Mem. S.A.It. Vol. 77, 146

Memorie della

Carbon stars in the SMC: pulsation properties from MACHO light-curves

G. Raimondo[1], M.R.-L. Cioni[2], R. Rejkuba[3], and D.R. Silva[3]

[1] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Teramo, Via M. Maggini s.n.c., I-64100 Teramo, Italy, e-mail: raimondo@te.astro.it
[2] SUPA, School of Physics, University of Edinburgh, IfA, Blackford Hill, Edinburgh EH9 3HJ, UK
[3] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching bei München, Germany

Abstract. A sample of 1149 of carbon-rich stars in the Small Magellanic Cloud (SMC) was selected from the combined 2MASS and DENIS catalogues, and the spectroscopic atlas by Rebeirot et al. (1993). For a smaller number (N = 1079) we also found MACHO observations, then pulsation periods and amplitudes were determined.

Key words. Stars: AGB and post-AGB – Stars: variables: general – (Galaxies:) Magellanic Clouds

1. Introduction

Carbon-rich red giants (C-stars) are post main-sequence stars which develop an anomalous chemical composition in their atmospheres, where carbon dominates instead of oxygen. The carbon enrichment is thought to be due to the dredge-up that follows thermal pulses in the Asymptotic Giant Branch (AGB) phase. Most of the AGB stars show light curve variations with a typical period of 100 days or longer.

We selected a sample of C-stars in the SMC from the combined 2MASS and DENIS catalogues on the basis of their $J-K_s$ color [$J-K_s \leq 1.33$ mag] and K_s-magnitude [$K_s \leq 12$ mag]. We find that 73% of these photometrically selected C-stars have confirmed C-type spectrum (Rebeirot et al. 1993). Additional confirmed C-stars brighter than the RGB-tip from the Rebeirot et al. (1993) spectroscopic atlas were included in the sample, for a total of 1149 stars.

By adopting a searching radius of 3″, we cross-correlated those stars with the MACHO database (Alcock et al. 1992), choosing as counterpart of the 2MASS sources the nearest and reddest MACHO star. For 1079 C-stars we find MACHO observations.

2. Pulsation Analysis

An independent Fourier analysis of the light-curves was performed in both MACHO bands to search for periodicities in the data (Raimondo et al. 2005). The method used to extract the light curve parameters is based on the Lomb-Scargle algorithm (Lomb 1976; Scargle 1982) as used by Rejkuba et al.

Send offprint requests to: G. Raimondo

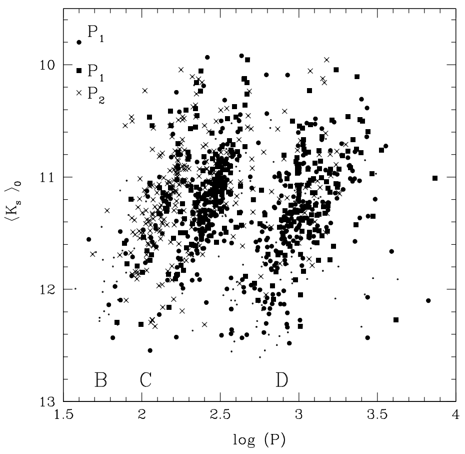

Fig. 1. $\langle K_s \rangle_0$ *versus logP* relation for all C-stars in the sample (small dots). Large symbols indicate stars with good-quality fit: filled circles refer to the first periods (P_1) of light-curves with one periodicity detected; filled squares and crosses correspond, respectively, to the first period and second period (P_2) for stars with two periodicities detected. $\langle K_s \rangle_0$ magnitude is the average of DENIS and 2MASS measurements. Letters identify the parallel sequences according to Wood et al. (1999).

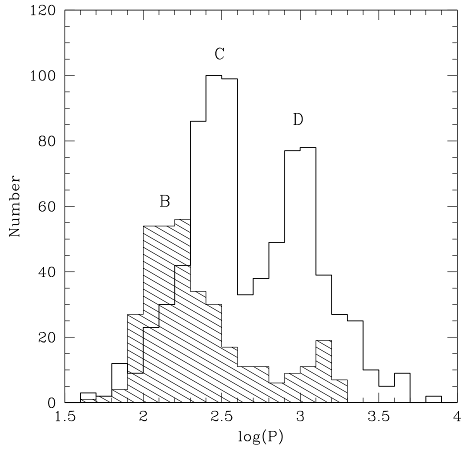

Fig. 2. Distribution of the periods found for B_M light-curves (for R_M light-curves results are very similar): P_1 (empty) and P_2 (shaded).

(2003). We looked for the first and second periodicities (P_1 and P_2) in each light-curve.

The MACHO time-baseline is about 2700 days (1992-2000), a factor two longer than that of OGLE-II. This very long-time baseline allowes us to confidently extract periods as long as $log(P) \sim 3.5$.

A sub-sample of 919 stars have high quality light-curves with amplitudes of at least 0.05 mag. Most of these stars have multiple well–defined periods, only 4% have a well–defined single period, while 15% have highly irregular light–curves.

The distribution of the logarithm of the period *versus* K_s-magnitude was analyzed (Fig. 1). Variable C-stars are distributed in three sequences: B, C, and D from Wood et al. (1999), and do not populate sequences with periods shorter than $\log P \sim 1.5$ (Fig. 2). About 10% of the variables fall on sequence B, 30% on C, and 34% on D. This last value is slightly higher than the 25% derived by Wood et al. (1999) and than the 21% derived by Groenewegen (2004) in the Large Magellanic Cloud. Monitoring of these variables over more than an 8-year period photometrically and spectroscopically is desirable in order to discern their nature. According to Wood et al. (2004) these stars belong to the only class of bright large amplitude variables whose properties cannot be explained with theoretical models at present.

References

Alcock, C., et al. 1992, ASP Conf. Ser., 34, 193
Groenewegen, M.A.T., 2004, A&A, 425, 595
Lomb, N.R., 1976, Ap&SS, 39, 447
Raimondo, G., et al. 2005, A&A, 438, 521
Rebeirot, E., et al. 1993, A&AS, 97, 603
Rejkuba, M., et al. 2003, A&A, 406, 75
Scargle, J.D. 1982, ApJ, 263, 835
Wood, P.R., et al. 1999, IAU Symp., 191, 151
Wood, P.R., et al. 2004, ApJ, 604, 800