Radial and Nonradial Pulsations as Probes of Stellar Physics
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Period-Gravity Relation for Semiregular Variable Stars

K. Szatmáry, L.L. Kiss

Department of Experimental Physics and Astronomical Observatory, University of Szeged, Hungary, e-mail: k.szatmary@physx.u-szeged.hu

1. Introduction

Red giant stars located on the AGB are intrinsically variable, which is usually associated with stellar pulsation. The complex light variation of semiregular variables (SRVs) has many alternative explanations. Besides the pulsation, other contributors to variability cannot be solidly excluded, such as time-dependent surface inhomogeneities, ellipsoidal deformation due to the presence of a close companion, or spots on a rotating star. The identification of ultra-short period M-giants with periods of a few days raised the possibility of very high-order overtone pulsation of these stars. Thus, it is very important to draw various constraints on the stellar pulsation in semiregular variables and to separate other physical causes. Here we present new empirical evidence for radial pulsation in SRVs through studying their period-gravity relation, following the ideas outlined by Fernie (1995, F95). F95 studied a log P versus log g relation for various types of radially pulsating variable stars. He found a well-defined linear relation, which might serve to test whether the pulsation is radial or nonradial and, in the former case, fundamental or overtone. The main goal of our study is to extend the relation into the domain of SRVs.

2. Methods of analysis and discussion

On the one hand, we have chosen all variable stars which could be identified in the lists of Dumm & Schild (1998) and Koen & Laney (2000, KL00). Accepting the published R and M values, we have calculated the logarithm of surface gravities. The final sample of short-period M-giants with *semi-empirical* masses and radii contains 119 stars (Fig. 1, single symbols). The periods were taken from ESA (1997). On the other hand, we have collected 56 SRVs with two well-determined periods based on long term visual data (Mattei et al., 1998; Kiss et al., 1999). To infer *theoretical* surface gravities (Fig. 1, paired symbols), we have assumed that the two periods correspond to fundamental and first-overtone pulsation, and performed a least-squares fit of $M = f(P_0, P_1)$ and $R = f(P_0, P_1)$ using the model grid calculated by Ostlie & Cox (1986).

The main properties of the data distribution in Fig. 1 can be listed as follows: (i) There are well-defined parallel ridges of stars which have very similar slopes to the empirical relation of F95. The ridges have Q-values which are "typical" for different modes of pulsation in theoretical models. (ii) Some symbols fall almost exactly on the predicted line. These stars are either monoperiodic (in the shorter period regime) or multiply periodic (in the longer period regime,

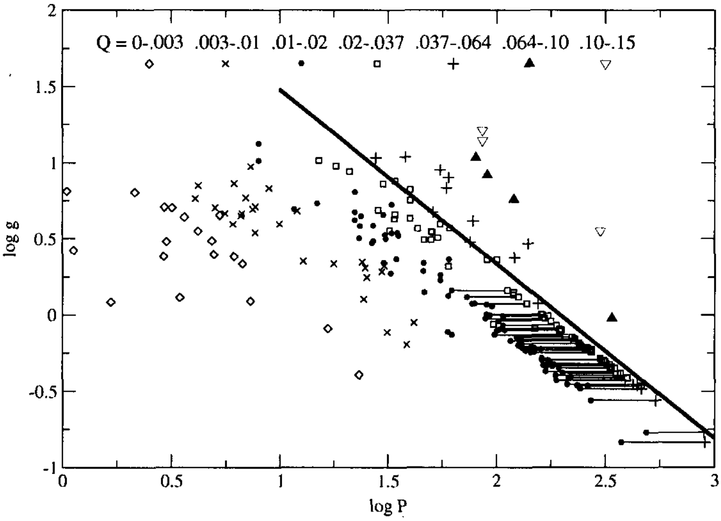

Figure 1. The log P – log g relation for the studied SRVs. The solid line refers to Fernie's relation. Symbols indicate Q values (see top of graph).

above 100 days). (iii) The locations of doubly periodic variables define very similar ridges to single-periodic stars. (iv) The slope of the ridges populated by the shortest period variables, called "rapidly oscillating M-giants" by KL00, is similar to that of the Fernie's line.

Based on these properties, we conclude that the light variation of the majority of programme stars is governed by radial pulsation. The very similar behavior of single and multiple periodic stars and short and long period semiregulars suggests similar nature of their light variations.

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