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PAMPERO: A NEW PHYSICAL APPROACH OF MOLECULAR PHOTOSPHERIC EJECTION AT HIGH ANGULAR RESOLUTION FOR EVOLVED STARS

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Abstract. PAMPERO is a numerical code for studying spectra-interferometric data for evolved stars. By using MARCS stellar atmospheric models for the simulation of a photosphere surrounded by a continuous and multi-layer molecular circumstellar disk, which is characterized according to the observed wavelength band. The model presented deduces the distributions of temperature and molecular density of the "MOLsphere" along the stellar radius. We aim to better understand the different mechanisms generating the important mass-loss which characterizes the large and rich family of evolved stars.

Keywords: methods: numerical – methods: observational – techniques: high angular resolution – techniques: interferometric – Infrared: stars – Stars: AGB and post-AGB, atmospheres – Stars: atmospheres – stars: fundamental parameters – stars: late-type

1 Introduction

In this work, we present simulations of two different prototypes of evolved stars (an Asymptotic Giant Branch -AGB- and a Red Giant Branch -RGB-), hypothetically observed by VLTI-AMBER (Petrov et al. 2007) at high spectral resolution in the K-band. We use the numerical model PAMPERO (for Physical Approach of Molecular Photospheric Ejection at high-angular-Resolution for evOlved-stars) in order to play with the physical proprieties of CO outer layers, namely : the distributions of the CO column density $N_{\rm CO}$ and the temperature $T_{\rm mol}$ along the stellar radius, to reproduce the observed flux and visibilities (further details in Hadjara et al. 2019b). In Sec. 2, we briefly describe the model and its results.

2 The model

PAMPERO is a multilayer MOLsphere model (inspired by Ohnaka 2013; Montargès et al. 2014), which surrounds the stellar Center-to-Limb intensity Variations (CLVs) obtained by preselected MARCS models (Gustafsson et al. 2008), by using Turbospectrum (Alvarez & Plez 1998; Plez 2012)* over the observed wavelength range thanks to the listed CO lines of Goorvitch (1994). PAMPERO is written in `Matlab` (for MATrix LABoratory). The description of our model is summarized on the synoptic diagram (Fig. 1-top-), while a sample of spectro-interferometric results are shown in Fig. 1-bottom-.

3 Conclusions

In the current paper, we show an application of PAMPERO for the molecule of CO on K-band. This is a small part of an important wok of a sample of eight different evolved stars observed with VLTI/AMBER (Hadjara et al. 2019b). We can also use PAMPERO for CHARA/VEGA (Mourard et al. 2011) data to study the Titanium monoxide (TiO) for Yellow Hyper-Giants (YHG) as an example, as well as characterize the temperature-density distribution of dust around evolved stars with the new instrument VLTI/MATISSE (Lopez et al. 2014).

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*To correct the spectral splitting caused by earth atmospheric air, we use Edlén's formula (Edlén 1966).

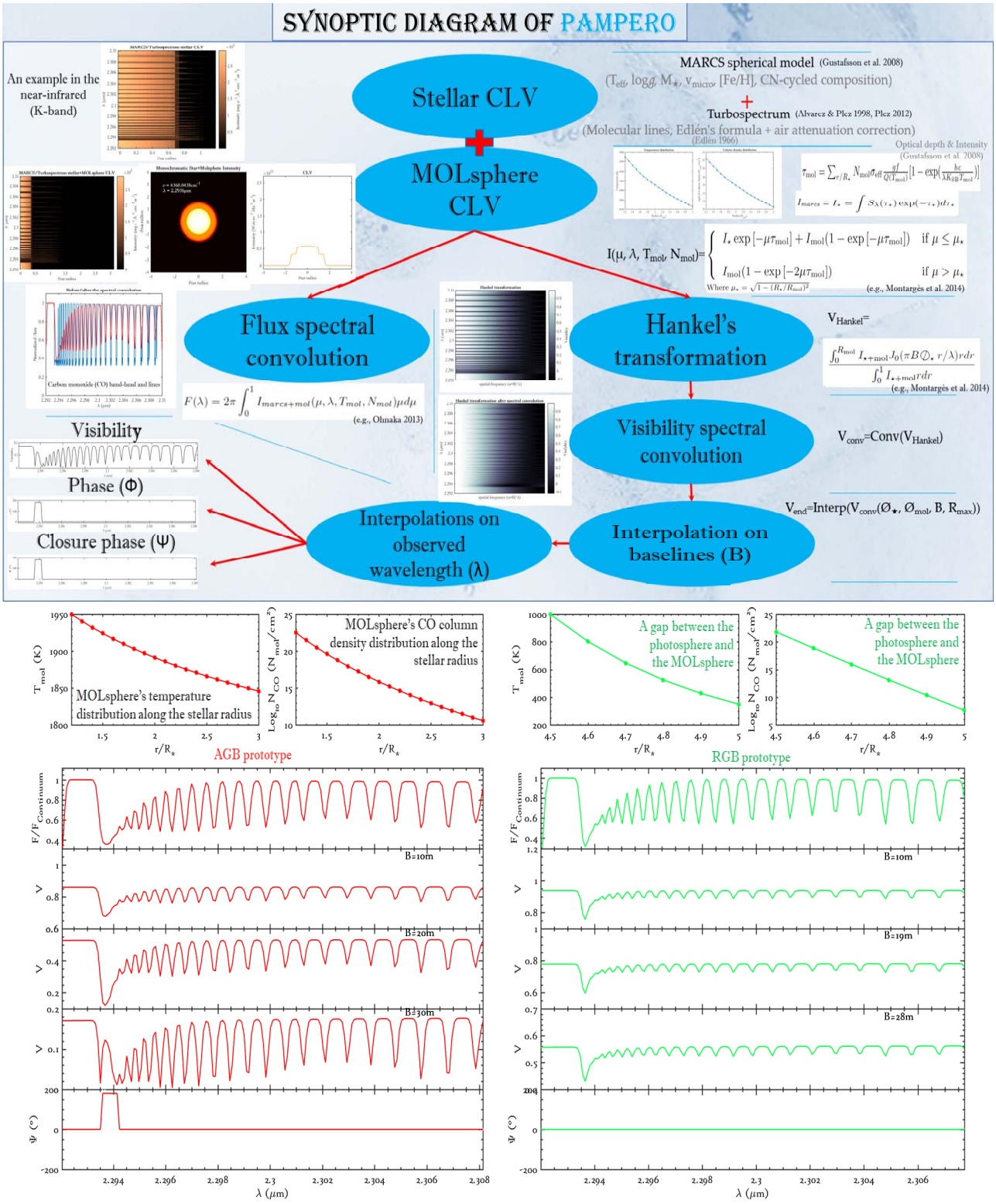

Fig. 1. Top: Synoptic diagram of PAMPERO. **Bottom:** Results for an AGB (in red lines) and a RGB prototypes (in green lines). ***Top panels:*** Temperature-density distribution along the stellar radius. ***Bottom panels:*** Spectro-interferometric data, namely : The normalized flux, visibilities (for a triplet of baselines B) and closure phase (Ψ).

References

Alvarez, R. & Plez, B. 1998, A&A, 330, 1109

Edlén, B. 1966, Metrologia, 2, 71
Goorvitch, D. 1994, ApJS, 95, 535
Gustafsson, B., Edvardsson, B., Eriksson, K., et al. 2008, A&A, 486, 951
Hadjara, M., Cruzalèbes, P., Nitschelm, C., et al. 2019, MNRAS, 489, 2595
Lopez, B., Lagarde, S., Jaffe, W., et al. 2014, The Messenger, 157, 5
Montargès, M., Kervella, P., Perrin, G., et al. 2014, A&A, 572, A17
Mourard, D., Bério, P., Perraut, K., et al. 2011, A&A, 531, A110
Ohnaka, K. 2013, A&A, 553, A3
Petrov, R. G., Malbet, F., Weigelt, G., et al. 2007, A&A, 464, 1
Plez, B. 2012, Turbospectrum: Code for spectral synthesis, Astrophysics Source Code Library