Comm. in Asteroseismology,
Vol. 159, 2009, JENAM 2008 Symposium № 4: Asteroseismology and Stellar Evolution
S. Schuh & G. Handler

A search for Extreme Horizontal Branch pulsators in ω Cen

S. K. Randall,[1] A. Calamida,[1] and G. Bono [2,3]

[1] ESO, Karl-Schwarzschild-Str. 2, 85748 Garching bei München, Germany
[2] Istituto Nazionale de Astrofisica, Osservatorio Astronomico di Roma,
Via Frascati 33, 00040 Monte Porzio Catone, Italy
[3] Università di Roma "Tor Vergata", Department of Physics,
Via della Ricerca Scientifica 1, 00133, Rome, Italy

Abstract

We report the discovery of a new pulsating EHB star from a search for rapidly pulsating Extreme Horizontal Branch in the globular cluster ω Cen.

Individual Objects: ω Cen

We report on the outcome of a search for rapidly pulsating Extreme Horizontal Branch (EHB) stars in ω Cen on the basis of 2 hours of SUSI2 rapid time-series photometry gathered at the 3.5-m NTT on La Silla, Chile. The field observed covers 5.5'×5.5' in the south-eastern quadrant of ω Cen, which was selected over more typical globular clusters for its well-populated EHB, as well as its relative proximity and low reddening. We used a U filter in order to minimize field crowding, and chose 3x3 binning to reduce the overhead time to 16 s, which combined with the exposure time of 20 s resulted in a cycle time of 36 s, low enough to detect the rapid oscillations expected in EC 14026 type stars, the main targets of our variability search.

These objects make up a small fraction ($\sim$ 5%) of subdwarf B (sdB) stars, which are evolved, core-helium burning objects located on the EHB of the H-R diagram. While they are thought to be the progeny of stars that suffered significant mass loss near the tip of the Red Giant Branch, the details of their formation remain unclear. It is hoped that eventually, the asteroseismic interpretation of the pulsators among them will enable a characterization of the mass and hydrogen-shell thickness distribution of the sdB population and thus help discriminate between different proposed evolutionary scenarios. First efforts in this direction appear promising, full asteroseismic analyses having so far been carried out for 12 out of at least 35 known EC 14026 stars (see Fontaine et al. 2008 for a recent review). However, until now, all known sdB pulsators belonged to the field population, despite several searches for variability among EHB stars in selected globular clusters.

The field we monitored with SUSI2 completely overlaps with available UBVI-band photometry of ω Cen gathered with WFI on the 2.2-m ESO/MPI telescope (Castellani et al. 2007). Performing simultaneous PSF-fitting photometry on the 192 SUSI2 frames obtained led to the detection of $\sim$ 20,000 stars, of which we were able to select potential EC 14026 star candidates from the WFI catalogue in terms of brightness ($16 \leq U \leq 18.5$), colour ($-2 \leq (U-V) \leq -0.8$), photometric accuracy, sharpness and separation index. For the 52 EHB stars thus identified we computed the airmass and seeing corrected light curves with respect to the mean SUSI2 u-band magnitude. Note that the latter was not calibrated and does therefore not constitute a standard magnitude. We then computed the Fourier transform

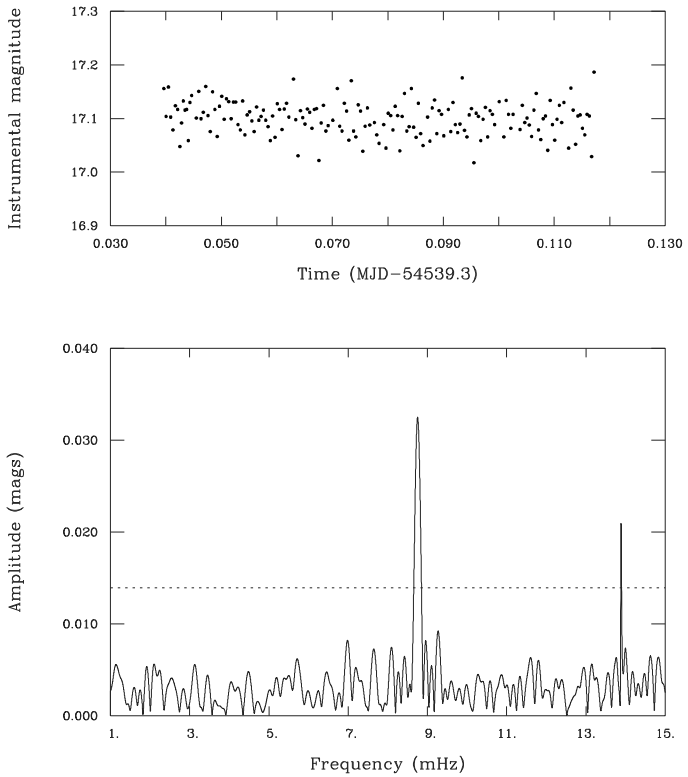

Figure 1: Light curve (top) and Fourier transform (bottom) for the pulsating EHB star discovered in ω Cen. Note that the relative u magnitude indicated for the light curve is offset by around $+0.25$ magnitudes with respect to the absolute U magnitude from the WFI catalogue. The dominant pulsation has a period of 114 s, while the strange-looking secondary peak corresponds to the Nyquist frequency. The horizontal dashed line indicates the 4σ detection threshold.

(FT) for each light curve in the 1−15 mHz range, appropriate for detecting the pulsations expected for the EC 14026 pulsators.

Of the 52 selected candidates, one shows a credible peak in the FT above the imposed detection threshold of 4σ. Its light curve and Fourier transform are displayed in Fig. 1, where both the 114-s (8.75 mHz) peak thought to indicate stellar oscillation as well as an observational artefact at 72 s (13.9 mHz) corresponding to the Nyquist frequency are visible. The latter is encountered in most of the targets monitored, while the former is unique to the star displayed. This strengthens the case for the discovery of real variability in the star rather than an instrumental or observational signature.

The period detected for the variable star ties in well with the typical 100−200 s pulsations observed for EC 14026 stars. Moreover, a comparison of the observed optical colours with Horizontal Branch models appropriate for ω Cen indicates an effective temperature of 31,500 $\pm$ 6,300 K for this object, placing it well within the 29,000−36,000 K instability strip for rapidly oscillating subdwarf B stars. Therefore, we are quite confident that we have discovered the first EC 14026 star in a globular cluster.

Further details on the work presented here can be found in Randall et al. 2009.

Acknowledgments. S.K.R. would like to thank the ESO La Silla staff, in particular SUSI2 instrument scientist Alessandro Ederoclite. Sadly, the observations reported here were among the last ever obtained with SUSI2 since the instrument has since been decommissioned.

References

Castellani, V., Calamida, A., Bono, G., et al. 2007, ApJ, 663, 1021

Fontaine, G., Brassard, P., Charpinet, S., et al. 2008, ASP Conf. Ser., 392, 231

Randall, S. K., Calamida, A., & Bono, G. 2009, A&A, 494, 1053