HR-pyPopStar: New SSP models of very high spectral resolution

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- The observed high resolution spectra from the last generation of instruments demand a theoretical basis for the interpretation of the physical parameters of the stellar populations, which is producing a trending need of high resolution spectra of Single Stellar Populations (SSPs).

- We have developed pyPopStar, a python-based updated and modern version of the PopStar code to compute SSPs.

- Our code uses high resolution synthetic stellar libraries for main sequence, post-AGB, planetary nebulae and Wolf-Rayet stars, as well as computes the nebular continuum spectra associated to the SSP in a self-consistent way combining the most precise atomic data and the number of ionizing photons (Q) of our computed stellar spectra.

Context

- State of the art instruments, such as MUSE, MEGARA, DESI, VLT/MOONS, create huge amounts of observational data.
- In order to extract all the information of the galaxy/galactic region that one has observed, such as Star Formation History, SFH; mean age of the stellar population, chemical enrichment history,… it is vital to have an accurate and fast way to process the spectra.
- High-resolution theoretical spectra of Single Stellar Populations (SSPs) are needed for the interpretation of the observational data.
- Synthetic spectra have the great advantage of having an excellent coverage of all the stellar parameters, what allows the computation of a wide range in age and metallicity of SSPs.
- Synthetic spectra can be computed very fast.

Model Description

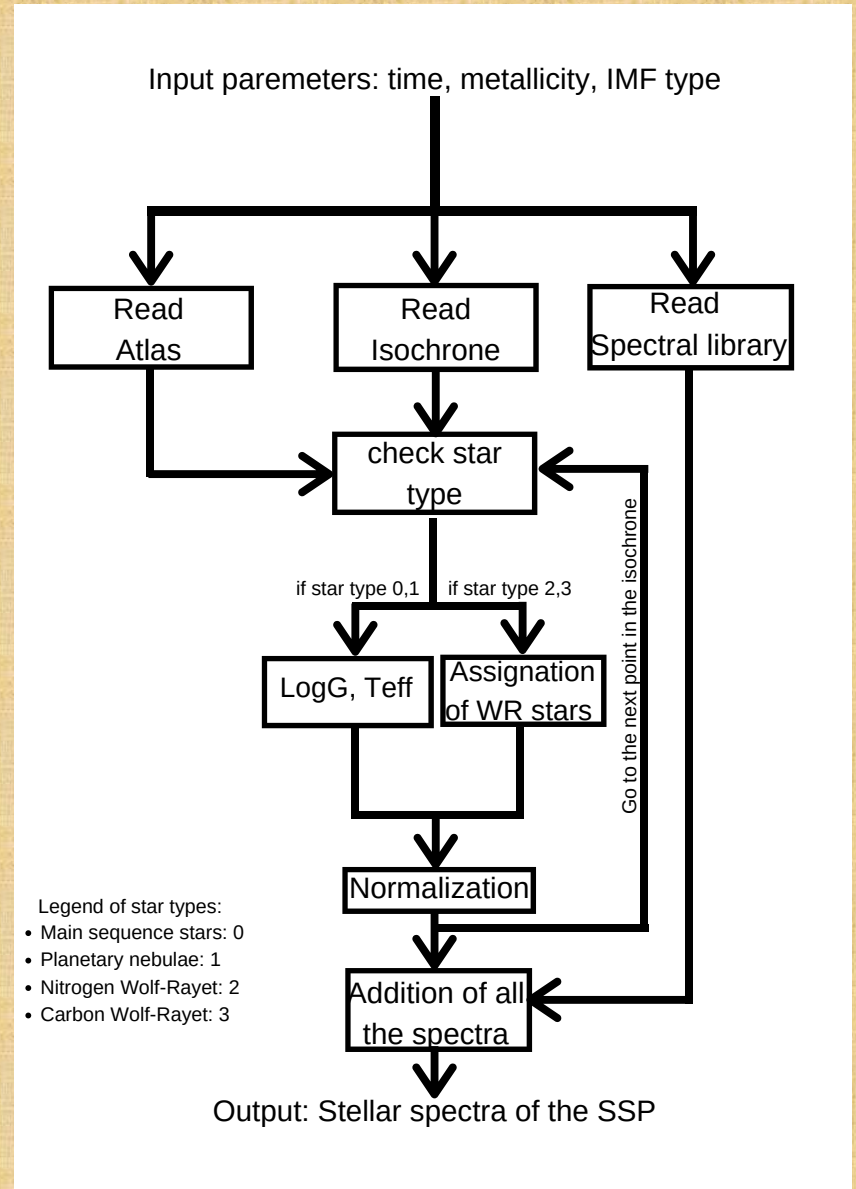
- We have developed pyPopStar, a python-based updated and modern version of the PopStar code to compute SSPs. In particular, we present the high-resolution spectra

- We have used the stellar libraries from:
  - Coelho (2014) — Main sequence stars
  - Rauch (2002) — Planetary nebulae
  - Sander (2015); Hainich et al. (2019) — O and B stars
  - Sander et al. (2012); Todt et al. (2015) — Wolf-Rayet stars

- Our code uses the isochrones of the Padova group:
  Bressan et al. (1993); Faggoto et al. (1994a, b) & Girardi et al. (1996).

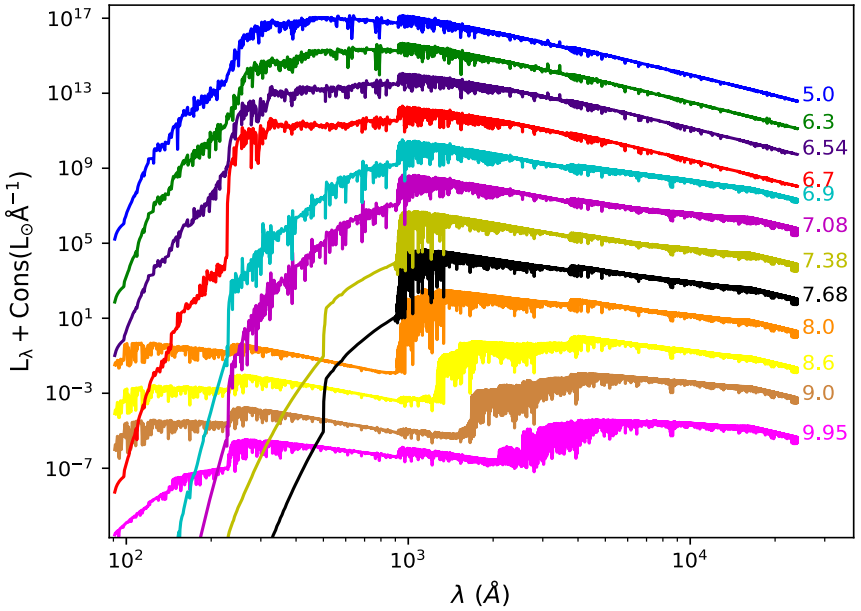
- The code also computes the nebular continuum spectra associated to the SSP in a self-consistent way combining the most precise atomic data (Osterbrock & Ferland 2006; Ercolano & Storey 2006) and the number of ionizing photons (Q) of our computed stellar spectra

Log(age) (yr)	Z
5.0 - 10.18	0.0017 - 0.026

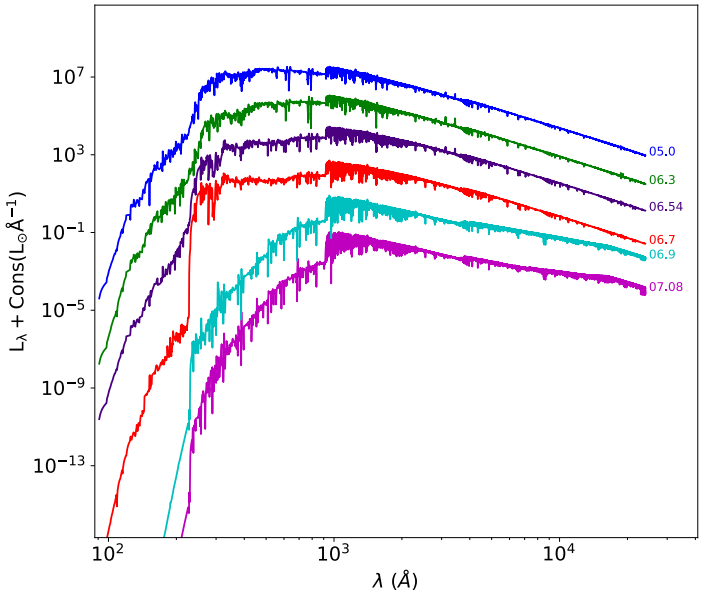


py-PopStar: code scheme

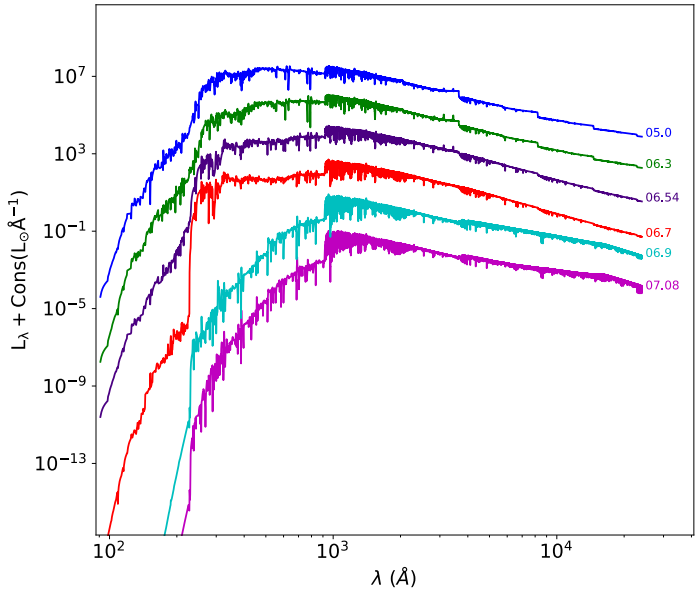
Products: SSP spectra



SSPs spectra for solar metallicity



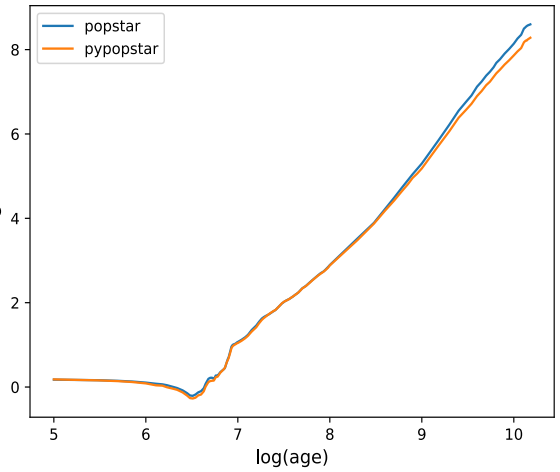
Young SSP set of stellar spectra for solar metallicity

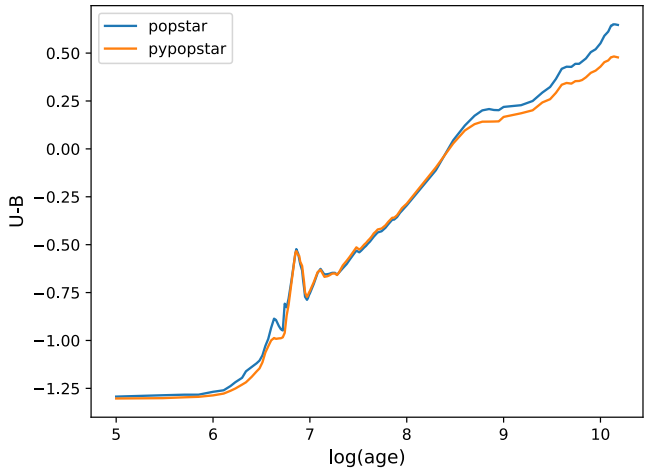


Young SSP set of stellar + nebular emission spectra for solar metallicity

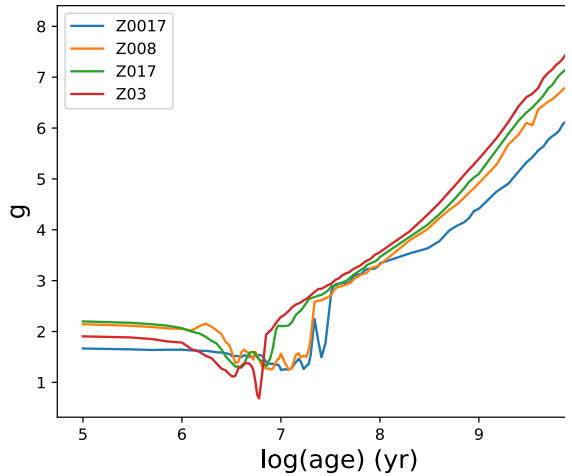
Our models have a spectral resolution of $\Delta\lambda = 0.06$ Å in the wavelength range from 91 Å to 24000 Å.

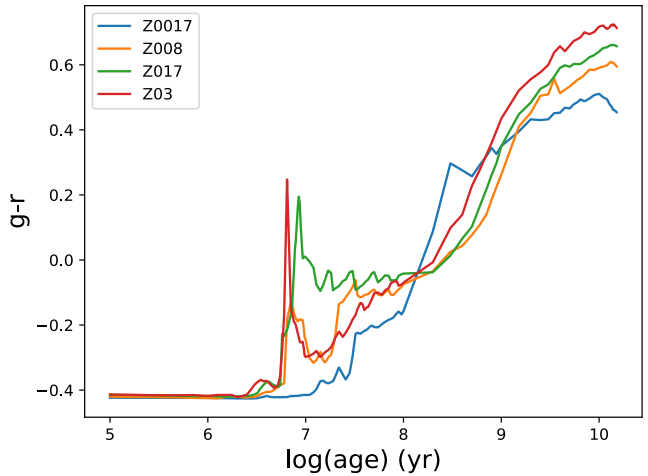
Results





Comparison between new HR-pyPopStar models and PopStar models for solar metallicity





Time evolution of g magnitude of SDSS and g-r colour for four metallicities as labelled in the figure.

- We have compared the results of our models of pyPopStar with the previous PopStar models to test them.
- The only appreciable difference is due to changes between the old and new stellar libraries.

Conclusions

- High-Resolution (HR) spectra of Single Stellar Populations are crucial for the interpretation (in terms of stellar populations) of state of the art observed data.
- We have developed pyPopStar, a python-based updated and modern version of the PopStar code that computes HR spectra of SSPs.
- Our models are consistent with previous model generations and other authors.
- The next step is to include new isochrones that treat in more detail the pre-Main Sequence and AGB phase.
- We will use these models in combination with the chemical evolution code to create accurate and self-consistent models of complex stellar populations.