*Rediscovering our Galaxy*
*Proceedings IAU Symposium No. 334, 2017*
*C. Chiappini, I. Minchev, E. Starkenburg*
*& M. Valentini, eds.*

© International Astronomical Union 2018
doi:10.1017/S1743921317007347

# YaPSI: a new database of evolutionary tracks and isochrones

**F. Spada[1], P. Demarque[2], Y. -C. Kim[3], T. S. Boyajian[2,4] and J. M. Brewer[2]**

[1]Leibniz-Institut für Astrophysik Potsdam (AIP), Germany
email: fspada@aip.de

[2]Department of Astronomy, Yale University, USA

[3]Yonsei University Observatory and Astronomy Department, Korea

[4]Physics and Astronomy, Louisiana State University, USA

**Abstract.** The Yale–Potsdam Stellar Isochrones (YaPSI) cover the low and intermediate stellar mass regime (0.15 to 5.0 $M_\odot$) for a wide range of solar-scaled chemical compositions (metallicity from −0.5 to +0.3; helium mass fraction from 0.25 to 0.37, assigned independently of each other). The tracks are finely spaced in mass, to allow for accurate interpolation. The models feature state-of-the-art input physics relevant to low-mass stars modeling (surface boundary conditions, equation of state), thus updating the faint end of the Yonsei-Yale (YY) isochrones. Utility codes, such as an isochrone interpolator in age, metallicity and helium content, are also provided. The YaPSI isochrones are in good agreement with the empirical mass–luminosity and mass–radius relations available to date, and provide satisfactory fitting of the color-magnitude diagrams of well-studied open clusters.

**Keywords.** HR diagram; stars: evolution; stars: fundamental parameters; stars: low-mass

Low-mass stars ($M_* \lesssim 0.7\,M_\odot$; late-K and M spectral types) constitute the majority of the stellar population of the Galaxy, and are very interesting objects: they undergo a non-trivial rotational evolution, exhibit strong, long-lived magnetic activity and magnetically inflated radii, and are promising candidates in the search for exoplanets located within the habitable zone (e.g., Newton *et al.* 2016; Feiden & Chaboyer 2012; Shields *et al.* 2016). Accurate models for these stars are crucial to interpret the rapidly growing body of observations. The recently constructed YaPSI models (Spada *et al.* 2017) extend and improve the low-mass end of the YY isochrones (Yi *et al.* 2001), by implementing updated treatment of the surface boundary conditions and of the equation of state, homogenizing the results of an earlier release (Spada *et al.* 2013) with the YY database. Special emphasis is placed on providing accurate mass–radius and mass–luminosity relations, densely sampled in mass, suitable for the characterization of exoplanet-host stars.

The YaPSI evolutionary tracks and isochrones are available for download from the project web page†. The tracks cover the evolution from the early pre-main sequence to the end of the red giant branch phase. They contain basic data, such as moments of inertia, depth of the outer convection zone, convective turnover timescale, that are useful in studies of the rotational evolution of late-type stars. The isochrones, with ages between 1 Myr and 20 Gyr, provide UBVRI colors in the Johnson–Cousins system, and JHK colors in the homogenized Bessell & Brett system, derived from the semi-empirical $T_{\rm eff}$–color calibrations of Lejeune *et al.* (1998) and Worthey & Lee (2011). An isochrone

† Yale mirror: http://www.astro.yale.edu/yapsi/; AIP mirror: http://vo.aip.de/yapsi/.



https://doi.org/10.1017/S1743921317007347 Published online by Cambridge University Press

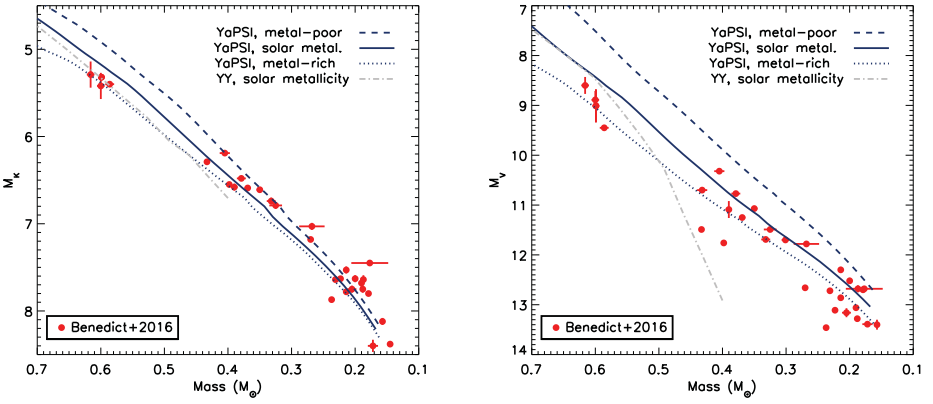


**Figure 1.** Comparison of the YaPSI mass–luminosity relations in the K and V band with their empirical counterparts (Benedict *et al.* 2016). Isochrones at 5 Gyr and for a metallicity range comparable to that of the data are shown. The improvement of the agreement at the low-mass end ($M_* \lesssim 0.5\,M_\odot$) with respect to the YY isochrone is apparent.

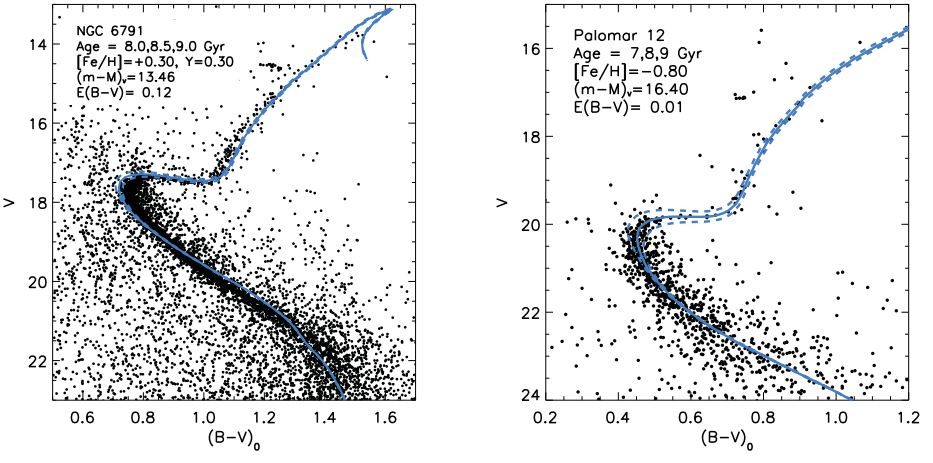


**Figure 2.** Isochrone fitting of the color-magnitude diagram of NGC 6791 and of Palomar 12 (data from Brogaard *et al.* 2012 and Stetson *et al.* 1989, respectively). Isochrones implementing the color-$T_{\rm eff}$ calibration of Worthey & Lee (2011) are shown.

interpolation code, written in `Fortran`, to construct custom isochrones with user-desired age, metallicity, and helium content, is also provided.

## References

Benedict, G. F., Henry, T. J., Franz, O. G., *et al.* 2016, *AJ*, 152, 141
Brogaard, K., VandenBerg, D. A., Bruntt, H., *et al.* 2012, *A&A*, 543, A106
Feiden, G. A. & Chaboyer, B. 2012, *ApJ*, 757, 42
Lejeune, T., Cuisinier, F., & Buser, R. 1998, *A&AS*, 130, 65
Newton, E. R., Irwin, J., Charbonneau, D., *et al.* 2016, *ApJ*, 821, 93
Shields, A. L., Ballard, S., & Johnson, J. A. 2016, *Physics Reports*, 663, 1
Spada, F., Demarque, P., Kim, Y.-C., & Sills, A. 2013, *ApJ*, 776, 87
Spada F., Demarque P., Kim Y. -C., Boyajian T. S., & Brewer J. M. 2017, *ApJ* 838, 161
Stetson, P. B., Hesser, J. E., Smith, G. H., Vandenberg, D. A., & Bolte, M. 1989, *AJ*, 97, 1360
Worthey, G. & Lee, H.-C. 2011, *ApJS*, 193, 1
Yi, S., Demarque, P., Kim, Y.-C., *et al.* 2001, *ApJS*, 136, 417

https://doi.org/10.1017/S1743921317007347 Published online by Cambridge University Press