Moving Through The Instability Strip

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The purpose: To look at period changes in pulsating variables from the point of view of stellar evolution. Is there evidence of systematic, slow changes that might be caused by the changes in mean density during passage across the Instability Strip?

The data: $O-C$ diagrams for 67 RR Lyrae stars and Cepheids by student assistants at the Maria Mitchell Observatory, and for 88 northern Cepheids by L. Szabados

The method: Least-squares lines and parabolae (unless the $O-C$ diagram shows that the period has changed in both directions). The rate of change of period comes from the coefficient of the square term in the parabola. The principal feature of these analyses is that the rate is taken to be non-zero only if the parabola is significantly better than the linear fit, at the 2-sigma level.

The results: This table summarises the directions of period change.

	N	Inc	Dec	Both	Cnst	Inc	Dec	Both	Cnst	I/(I+D)
Pop. II										
RRab, $P < 0.4d$	3	0	1	2	0	0%	33%	67%	0%	
RRab, $P > 0.4d$	36	10	2	6	18	28%	6%	17%	50%	0.83
CWB, $P < 0.4d$	10	3	4	1	2	30%	40%	10%	20%	0.43
CWB, $P > 0.4d$	9	1	1	5	2	11%	11%	56%	22%	
Pop. I										
DCEP	79	20	17	14	28	25%	22%	18%	35%	0.54
DCEPS	11	1	0	7	3	9%	0%	64%	27%	
Pop. ?										
CEP	7	1	0	1	5	14%	0%	14%	71%	
Total	155	36	25	36	58	23%	16%	23%	37%	0.59

Discussion: Period change in both directions is most frequent among the W Vir stars and the s-Cepheids. The three shortest periods among the RR Lyrae stars, unusually short for RRab, are also quite unstable. For half of the other RR Lyrae stars, a constant period can be excluded at the 2-sigma level; increasing periods are favoured over decreasing by 5 to 1. Are we seeing these stars evolving? The e-folding times, typically a few million years, are consistent with stellar evolution on and immediately after the horizontal branch. Much of the other period behaviour is too noisy to be due to evolution. Its cause is undetermined.

https://doi.org/10.1017/S025292110011810X Published online by Cambridge University Press