In search of binaries among RV Tauri stars without dust

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Project Level: MSc

RV Tauri stars are a group of luminous radial pulsators that are primarily defined by their light curves that show alternating deep and shallow minima. Past infrared (IR) surveys revealed that many of them are surrounded by dust. The dust is a result of high mass-loss at an earlier stage of their evolution called the asymptotic giant branch (AGB) phase, whereby the star ejects its outer envelope. At the post-AGB stage (Van Winckel 2003), the ejected dusty envelope appears as an IR-excess in their spectral energy distribution (SED, see left panel of Figure 1). The dust is in the form of a stable keplerian disc (De Ruyter et al. 2006, Kluska et al. 2018). It has been well established that the ones with a dusty disc are mostly found in binary systems (Van Winckel et al 2009, Manick et al. 2017, Oomen et al. 2018).

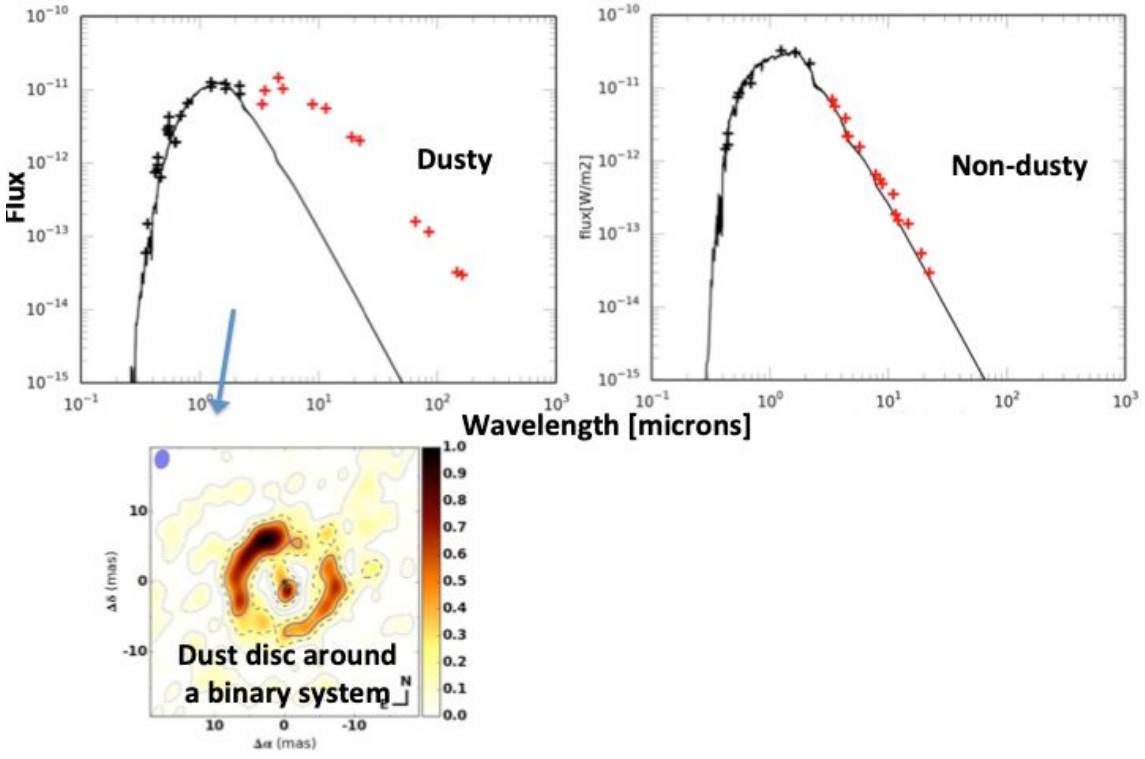

Figure1: Left, the SED of an RV Tauri star surrounded by a dusty disc. The red points show the IR-excess due to dust. Right, the SED of an RV Tauri star displaying no dust in the IR (Gezer et al. 2015).

Recent infrared surveys, however, have revealed that a large fraction of RV Tauri stars (~ 45%) do not display dust around them (non-IR, right panel of Figure 1). These non-IR objects are interesting because they do not seem to follow the general evolutionary scheme of stars in their late stages, i.e, the post-AGB stage. When we trace their evolution on the Hertzsprung-Russell diagram (HRD), it is seen that many of them appear at very low luminosities (Kamath et al. 2014, 2015, Manick et al. 2018). Such low luminosities are not predicted by single star evolutionary models. We therefore think that these are likely products of binary systems. However, none of them have been proven to be spectroscopic binaries yet.

In the first stage of this project the student will review the literature on RV Tauri stars and late stages of stellar evolution. The student will then proceed to analysing spectroscopic data of the whole sample of non-IR objects obtained from the Belgian Mercator Telescope operated in Spain. These will be complemented by spectroscopic data obtained from the South African Large Telescope (SALT) for the fainter targets.

The aim is to identify potential binary candidates among the whole sample of non-IR objects. Knowing their binary status will give us interesting clues about the nature of the companions. Moreover, if these turn to be post-AGB binaries, it would mean that in principle they should have had a disc in an earlier stage of their evolution which is dissipated by now. The results will potentially give us insights about disc dissipation lifetime and has the potential of opening new windows in our understanding of dust-dissipation physics. This will help to significantly improve the input physics in radiative transfer models of protoplanetary and post-AGB discs (e.g Min et al. 2009).

Interested students are expected to contact me through email and we can organise a Zoom meeting.