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Long-term light curve variations of AGB stars: episodic mass-loss or binarity?

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Abstract. A significant fraction of the stars near the tip of the AGB phase become regular or semi-regular (Mira-type, SRs) pulsators. However, some of these light curves have shown intriguing secondary minima or sharp dips with much longer periods. Although this phenomenon shows some resemblance with the R CrB variables, the light curve is generally symmetric before and after the dip, whereas in R CrB the luminosity recovers slower after its minimum. More recently, high-resolution ALMA CO observations revealed a spiral structure around some of these stars, which suggests the presence of a stellar or sub-stellar companion. In these cases, the long-term light curve minima could be caused by periodic eclipses of the primary by a spiral circumstellar structure, and the long-period would be related to the orbital period. In this paper we discuss the pros and cons of the various proposed scenarios for the long-term minima of pulsating AGB stars.

Keywords. AGB stars, variable stars, binaries, mass-loss

1. Introduction

The asymptotic giant branch (hereafter AGB) is an evolutionary phase when an intermediate-mass star reaches a high luminosity, which favours a strong mass-loss rate (up to $10^{-4} M_{\odot}\mathrm{yr}^{-1}$). A significant fraction of the AGB stars develop radial pulsation in a scale of a few hundreds of days. Pulsation can be regular (the Mira-type variables), semi-regular (SRa, SRb types) or irregular (Lb). The high mass-loss rate often generates a optically-thick dust shell that may obscure (partial or totally) the visual spectrum of the star. The opacity of the dust shell is generally higher in carbon-rich stars (*i.e.* when $[C]/[O] > 1$), except in the cases where the O-rich AGB star undergoes a very high mass-loss rate (e.g. OH/IR stars, Lépine et al. 1995).

Long-term photometric observations (often limited to visual) of pulsating AGB stars obtained along the last century have revealed various kinds of inhomogeneities in their light curves, such as: variable amplitude and period, occurrence of multiple periods, changing light curve shapes, etc. However, about half of these pulsating stars show an intriguing very long secondary period (Soszyński et al. 2021), and a small fraction of them exhibit deep and sharp luminosity drops that can last one or a few pulsation cycles (Fig. 1). During these events, the visual brightness can decline 5 or 6 magnitudes, and the phenomenon can repeat in regular intervals of many years (between $18 \sim 37$ yrs in Table 1). The vast majority of these objects are C-rich.

In this paper, we discuss the most likely scenarios proposed in the literature to explain these long-term brighness decays, their pros and cons, considering multi-wavelength observations obtained at various spectral and spatial resolutions.