



Type II Cepheids in the Kepler – K2 mission



Monika I. Jurkovic^{1,2}, Emese Plachy², László Molnár²,
Martin A. T. Groenewegen³, Róbert Szabó²

¹ Astronomical Observatory Belgrade, Volgina 7, 11060 Belgrade, Serbia

² Konkoly Thege Miklós Astronomical Institute, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, H-1121 Budapest, Konkoly Thege Miklós út 15-17., Hungary

³ Koninklijke Sterrenwacht van België, Ringlaan 3, 1180, Brussels, Belgium

Type II Cepheids are old, low-mass ($\sim 0.5 M_{\odot}$) stars. They, mainly, pulsate in a radial mode, but recent discoveries have showed that there are first overtone pulsators among them, and they can exhibit a phenomena called “period doubling”. They are separated into three subgroups according to their period of pulsation: BL Her, $1 < P[d] < 4$, W Vir: $5 < P[d] < 20$, RV Tau: $20 < P[d] < 150$. Anomalous Cepheids have an average mass of $1.2 M_{\odot}$, and they pulsate in a fundamental mode, as well as, the first overtone. Their periods are in the range from 0.4 to 2.4 days. The Kepler space telescope's original field did not contain any Type II Cepheids, but that changed in the K2 mission. Here we present the 12 stars that were observed in Cycles 1 – 14 of the K2 mission. We have found five Type II Cepheids that show “period doubling”, and four possible anomalous Cepheids among the 12 stars.

DATA: The data for the Kepler – K2 mission was downloaded from the Mikulski Archive for Space Telescopes database (MAST, <https://archive.stsci.edu>), and analysed with the Extended Aperture Photometry (EAP), Plachy et al. (2017). For each star an individual aperture was applied, as seen in Figure 1 on the right for the star 218128117 from Cycle 7, where the telescope made significant jumps during the run of the cycle. We have also used the magnitudes from the EVEREST pipeline for comparison. Table 1., below, gives the basic information about each star in the sample.

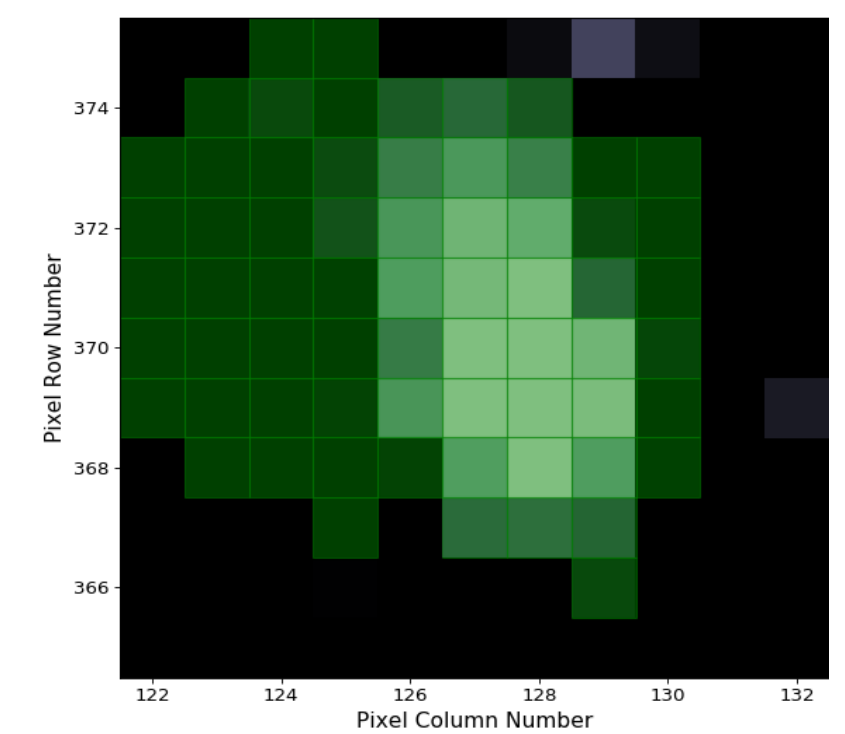


Figure 1.: The used pixel mask for star 218128117 from Cycle 7.

Table 1.: Basic information about the stars in the sample. The periods (P[d]) and average magnitudes ($\langle K_{\text{mag}} \rangle$) are the result of our Fourier analysis.

Cycle	EPIC ID	RA (2000)	DEC (2000)	P [d]	$\langle K_{\text{mag}} \rangle$	Notes
2	202862302	16 36 52.85	-28 05 34.26	1.956	12.926	V1287 Sco: W Vir
4	210622262	04 20 01.80	+17 16 45.80	16.657	16.882	W Vir with PD
7	217235287	19 16 10.99	-20 55 55.86	1.259	15.155	V527 Sgr: BLH
7	215881928	18 59 37.24	-23 21 52.27	1.835	14.606	V839 Sgr: BLH
7	217987553	19 06 26.95	-19 36 35.25	13.448	12.482	V1077 Sgr: W Vir with PD
7	218642654	19 06 03.14	-18 25 41.62	13.758	12.166	V410 Sgr: W Vir with PD
7	217693968	18 48 09.79	-20 07 35.61	16.215	13.289	V377 Sgr: W Vir with PD
7	218128117	19 34 34.67	-19 21 39.96	2.119	12.735	AC?
12	246015642	23 39 54.14	-09 05 01.81	1.071	15.399	AC
12	246385425	23 15 26.54	-01 22 28.73	1.502	17.972	AC
12	246333644	23 22 33.11	-02 23 40.13	1.287	17.792	AC
13	247445057	05 05 14.27	+21 45 48.93	13.944	12.355	VZ Tau: W Vir with PD?

RESULTS:

- we have found four anomalous Cepheids (see Figure 2 for their phased EVEREST light curves);
- five W Virginis stars show “period doubling” (PD), making this phenomena more wide spread than previously known with their residual Fourier spectra. Star 247445057 does not show PD, but it does have an additional modulation.

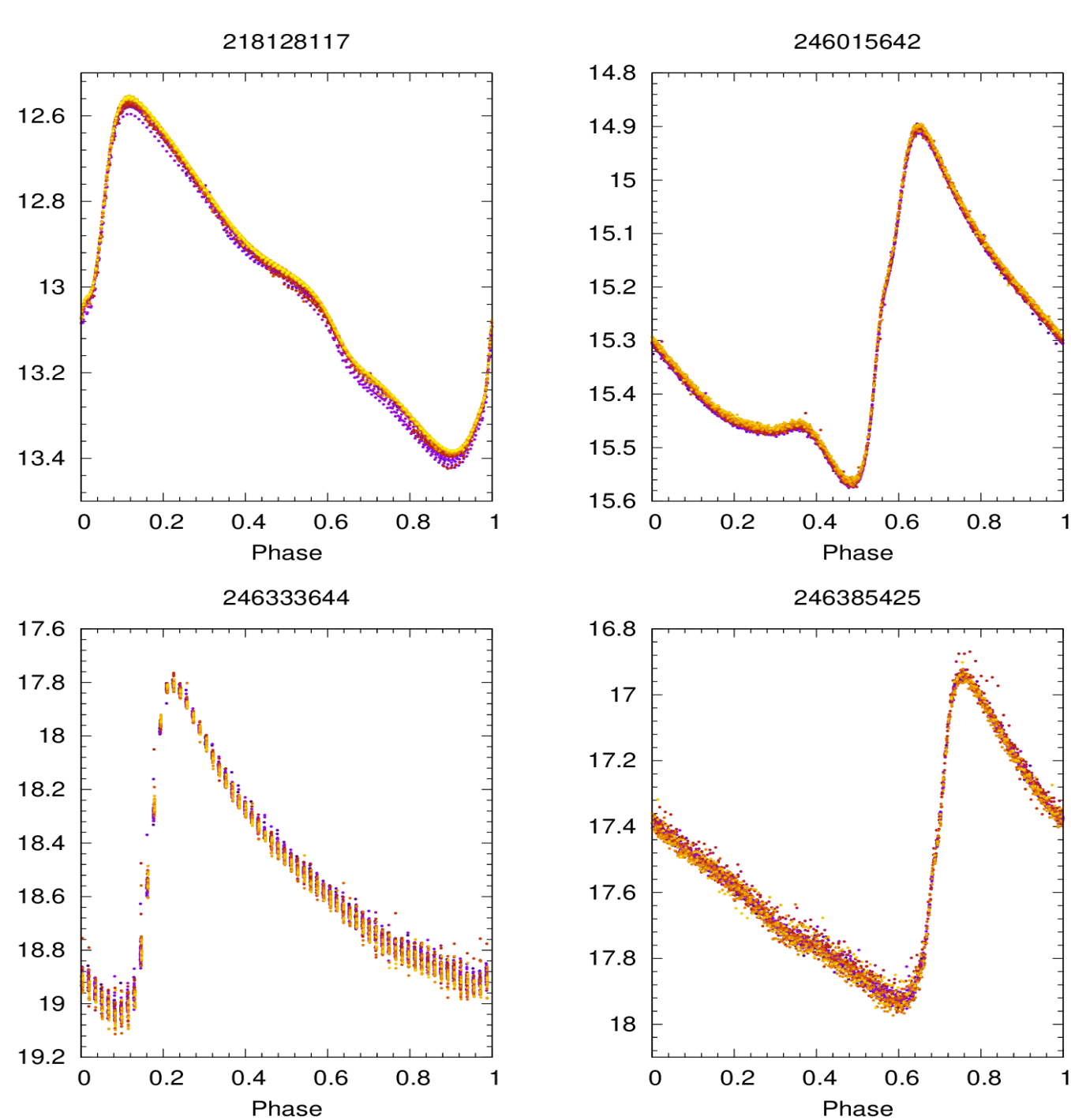


Figure 2.: Phased light curves of newly discovered anomalous Cepheids in the K2 sample of Type II Cepheids.

References:

Plachy E., Klagyivik P., Molnár L., Sódor Á., Szabó R., 2017a, in European Physical Journal Web of Conferences. p. 04009(arXiv:1704.00289), doi:10.1051/epjconf/201716004009

Acknowledgement: This project has been supported by the NKFIH K-115709 grant of the Hungarian National Research, Development and Innovation Office. MIJ acknowledges financial support from the Ministry of Education, Science and Technological Development of the Republic of Serbia through the project 176004. Research partially supported by the Delvidkert Kiss Foundation and Maria Lugaro's OTKA/NKFI-6 grant. LM was supported by the Premium Postdoctoral Research Program, E.P. by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences.

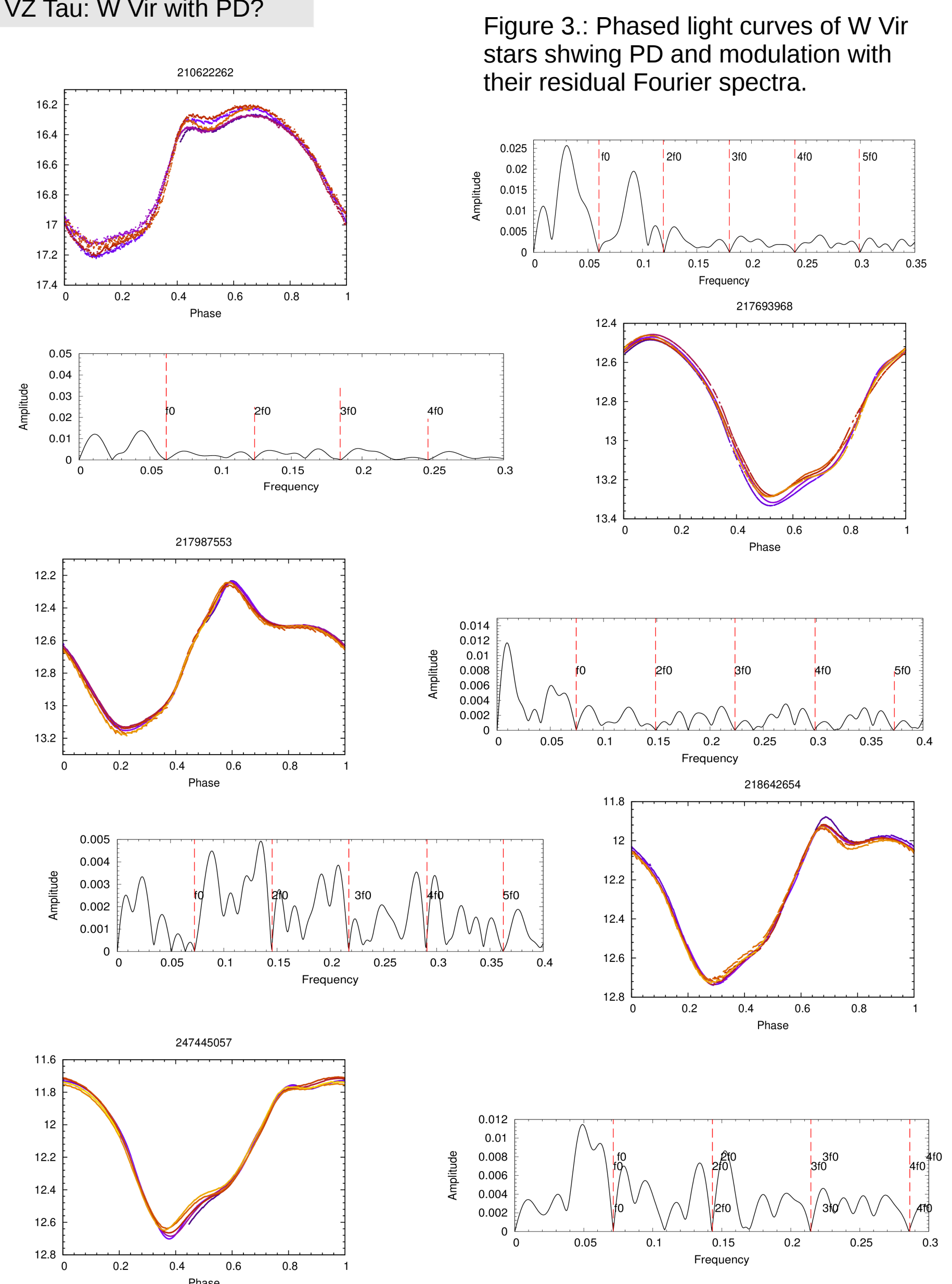


Figure 3.: Phased light curves of W Vir stars showing PD and modulation with their residual Fourier spectra.