User Guide for MIST

I. OVERVIEW

This is a README file for the MESA Isochrones and Stellar Tracks (MIST). The evolutionary tracks are computed using the publicly available stellar evolution package Modules for Experiments in Stellar Astrophysics (MESA v7503; Paxton et al. 2011, 2013, 2015), and the isochrones are generated using Aaron Dotter's publicly available `iso` package on github.[1] The input physics, general overview of the models, and comparisons with observations are described extensively in Paper I (Choi et al. 2016). The isochrone construction procedure is explained in detail in Paper 0 (Dotter 2016). The user is strongly encouraged to read Papers 0 and I and to refer to the MESA papers for additional information. See the end of this document for updates pertaining to each version release.

There are three types of models offered: the equivalent evolutionary point (EEP) tracks, theoretical isochrones, and synthetic photometry.

1. The EEP tracks are processed versions of the raw MESA evolutionary track files (or "history files" in MESA-speak). These EEP tracks, resampled from regular time coordinates to uniform "EEP coordinates," are much smaller in size compared to the raw MESA files but still describe the evolutionary history in sufficient detail. For consistency, we retain the column header names used in MESA in the EEP files (see Table I in `README_tables` for a list of column header names and descriptions).

2. Theoretical isochrones are generated from a grid of EEP tracks, and also use the same column header names.

3. Synthetic photometry files are transformations of theoretical isochrones via a set of bolometric corrections, which are largely based on a new grid of stellar atmosphere and synthetic spectra models computed with the ATLAS12/SYNTHE 1D atmosphere codes (Kurucz 1970, 1993; Conroy et al. in prep.). The ATLAS12/SYNTHE spectra are supplemented with synthetic spectra for H-rich WDs from Koester (2010) and a set of blackbody spectra at the highest temperatures ($T_{\rm eff} \geq 2 \times 10^5$ K). The list of available filters can be found in Table II of `README_tables`. The zero points depend on the photometric system—check the file headers for details.

   The bolometric corrections include a range of extinction values, as characterized by A_V and R_V, following the extinction curve of Cardelli et al. (1989). We provide $A_V = 0$ to 6 with $R_V = 3.1$, though other R_V values can be made available upon request.

II. TARBALLS

A. Models

We provide separate tarballs of EEPs, theoretical isochrones, and synthetic photometry at every metallicity grid point we have computed. We interpolated new EEP tracks at masses where the original stellar evolution calculation did not run to completion due to computational problems. These interpolated EEP files have the suffix `_INTERP` at the end

of the file name, e.g., `00200M.track.eep_INTERP`. We also include the original incomplete EEP files in the tarballs for comparison purposes.

Theoretical isochrones are provided in two flavors: basic and full. The basic isochrones contain columns such as age, stellar mass, $\dot{M}$, $\log L$, $\log T_{\rm eff}$, $\log g$, and surface and central abundances of a few elements. The full isochrones are much more comprehensive; see Table I in `README_tables` for the full list. The default set of ages in the isochrones ranges from $\log \mathrm{Age} = 5.0$ to $\log \mathrm{Age} = 10.3$ with $\Delta \log \mathrm{Age} = 0.05$. The synthetic photometry is in AB/Vega depending on the filter set (this information is contained in the header for each file) and has $A_V = 0$.

Users seeking additional masses (EEP tracks) and ages (isochrones) as well as synthetic photometry with extinction should utilize the web interpolator.

B. "Other Stuff"

In addition to tarballs of ready-to-use EEPs and isochrones, we also provide everything necessary should any user wish to run his/her own set of models with MESA v7503. They include MESA `inlists`, `run_star_extras.f`, a grid of boundary condition tables computed from ATLAS12/SYNTHE, and a number of modified routines. This is found under the "Resources" tab on the website.

III. WEB INTERPOLATED MODELS

We provide a web interface to interpolate new evolutionary tracks and isochrones of user-defined age, metallicity, and extinction from the pre-computed grids of models. See the webpage for instructions.

IV. NEWS & UPDATES

- 03/28/16: MIST v1.0 released.
- 02/15/16: Non-rotating models released. "UBVRIplus" now includes Hipparcos, Tycho, and Gaia filters. JWST and LSST are also available.
- 09/12/17: MIST v1.1 released. Metallicity interpolation bug in the CMD routine is fixed. Carbon-star BCs were left out in MIST v1.0 but are now included. Theoretical isochrones and tracks are unaffected by this update but they have been bumped up to v1.1 for consistency in the file naming convention.
- 04/27/18: Gaia DR2 and TESS photometry are now available through "UBVRIplus." In their description of the Gaia photometric system, Evans et al. (2018) adopt a different spectrum of Vega than we typically use in MIST (CALSPEC). This discrepancy leads to a modest correction of the Gaia DR2 magnitudes reported in the MIST files. We have updated our bolometric corrections to address this issue. The difference between the magnitudes released with the new Gaia_*_DR2Rev prior to the actual data release and those which have the above correction applied are BP ~ 0.0296 mag, RP ~ 0.0164 mag, and G ~ 0.0250 mag.

- 06/18/18: MIST v1.2 fixes a subtle bug in the interpolation of secondary EEPs. This is relevant for both the EEP tracks and the isochrones. If you use MIST primarily for plotting, such as comparing isochrones to CMDs or similar, this bug should not concern you. On the other hand, if you are sampling the tracks or isochrones using EEP number as an independent variable—which you should do—then you will want to use v1.2.

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[1] https://github.com/aarondotter/iso