PERIOD VARIATIONS AND EVOLUTION OF DELTA SCUTI VARIABLES

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The Short periods of Delta Scuti Stars allow the observational detection of the period changes expected from the stellar evolution within several tens years. For about 30 years we are keeping this topic as a small systematic observational program with our 60 cm telescope. Here we publish the period variation of 18 stars in table I. The data of 28 And are taken from R. Garrido et al. in *AAp* **144** (1983), 211; the period variation rate of 4 CVn is given by M. Breger. Both of them are low amplitude variables.

From these data we find out that both the population I and II variables can have period increasing and decreasing. The rate is between 2×10^{-6} to 8×10^{-8} days/year. Due to the period range of about 0.2 days, the time scale of period variation in one direction is limited within about 2 million to 200 million years. Usually we take the mass of this A to F type variables as 1.5 to 2.0 solar mass, so the main sequence life time is about several billion years. If all these A to F type main sequence stars will be variable in some period of its life time the possibility for a star to show Delta Scuti type variation is about hundredth, especially for the high amplitude type. Up to now we have found some 50 high amplitude variables with $V < 10.5$, and the total number of A3 to F5 with $V < 10.5$ is about 1.2×10^5, so the incidence of high amplitude variables is about 0.04%.

It seems that these period variations are mainly caused by stellar evolution. The period variation is smooth and continuous in general from the diagram of (O$-$C) of the time of light maxima. Both for the population I and II, there are always quite clear random fluctuations of the time of light maxima within an observational season. Normally this kind of fluctuation can be as large as 1 to 2 percentages of the pulsation period itself, so if in some season only having few times of light maxima, you can not have any true idea about the period variations. Some people often suggest abrupt variation for some stars may just caused by this reason.

For BL Cam there are only four groups of time of light maxima. From the first two groups D. H. McNamara get a period of 0.0390976 days. The error should be less than ± 0.0000001, but from the observations of McNamara to the next observations of E. Rodriguez et al. in *IBVS* No. 3428, 1990, the time span is too large so that we can not easy to find correct cycle number for them. If we use the formula given by McNamara, we have 110335.5423. So the cycle number may be 110335 or 110336. The first makes period increasing and the second makes the period decreasing. Now we have some

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TABLE I

star	P_0	P and P/P_0	ΔV	Tp	Sp
28 And	0.069304115	$(1.2\pm0.5)\times10^{-8}$	0.03	2×10^{7}	F0IV
	11	1.7×10^{-7}			
BS Aqr	0.197822854	$-(9.2\pm2.0)\times10^{-9}$	0.52	2×10^{7}	A8-F3
	56	4.7×10^{-8}			
GY Aqr	0.0610384097	$-(4.6\pm0.0)\times10^{-9}$	0.54	4×10^{7}	A2-A8
	21	2.5×10^{-8}			
YZ Boo	0.104091579	$(3.0\pm0.4)\times10^{-9}$	0.50	6×10^{7}	A6-F1
	2	2.9×10^{-8}			
BL Cam	0.03909783	$(1.5\pm0.1)\times10^{-7}$	0.33	1×10^{6}	PEC
	2	$3.9\times10-6$			
AD CMi	0.12297422	$(1.89\pm0.09)\times10^{-8}$	0.30	1×10^{7}	F0III-F3III
	1	1.5×10^{-7}			
VZ Cnc	0.178364047	$-(3.4\pm0.8)\times10^{-8}$	0.45–0.80	4×10^{6}	A7III-F2III
	5	1.9×10^{-7}			
XX Cyg	0.13486509	$(1.9\pm0.1)\times10^{-9}$	0.85	8×10^{7}	A5
	2	1.4×10^{-8}			
RS Gru	0.14701153	$-(2.2\pm0.7)\times10^{-8}$	0.59	8×10^{6}	A6-A9IV-F0
	9	1.5×10^{-7}			
DY Her	0.14863130	$-(5.2\pm0.6)\times10^{-9}$	0.51	3×10^{7}	A7III-F4III
	.1	3.5×10^{-8}			
KZ Hya	0.05951104	$(1.8\pm0.1)\times10^{-8}$	0.80	8×10^{6}	A0
	2	3.0×10^{-7}			
EH Lib	0.088413258	$-(7.6\pm2.9)\times10^{-10}$	0.60	2×10^{8}	A5-F3
	62	8.6×10^{-9}			
SZ Lyn	0.12053482	$(1.9\pm0.2)\times10^{-8}$	0.64	8×10^{6}	A7-F2III-IV
	2	1.6×10^{-7}			
HD79889	0.09586955	$-(8.0\pm1.9)\times10^{-8}$	0.40	3×10^{6}	A3
	6	9.3×10^{-7}			
ZZ Mic	0.0671796	$-(5.2\pm2.0)\times10^{-8}$	0.42	4×10^{6}	A3-A8IV
	2	7.7×10^{-7}			
DY Peg	0.072926362	$-(2.3\pm0.07)\times10^{-9}$	0.70	7×10^{7}	A3-F1
	1	3.2×10^{-8}			
SX Phe	0.054964509	$-(3.2\pm0.2)\times10^{-9}$	0.40–0.77	5×10^{7}	A2-F4
	2	5.8×10^{-8}			
4 CVn	0.11635	$-(1.3\pm?)\times10^{-7}$	<0.026	2×10^{6}	F3III-IV

observations with a focal reducer CCD camera on the 1 metre telescope of Yunnan observatory in February of 1991, which makes a cycle number differences of 132547.6091. So it may be 132547 or 132548 from the beginning. But after we consider about the period variations we choose the 110333 for

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the first of Rodriguez and the 132544 for the first of our observation. That means the first cycles differences makes a phase differences of 2.5423 cycles, the second one makes a phase differences of 3.6091 cycles which is quite good match with the cycles differences.

From all these we think all these stars are very close to the main sequence, and the evolution are not directly but spiral like to leave the main sequence.

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