pojmanski 2002)
54634.3213	578	0.0968	3	AAVSO
54656.6810	581	0.0262	3	ASAS (Pojmanski 2002)
55023.1371	630	0.1219	3	ASAS (Pojmanski 2002)
55314.6843	669	0.0761	3	AAVSO

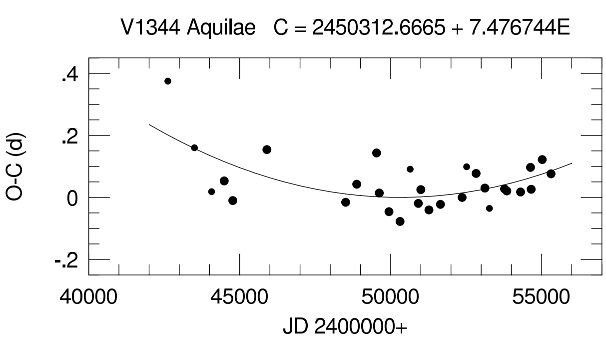

Figure 4. $O - C$ diagram (for the median brightness on the ascending branch) of V1344 Aql based on the values listed in Table 6. The pattern of the graph indicates that the pulsation period of V1344 Aql has been continuously increasing.

The wavelength dependence of the photometric amplitudes studied by Klagyivik & Szabados (2009), however, hints at the presence of a red companion.

RV data have been available from two consecutive years: from 1980 by Balona (1981) and from 1981 by Arellano Ferro (1984). Additional spectroscopy of V1344 Aql was performed by Luck & Lambert (2011) but they concentrated on the chemical composition of their numerous target Cepheids without determining RV values from the spectra. They obtained an atmospheric iron abundance of [Fe/H]= 0.15 for V1344 Aql.

The two earlier RV data series for V1344 Aql (Balona 1981; Arellano Ferro 1984) already imply a slight shift between the annual mean velocity. (When constructing the phase curve from these data, it became obvious that there might be a misprint in the list of Arellano Ferro's data: instead of -14.31 km s^{-1}, the correct value should be +4.31 km s^{-1} at JD 2 444 829.762.)

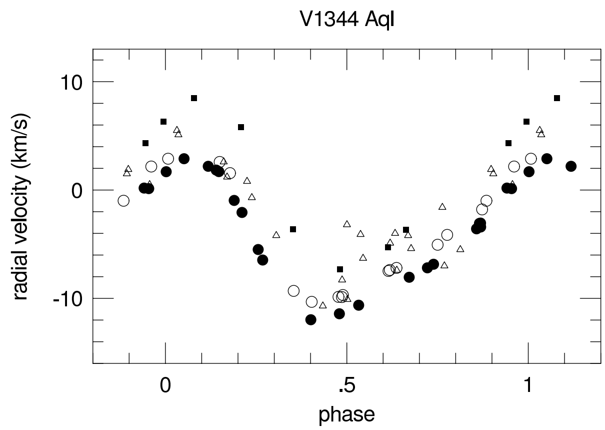

Figure 5. Merged RV phase curve of V1344 Aql. The filled and open circles represent our new data obtained in 2012 and 2013, respectively, triangles denote Balona's (1981) data, while Arellano Ferro's (1984) data are marked as black squares.

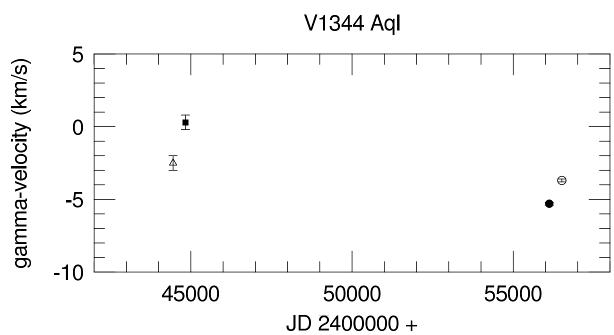

Figure 6. Temporal variation in the γ-velocity of V1344 Aql. The symbols for the different data sets are the same as in Fig. 5.

Supplemented with our new data, the merged phase diagram of all RV observations is plotted in Fig. 5. In order to reach correct phasing of data obtained in widely different epochs, the RV data have been folded on the pulsation period given in the ephemeris in equation (2). The zero phase has been arbitrarily chosen at JD 2 400 000. The data in Fig. 5 clearly show a vertical shift between the mean RV values exceeding 2 km s^{-1} within one year, referring to the membership of V1344 Aql in a SB system.

Table 7 summarizes the pulsation averaged mean RV values. Variability in the γ-velocity is visualized in Fig. 6. The pattern of the data points in this figure implies an orbital period of several hundred days which is rather short among the SB Cepheids.

Table 7. γ-velocities of V1344 Aql

Mid-JD 2 400 000+	v_γ (km s^{-1})	σ (km s^{-1})	N	Data source
44449	−2.5	0.5	24	Balona (1981)
44832	+0.3	0.5	8	Arellano Ferro (1984)
56117	−5.3	0.1	22	Present paper
56507	−3.7	0.1	16	Present paper

5 CONCLUSIONS

We pointed out that the classical Cepheids FN Aql and V1344 Aql have a variable γ-velocity which implies their membership in SB systems. The available RV data are insufficient to determine the orbital period and other elements of the orbit. However, the temporal variations in the γ-velocity indicate an orbital period as long as several decades for the FN Aql system and a rather short orbital period for the SB system involving V1344 Aql.

The value of the orbital period for SB systems with a Cepheid component is often unknown: according to the on-line data base (Szabados 2003b) the orbital period has been determined for about 20% of the known SB Cepheids. For most of them, the known orbital period exceeds a thousand days.

Our finding confirms the previous statement by Szabados (2003b) about the high percentage of binaries among classical Cepheids and the observational selection effect hindering the discovery of new cases. Moreover, another statistical bias is apparent from the list of Galactic Cepheids known in binary systems consisting of 165 items: only 40% of the Cepheids have a positive declination, indicating that the northern sky has not been investigated satisfactorily.

Regular monitoring of the radial velocities of a large number of Cepheids will be instrumental in finding more long-period spectroscopic binaries among Cepheids. RV data to be obtained with the *Gaia* astrometric space probe (launched on 19 Dec 2013) will certainly result in revealing many new spectroscopic binaries among Cepheids brighter than 13–14 mag.

In principle, the orbital motion gives rise to a light-time effect in the $O-C$ diagram of pulsating stars. In our case, however, its amplitude is either too small (for V1344 Aql, the effect is of the order of a thousandth of a day), or it cannot be revealed yet because of the length of the orbital period (several decades in the case of FN Aql). Both Cepheids show secular variations in the pulsation period (see the $O-C$ diagrams in Figs 1 and 4, respectively). In addition to these changes of evolutionary origin, the recently discovered period jitter in classical Cepheids (Derekas et al. 2012) is also against revealing a very low amplitude light-time effect in the $O-C$ diagrams of Cepheids.

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