A&A 636, A48 (2020)
https://doi.org/10.1051/0004-6361/201937271

Astronomy & Astrophysics

The VMC Survey

XXXVII. Pulsation periods of dust-enshrouded AGB stars in the Magellanic Clouds⋆,⋆⋆

M. A. T. Groenewegen[1], A. Nanni[2], M.-R. L. Cioni[3], L. Girardi[4], R. de Grijs[5,6,7], V. D. Ivanov[8], M. Marconi[9], M.-I. Moretti[9], J. M. Oliveira[10], M. G. Petr-Gotzens[8,11], V. Ripepi[9], and J. Th. van Loon[10]

[1] Koninklijke Sterrenwacht van België, Ringlaan 3, 1180 Brussels, Belgium
e-mail: martin.groenewegen@oma.be
[2] Aix Marseille Université, CNRS, CNES, LAM, 38, Rue Frédéric Joliot-Curie, 13388 Marseille Cedex 13, France
[3] Leibniz Institut für Astrophysik Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany
[4] Osservatorio Astronomico di Padova-INAF, Vicolo dell'Osservatorio 5, 35122 Padova, Italy
[5] Department of Physics and Astronomy, Macquarie University, Balaclava Road, Sydney, NSW 2109, Australia
[6] Research Centre for Astronomy, Astrophysics and Astrophotonics, Macquarie University, Balaclava Road, Sydney, NSW 2109, Australia
[7] International Space Science Institute–Beijing, 1 Nanertiao, Zhongguancun, Hai Dian District, Beijing 100190, PR China
[8] European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching bei München, Germany
[9] INAF – Osservatorio Astronomico di Capodimonte, Via Moiariello 16, 80131 Naples, Italy
[10] Lennard-Jones Laboratories, School of Chemical and Physical Sciences, Keele University, Keele ST5 5BG, UK
[11] Universitäts-Sternwarte, Ludwig-Maximilians-Universität München, Scheinerstr 1, 81679 München, Germany

Received 5 December 2019 / Accepted 2 March 2020

ABSTRACT

Context. Variability is a key property of stars on the asymptotic giant branch (AGB). Their pulsation period is related to the luminosity and mass-loss rate of the star. Long-period variables (LPVs) and Mira variables are the most prominent of all types of variability of evolved stars. The reddest, most obscured AGB stars are too faint in the optical and have eluded large variability surveys.
Aims. We obtained a sample of LPVs by analysing K-band light curves (LCs) of a large number of sources in the direction of the Magellanic Clouds with the colours expected for red AGB stars ($(J-K) > 3$ mag or equivalent in other colour combinations).
Methods. Selection criteria were derived based on colour-colour and colour-magnitude diagrams from the combination of the VISTA Magellanic Cloud (VMC) survey, *Spitzer* IRAC and AllWISE data. After eliminating LPVs with known periods shorter than 450 days, a sample of 1299 candidate obscured AGB stars was selected. K-band LCs were constructed by combining the epoch photometry available in the VMC survey with literature data, were analysed for variability, and fitted with a single period sine curve to derive mean magnitudes, amplitudes, and periods. A subset of 254 stars are either new variables, known variables where the period we find is better determined than the literature value, or variables with periods longer than 1000 days. The spectral energy distributions (SEDs) of these stars were fitted to a large number of templates. For this purpose the SEDs and *Spitzer* IRS spectra of some non-AGB stars (Be stars, HII regions and young stellar objects – YSOs) were also fitted to have templates of the most likely contaminants in the sample.
Results. A sample of 217 likely LPVs is found. Thirty-four stars have periods longer than 1000 days, although some of them have alternative shorter periods. The longest period of a known Mira in the Magellanic Clouds from Optical Gravitational Lensing Experiment data (with $P = 1810$ d) is derived to have a period of 2075 d based on its infrared LC. Two stars are found to have longer periods, but both have lower luminosities and smaller pulsation amplitudes than expected for Miras. Mass-loss rates and luminosities are estimated from the template fitting. Period-luminosity relations are presented for carbon (C-) and oxygen (O-) rich Miras that appear to be extensions of relations derived in the literature for shorter periods. The fit for the C stars is particularly well defined (with 182 objects) and reads $M_{\rm bol} = (-2.27 \pm 0.20) \cdot \log P + (1.45 \pm 0.54)$ mag with an rms of 0.41 mag. Thirty-four stars show pulsation properties typical of Miras while the SEDs indicate that they are not. Overall, the results of the LC fitting are presented for over 200 stars that are associated with YSOs.

Key words. stars: variables: general – Magellanic Clouds – stars: AGB and post-AGB

1. Introduction

At the end of their lives, essentially all low- and intermediate mass stars (roughly ∼0.9 to ∼10 $M_\odot$ on the main sequence) will go through the (super)-asymptotic giant branch (AGB) phase. They end up as ∼0.55−1.4 $M_\odot$ white dwarfs, which means that a large fraction of the initial mass of the star is lost to the interstellar medium. An important characteristic of AGB stars is that they pulsate, and they are classically divided into stars with small amplitudes (the semi-regular variables, SRVs) and the large-amplitude Mira variables. It is now common to use the term long-period variable (LPV) regardless of pulsation amplitude for a pulsating star on the AGB. Pulsation-induced shock waves and radiation pressure on dust is the most promising mechanism to explain wind driving, especially regarding the more

⋆ Full Tables A.1–A.3, and D.1 are only available at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsarc.u-strasbg.fr/viz-bin/cat/J/A+A/636/A48
⋆⋆ Based on observations made with VISTA at ESO under programme ID 179.B-2003.