Stellar Populations as Building Blocks of Galaxies
Proceedings IAU Symposium No. 241, 2006
A. Vazdekis & R. F. Peletier, eds.

doi:10.1017/S1743921307007387

BaSTI – a library of stellar evolution models: updates and applications

A. Pietrinferni[1], S. Cassisi[1], M. Salaris[2], D. Cordier[3] and F. Castelli[4]

[1]INAF – Astronomical Observatory of Collurania, via M. Maggini 64100 Teramo, Italy email: pietrinferni,cassisi@oa-teramo.inaf.it

[2]Astrophysics Research Institute, Liverpool John Moores University, Twelve Quays House, Birkenhead, CH41 1LD, UK email: ms@astro.livjm.ac.uk

[3]Ecole Nationale Superieure de Chimie de Rennes, Campus de Beaulieu, 35700 Rennes, France, email: daniel.cordier@ensrc-rennes.fr

[4]INAF – Astronomical Observatory of Trieste, via Tiepolo 11, 34131 Trieste, Italy, email: castelli@ts.astro.it

Abstract. We present a new library of stellar evolution models for a large range of masses and chemical compositions, based on an up-to-date theoretical framework. We briefly discuss the physical inputs and the assumptions adopted in computing the models. The last developments of this database are also presented.

Keywords. stars: evolution, stars: pre-main-sequence stars: luminosity function

1. The BaSTI library

The main aim of this project is to realize an up-to-date, extended and homogeneous on-line library of stellar models for both low-, intermediate-, and high-mass stars; i.e. a fundamental tool for investigating resolved and unresolved stellar populations. All the adopted physical inputs have been updated as well; in particular, the radiative opacity (κ_r) tables (Iglesias & Rogers 1996 and Alexander & Ferguson 1994), thermal conduction (Potekhin 1999). As for the Equation of State, we employ the FreeEos by A. Irwin†. The nuclear reaction rates have been updated by using the NACRE compilation (Angulo *et al.* 1999), with the exception of the $^{12}C(\alpha,\gamma)^{16}O$ reaction (Kunz *et al.* 2002). In order to cover a wide range of chemical compositions, we provide models for 11 different metallicities assuming two different heavy element distributions: scaled-solar (Grevesse & Noels 1993) and α-enhanced (Seaton 1992). For each chemical compositions we have computed (see Pietrinferni *et al.* 2004 and Pietrinferni *et al.* 2006 for a more detailed discussion):

- models in the mass range $0.5 \leqslant M/M_{\odot} \leqslant 10$, from Pre-Main Sequence to the end of thermal pulses along the AGB or C-ignition, including mass loss (using the Reimers formula with η=0.4 and η=0.2), with or without overshooting (i.e. λ_{OV}=0.0 and λ_{OV}=0.2);
- additional low-mass He-burning models (with He core mass and envelope chemical profile fixed by a RGB progenitor having an age of about 13 Gyr at the RGB tip);
- isochrones from 30 Myr to 19 Gyr.

All theoretical results have been transferred from the theoretical plane to magnitudes and colours in various photometric filters (UBVRIJHK, ACS-HST, Strömgren), by using colours-T_{eff} transformations and bolometric corrections (CT), based on an updated set

† Detailed informations about this EOS can be found at the following URL http://freeeos.sourceforge.net.

of model atmosphere (Castelli 2005 – private comunication). For the first time, we have these transformations for both scaled-solar and α-enhanced mixture. By following the link http://www.oa-teramo.inaf.it/BASTI it is possible to approach our online library which is structured as two main sections: the data archive and the web tools.

The data archive contains all our computations listed by chemical composition; tracks, isochrones, HB models and various tables can be visualized and also downloaded.

The web tools session is a set of three web interfaces:

isochrones-tracks maker – the user can calculate an isochrone/track for a given age/mass for each chemical composition by interpolating among the existing data;

luminosity function maker – this tool provides the luminosity functions for a set of isochrones previously downloaded by the user;

synthetic colour-magnitude diagrams maker – the user is free to fix several parameters of the stellar synthetic population calculations (like Star Formation History, photometric and spectroscopic error, etc.). The results can be visualized and downloaded by the user following a URL link notified him by e-mail.

2. Future developments

This library is continuously updated. In addition to models transferred in other photometric filters (HST-WFI, Sloan, Walraven), in the near future we will include models computed, for each given metallicities, by adopting at least other two values for the initial Helium abundance. Moreover we plan to extend both the metallicity range, and the covered stellar mass range. We will provide soon integrated colors and magnitudes and mass-to-light ratios, based on these models.

Following recent claims (Weiss *et al.* 2006) according to which there is a problem in the α-enhanced low-T opacity tables provided by Alexander & Ferguson (1994), we have investigated the impact of the more recent, correct opacity evaluations provided by Ferguson *et al.* (2005):

(*a*) for a scaled-solar mixture, the use of new κ_r has no effect on the evolutionary predictions once – as required – the mixing length has been properly recalibrated through the Standard Solar Model;

(*b*) for the α-enhanced mixture, the use of the new updated κ_r has no significant effect on the evolutionary models for metallicity lower than Z=0.001(see Weiss *et al.* 2006), for larger Z the effect on the RGB T_{eff} is of the order of 100 K;

For these reasons we are currently recomputing all BaSTI models (only for α-enhanced mixture) for $Z \geqslant 0.001$.

References

Alexander, D. R., & Ferguson J. W. 1994, *ApJ* 437, 879
Angulo, C. *et al.* (NACRE coll.) 1999, *Nuclear Physics* A 656, 3
Ferguson, J. W. *et al.* 2005, *ApJ* 623, 585
Grevesse, N. & Noels A. 1993, in: Prantzos N., Vangioni-Flam E., Casse M. (eds.), *Origin and Evolution of the Elements*, (Cambridge University Press),15
Kunz, R. *et al.* 2002, *ApJ* 567, 643
Iglesias, C. A., & Rogers, F. J. 1996, *ApJ* 464, 943
Pietrinferni, A. *et al.* 2004, *ApJ* 612, 168
Pietrinferni, A. *et al.* 2006, *ApJ* 642, 797
Potekhin, A. Y. 1999, *A&A* 351, 787
Weiss, A. *et al.* 2006, *astro-ph/0605666*

https://doi.org/10.1017/S1743921307007387 Published online by Cambridge University Press