Massive Stars Near and Far
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CMD for atmospheres of massive stars created by using CMFGEN synthetic spectra

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Abstract. We present Color Magnitude Diagrams (CMDs) created by using our database of 43,340 synthetic CMFGEN spectra.For each calculated spectra we measure the absolute flux by Johnson and Gaia photometry filters and build synthetic CMDs.

Keywords. Color Magnitude Diagram, massive star, Hertzsprung-Russell Diagram, stellar wind

1. Introduction

GaiaData Release provides very high-precision astrometry and photometry for a large number of stars. Now very precise Hertzsprung-Russell Diagrams (HRDs) have been constructed and extremely fine structures for open and globular clusters have been reported (Gaia Collaboration et al. 2018). A detailed study of these fine structures will provide important constraints for stellar structure and evolutionary studies.

2. Our atmosphere grids

To calculate the synthetic spectra we use CMFGEN (Hillier & Miller 1998, 1999) non local thermal equilibrium stellar atmosphere code.

In order to properly constrain the input parameters, we used stellar evolutionary tracks and isochrones for both rotating and stationary stellar models reported by Ekström et al. (2012). The luminosity L, surface temperature T_{eff}, mass $M_{\odot}$ and mass-loss rates $\dot{M}$ and surface chemical composition for 9 evolutionary tracks (initial masses between 12 to 120 $M_{\odot}$) as well 8 isochrones (log age 6.5 to 7.2 yrs) were taken from Ekström et al. (2012).

To describe the wind structure we estimate $V_{\rm inf}$ using V_{esc}. For each stellar model we calculated 28 atmosphere models using combinations of $F_{cl} = 0.05$, 0.3, 0.6 and 1.0, and the type of velocity law of the wind $\beta = 0.5$, 0.8, 1.1, 1.4, 1.7, 2.0 and 2.3.

The chemical elements included in our models are H, He, C, N, O reported by Ekström et al. (2012) and we assumed solar metallicity as reported by Asplund et al. (2009) for Si, P, S, and Fe in all models.

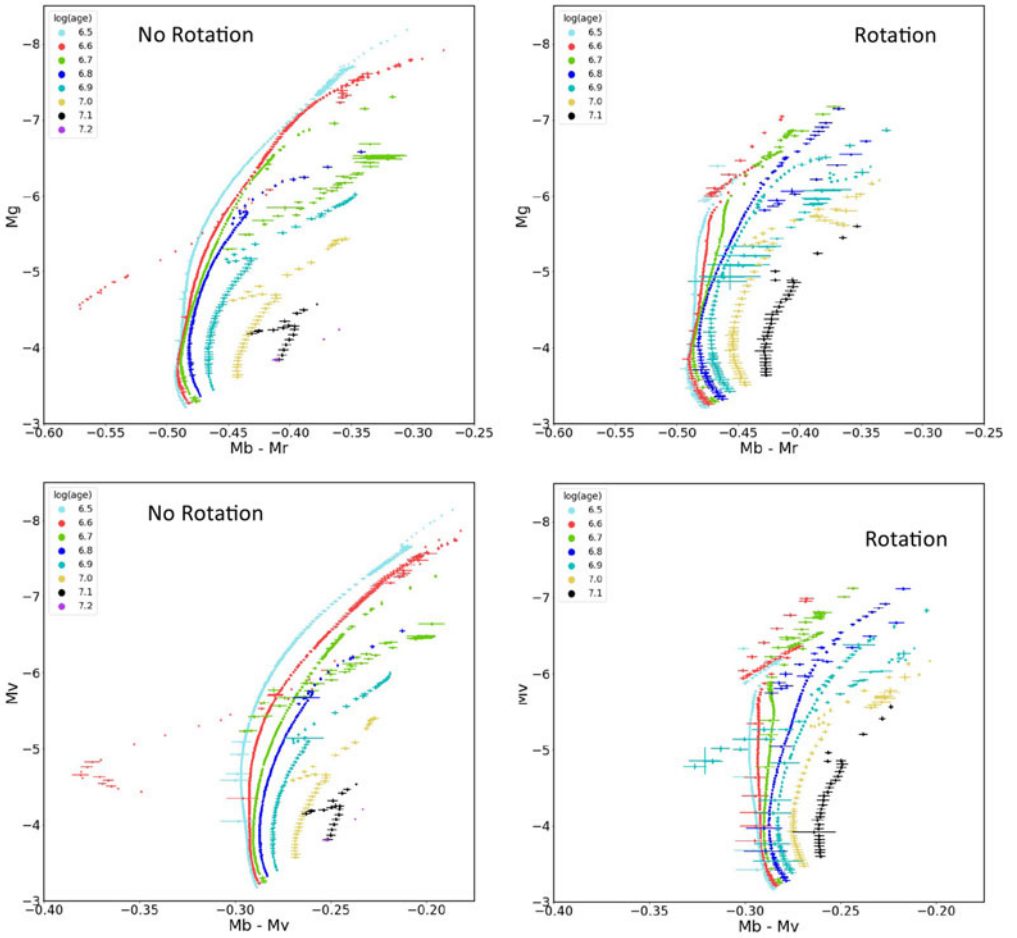

Figure 1. Syntetic color-magitude diagrams for Gaia (top) and Johnson (bottom) filters for evolutionary tracks.

3. Color-Magnitude Diagrams

Synthetic photometry for the grid of models has been calculated in order to obtain absolute magnitudes and colors in the BV Johnson and Gaia systems. For each broadband filter the computed magnitude and colors are:

$$M_i = -2.5 \frac{\int F(\lambda) S_i(\lambda) d\lambda}{\int F_0(\lambda) S_i(\lambda) d\lambda} + C_1 \tag{1}$$

and

$$(M_i - M_j)_{obs} = (M_i - M_j)_{calc} + C_2. \tag{2}$$

Where $F(\lambda)$ is the CMFGEN flux computed for a distance of 1 kpc from the star, $S_i(\lambda)$ is the filter response in the i band, $F_0(\lambda)$ is the Vega observed flux and C_1 and C_2 are constants needed to fix the zero point. Due to the characteristics of CMFGEN it is not possible to generate a model for a Vega type star, for this reason stars for which there is a fitted CMFGEN model and whose colors are known have been used (Fierro-Santillán et al. (2018)).

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A CMD was constructucted for Johnson and Gaia photometry filters. For different wind parameters in a same stellar model, the color index and absolute magnitude show a dispersion. We found that the position in color diagram have an important dependence not only on temperature and abundance, but with wind parameters as well. In order to visualize the dispersion, Figure 1 shows the average and standard deviation in the position for each stellar parameter model calculated with different wind parameters.

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