

Retrieving stellar parameters and dynamics of AGB stars with Gaia parallax measurements and radiative hydrodynamics simulations

Low- to intermediate-mass stars that have evolved to the Asymptotic Giant Branch (AGBs), have strong and steady winds that enrich massively the interstellar medium with diverse elements and contribute to the formation of the next generation of objects. They are characterized by complex photosphere (convection, pulsation) and atmosphere (shockwaves, winds, dust) dynamics.

Gaia Data Release 3 (GDR3) has grant access to plenty of information ; in particular, the measurement of the parallax for around 1.46 billion sources, including Mira stars which are peculiar pulsating AGBs with an extreme variation of magnitude.

In Chiavassa et al. 2018 (A&A, 617, id.L1) and 2022 (A&A, 661, id.L1), the authors used 3D radiative-hydrodynamics (RHD) simulations of convection with CO5BOLD and showed that stellar surface of evolved stars like AGBs is characterized by the presence of long-to-short convection-related structures that cause temporal variability on the emerging intensity in Gaia band [325 to 1030 nm]. As a consequence, the position of the photocentre (ie, the intensity-weighted mean of all emitting points of the stellar surface) is affected by temporal fluctuations. The authors also found that convection-related variability accounts for a substantial part of the parallax error.

Recently, Ahmad et al. 2022 (A&A, 669, id.A49) provided a large grid of AGB simulations that covers (in terms of stellar parameters) a substantial part of Gaia parallax measurements of Mira stars. We used 34 simulations to explore the impact of convection of AGBs on the photocentre variability and estimate its effect on the parallax measurements of 148 stars in GDR3 (see also Uttenthaler et al. 2019, A&A, 622, id.A120). Moreover, we provide a correlation with stellar fundamental parameters, dynamical properties, and photocentre displacement based on the comparison with Gaia astrometric error on its measurements.

I will present this work and show that, in the end, Gaia parallax variations could be exploited quantitatively to extract stellar parameters using analytical laws obtained from appropriate RHD simulations corresponding to the observed stars.