Precision Asteroseismology
Proceedings IAU Symposium No. 301, 2013
J. A. Guzik, W. J. Chaplin, G. Handler & A. Pigulski, eds.

doi:10.1017/S1743921313014889

Ground-based photometry for 42 *Kepler*-field RR Lyrae stars

Young-Beom Jeon[1], Chow-Choong Ngeow[2] and James M. Nemec[3]

[1]Korea Astronomy and Space Science Institute (KASI), Daejeon 305-348, Korea
email: ybjeon@kasi.re.kr

[2]Graduate Institution of Astronomy, National Central University, Taiwan
email: cngeow@gmail.com

[3]Department of Physics & Astronomy, Camosun College, Victoria, British Columbia, Canada
email: jmn@isr.bc.ca

Abstract. Follow-up $(U)BVRI$ photometric observations have been carried out for 42 RR Lyrae stars in the *Kepler* field. The new magnitude and color information will complement the available extensive high-precision *Kepler* photometry and recent spectroscopic results. The photometric observations were made with the following telescopes: 1-m and 41-cm telescopes of Lulin Observatory (Taiwan), 81-cm telescope of Tenagra Observatory (Arizona, USA), 1-m telescope at the Mt. Lemmon Optical Astronomy Observatory (LOAO, Arizona, USA), 1.8-m and 15-cm telescopes at the Bohyunsan Optical Astronomy Observatory (BOAO, Korea) and 61-cm telescope at the Sobaeksan Optical Astronomy Observatory (SOAO, Korea). The observations span from 2010 to 2013, with ∼200 to ∼600 data points per light curve. Preliminary results of the Korean observations were presented at the 5th KASC workshop in Hungary. In this work, we analyze all observations. These observations permit the construction of full light curves for these RR Lyrae stars and can be used to derive multi-filter Fourier parameters.

Keywords. stars: variable: RR Lyrae

We obtained ground-based $(U)BVRI$ photometric observations for 42 RR Lyrae stars in the *Kepler* field. Figure 1 shows a phased light curve of KIC 3864443 and the correlation between $\phi_{31}(Kp)$ and $\phi_{31}(V)$ for all Blazhko and non-Blazhko RRab stars. Table 1 presents the total amplitudes, $A_{\rm tot}$, and ϕ_{31} parameters from Fourier analysis of RRab

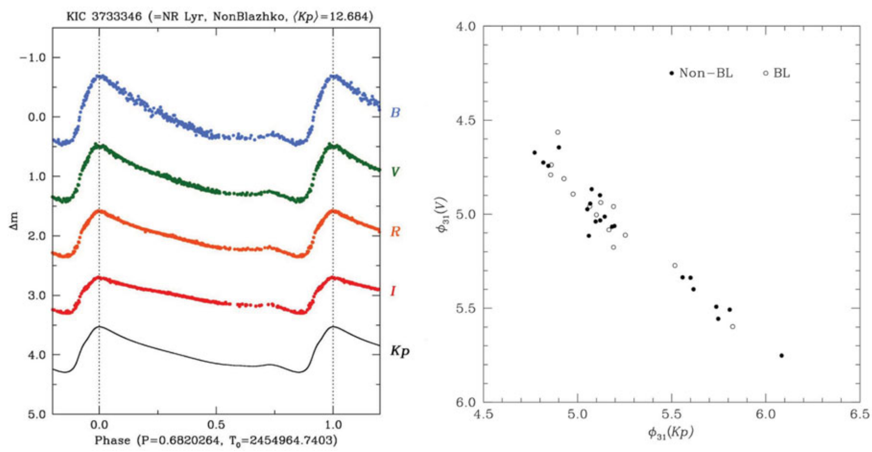

Figure 1. A sample phased light curve of KIC 3864443 (left) and the correlation between $\phi_{31}(Kp)$ and $\phi_{31}(V)$ for Blazhko and non-Blazhko RRab stars (right).

Table 1. Fourier parameters for RRab stars

KIC	GCVS	Period day	$\mathbf{A}_{tot}(B)$ mag	$\phi_{31}(B)$ rad	$\mathbf{A}_{tot}(V)$ mag	$\phi_{31}(V)$ rad	$\mathbf{A}_{tot}(R)$ mag	$\phi_{31}(R)$ rad	$\mathbf{A}_{tot}(I)$ mag	$\phi_{31}(I)$ rad
Blazhko:										
3864443	V2178 Cyg	0.48695	1.106	4.245	0.834	4.564	0.712	4.556	0.554	4.905
4484128	V808 Cyg	0.54786	1.398	4.856	1.115	5.055	0.922	5.254	0.707	5.621
5559631	V783 Cyg	0.6207	1.220	5.105	0.969	5.263	0.783	5.609	0.625	5.973
6183128	V354 Lyr	0.56169	1.028	4.942	0.821	5.168	0.639	5.496	0.490	6.082
6186029	V445 Lyr	0.51312	0.664	[6.514]	0.529	[6.964]	0.464	[7.106]	0.449	5.030
7257008	—	0.51178	1.252	4.632	0.997	4.769	0.739	5.149	0.594	5.057
7505345	V355 Lyr	0.4737	1.417	4.796	1.189	4.894	0.965	4.990	0.756	5.362
7671081	V450 Lyr	0.50461	1.122	4.519	0.873	4.919	0.736	4.884	0.614	5.381
9001926	V353 Lyr	0.5568	1.288	4.714	1.004	4.879	0.830	5.202	0.699	5.721
9578833	V366 Lyr	0.52703	1.344	4.935	1.067	5.090	0.869	5.385	0.662	5.576
9697825	V360 Lyr	0.55758	1.005	4.755	0.760	4.991	0.669	5.114	0.479	5.771
9973633	—	0.51075	1.506	5.240	1.315	5.107	0.909	5.206	0.732	5.526
10789273	V838 Cyg	0.48028	1.645	4.645	1.335	4.784	1.131	4.933	0.875	5.236
11125706	—	0.61322	0.706	5.302	0.540	5.614	0.452	5.970	0.352	[6.400]
12155928	V1104 Cyg	0.43639	1.603	4.657	1.295	4.689	1.062	4.851	0.891	5.242
Non-Blazhko:										
3733346	NR Lyr	0.68203	1.124	4.829	0.915	4.977	0.759	5.172	0.588	5.590
3866709	V715 Cyg	0.47071	1.525	4.702	1.226	4.643	1.015	4.929	0.841	5.269
5299596	V782 Cyg	0.52364	0.836	5.168	0.665	5.449	0.539	5.811	0.451	6.170
6070714	V784 Cyg	0.53409	1.055	5.477	0.830	5.839	0.616	6.191	0.482	[6.435]
6100702	—	0.48815	0.926	5.261	0.714	5.547	0.569	5.841	0.440	[6.357]
6763132	NQ Lyr	0.58779	1.185	4.811	0.954	4.958	0.770	5.105	0.606	5.628
6936115	FN Lyr	0.5274	1.482	4.622	1.226	4.758	0.996	4.857	0.813	5.204
7021124	—	0.62249	1.489	4.560	1.176	5.159	0.957	5.078	0.686	5.065
7030715	—	0.68361	0.944	5.162	0.732	5.437	0.605	5.639	0.473	6.202
7176080	V349 Lyr	0.50707	0.111	6.213	0.078	[8.054]	0.078	[6.859]	0.061	[7.009]
7742534	V368 Lyr	0.45649	1.666	4.551	1.327	4.705	1.104	4.932	0.976	5.174
7988343	V1510 Cyg	0.58114	1.496	4.850	1.247	4.963	0.970	5.122	0.759	5.427
8344381	V346 Lyr	0.57683	1.430	4.858	1.163	5.009	0.945	5.036	0.563	4.416
9508655	V350 Lyr	0.59424	1.452	4.809	1.189	4.955	0.974	5.130	0.758	5.523
9591503	V894 Cyg	0.57139	1.577	4.871	1.257	4.961	1.037	5.148	0.824	5.452
9658012	—	0.53321	1.402	4.811	1.125	5.012	0.943	5.103	0.719	5.489
9717032	—	0.55691	1.384	4.852	1.021	5.070	0.852	5.399	0.704	5.432
9947026	V2470 Cyg	0.54859	0.880	5.254	0.693	5.488	0.571	5.900	0.458	[6.344]
10136240	V1107 Cyg	0.56578	1.178	4.899	0.961	5.113	0.785	5.326	0.618	5.648
10136603	V1107 Cyg	0.43377	1.235	5.186	0.947	5.121	0.732	5.667	0.572	6.139
11802860	AW Dra	0.68722	1.321	5.240	1.045	5.431	0.848	5.639	0.652	6.045

Notes: [ ] denotes ϕ_{31} larger than 2π.

stars. RRc stars are expected to behave differently from the RRab stars and require special treatment, so they are not included. We used IRAF/digiphot/phot program to obtain the photometry. The periods in Table 1, as well as T_0 and Kp in Fig. 1, were taken from Nemec *et al.* (2011, 2013). The Fourier analysis was based on Géza Kovács' Fourier decomposition program.

From Table 1 we can calculate the mean differences between ϕ_{31} in $BVRI$ bands and $\phi_{31}(Kp)$ and their standard deviations. They are the following: $\Delta\phi_{31}(B) = \langle\phi_{31}(B) - \phi_{31}(Kp)\rangle = 0.430 \pm 0.107$ rad from 34 stars, $\Delta\phi_{31}(V) = 0.174 \pm 0.085$ rad from 34 stars, $\Delta\phi_{31}(R) = -0.018 \pm 0.053$ rad from 34 stars and $\Delta\phi_{31}(I) = -0.192 \pm 0.063$ rad from 35 stars. Earlier, $\Delta\phi_{31}(V) = 0.151$ rad was derived by Nemec *et al.* (2011) based on only three RR Lyrae stars. These results can help to derive metal abundances using Fourier parameters if $\phi_{31}(B, V, R, I)$ vs. $\phi_{31}(Kp)$ relations will be used to translate the former to the latter and then the [Fe/H] vs. $\phi_{31}(Kp)$ relation of Nemec *et al.* (2013) will be used to derive [Fe/H].

Transformation to standard photometry is currently in progress.

References

Nemec, J. M., Smolec, R., Benkő, J. M., *et al.* 2011, *MNRAS*, 417, 1022

Nemec, J. M., Cohen, J. G., Ripepi, V., *et al.* 2013, *ApJ*, 773, 181

https://doi.org/10.1017/S1743921313014889 Published online by Cambridge University Press