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A Century in Period Changes of the Variables in M15

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Abstract. Period behaviour of 62 RR Lyrae stars in the M15 globular cluster has been investigated. About one half of the sample (30 stars) exhibited linear period change. The remaining 32 variables can be characterized by abrupt or erratic changes in their periods.

1. Introduction

In the year 1896 Bailey took the first photographs on the globular cluster M15 at the Boyden Station of the Harvard Observatory in Arequipa, Peru (Bailey, 1919). Since these photographs a plethora of plates (over 1000) has been taken at different observatories.

2. Data and results

Photographic observations have been carried out between the years 1937 - 1966 at Konkoly Observatory in Budapest with the 24-in Newton telescope (Barlai, 1989) and between 1975 - 1991 at Piszkéstető, its mountain station with the 1m RCC telescope. From the 112 variables detected so far 63 were measurable on our plates. Besides this plate material, all the observations published on M15 during this century were collected and analysed concerning the change of the periods. Period changes of 62 RR Lyraes of the cluster were followed up. From these data O–C curves were constructed considering the phase shift of the folded light curves of each single year.

If the star's period has changed linearly (either increasing or decreasing) its rate can be characterized by the quantity $\beta = dP/dt$.

The phase of the maxima has been computed from JD = 2431000 being this date roughly the middle of the 95 year long observational interval. Among the 62 RR Lyrae variables studied the period changes could have been fitted by parabolae or straight lines in 30 cases. 18 variables – 8 RRab and 10 RRc stars – exhibit (+) β values while (–) β values characterize the period changes of 12 variables – 6 RRab and 6 RRc stars. It means 30% increasing and 20% decreasing periods. The behaviour of the remaining 50% (32 stars) could not be characterized by linear period change.

The average values of the rates of period changes – $10^{10}1/P(dP/dT)$ – are:
$+0.57 \pm 1.32$ for the 16 RRc stars;
-0.47 ± 2.86 for the 14 RRab stars and
$+0.08 \pm 1.48$ for these 30 RR Lyraes together.

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It is worth mentioning that from the 14 double mode RR Lyrae stars (Jurcsik & Barlai, 1990) in the cluster 9 exhibit erratic period change and 5 can be characterized by linear period change.

The sign of the period changes does not seem to depend on the single star's position within the RR Lyrae gap (Smith & Sandage, 1981). The slight increase in the average value of the period changes and the distribution of the β values may support Lee's (1991) theory. The occurrence of a great number of RR Lyrae stars that show abrupt and erratic changes in their periods cannot be easily reconciled with the present theories, where period change is due to evolution alone. The small number of the stars involved and the joint handling of the fundamental and first overtone pulsators may also throw some obstacle in the way of statistical evaluation of the data.

In our view preference should be given to Sweigart & Renzini's (1979) theory. According to it the observed period changes are due to random events happening in a semiconvective zone around the convective core. Including this instability in the core's composition the size and sign of the real period changes can be explained. Still a positive mean rate of period change can be expected in course of centuries due to nuclear evolution.

The present paper covers a long observational interval and a large sample of variables in M15. This sample does not show distinct bias towards increasing periods during the century elapsed as Lee (1991) supposed in his thoroughly computed theory. Nuclear evolution of RR Lyrae stars, however, can be grasped by further sudying of period changes in the coming centuries.

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