Sunrise

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Introduction

To convert stellar particles of certain mass, age and metallicity, Sunrise uses pre-calculated stellar population models. Any kind of model can be used, all that is needed is to generate a FITS file with the format specified below and specify that file in the sfrhist configuration file.

There are two kinds of files, those used for bare stellar populations and those used to represent star-forming regions (comprising the young stars, the HII region, and the matter immediately surrounding it).

Stellar population files

The stellar model files are FITS files with 3 or 4 extensions.

pHDU

The pHDU is empty, apart from the keyword FILETYPE which should have the value "STELLARMODEL".

HDU "STELLARMODEL"

This HDU only contains header data. There are a few required keywords that sfrhist needs to be able to interpret the file, but it can contain an arbitrary number of keywords describing the stellar model. Preferably these keywords should completely determine the model used to calculate the SEDs, because they are copied into the output file by Sunrise to keep provenance information.

The keywords required by sfrhist are:

- powerunit
  - The unit used for luminosity in the file. This should preferably be W.
- timeunit
  - The time unit used for population age. Preferably yr.
- lengthunit
  - The unit used for wavelengths, preferably m.
- massunit
  - The unit used for masses, preferably solar masses (written as "M_sun").
- refmass
  - This keyword gives the zero-age main sequence mass normalization for the SEDs.
- logflux
  - This is a bool keyword which if true means that the SED is actually stored as the log of the values. (This can be useful because if the SED is in floats, the normal

> > units can overflow a float, but it's easier to just save the SED as doubles.)

HDU "SED"

This HDU is a 3D image (data cube) that contains the actual SED data. The axes are time, metallicity and wavelength. (These are described in the next HDU.) The HDU should contain the keyword UNIT which contains the unit of the image values. The SED should be stored as L_lambda, i.e dL/dlambda, so to be consistent the unit keyword should be powerunit/lengthunit.

Note that the SED should be normalized according to the *zero-age main sequence* mass of the stellar population. As the stellar population ages and loses mass, the SED should *not* be renormalized to the current mass. It should represent the light output from an aging population of stars whose ZAMS mass was `refmass`.

HDU "AXES"

This HDU is a binary table that contains the axes values of the time, metallicity and wavelength axes of the data cube in the previous HDU.

- column "time"

  > > This column contains the ages of the stellar population stored in the SED data cube. The column unit should be `timeunit` and it should have the same number of entries as the **first** dimension of the data cube.

- column "metallicity"

  > > This column contains the metallicities of the SEDs, as total mass fraction (*not* fraction of solar metallicity). The column should have the same number of entries as the **second** dimension of the data cube.

- column "lambda"

  > > This column contains the wavelengths for which the SEDs are given. The column unit should be `lengthunit` and it should have the same number of entries as the **third** dimension of the data cube.

HDU "current_mass"

This is an optional HDU that contains the mass loss as a function of time assumed in the stellar model. If present, it should be a 2D image with the current mass, as a fraction of the initial mass, as a function of time and metallicity. (So the same first and second dimensions as the SED HDU.)

This is used for backing out the ZAMS mass of old stars, but this approach is troublesome so isn't used much these days. The *proper* way of doing this is to self-consistently track both creation mass and current mass in the hydro code (otherwise you have to choose between violating mass conservation or light conservation...)

Star-forming region (MAPPINGS) files

These files contain the SEDs of the star-forming regions calculated by the MAPPINGS code. These models attempt to parametrize the SED of a star-forming region, including the stars and the surrounding HII region and PDR, as a function of metallicity, mass of the star cluster, and the ISM pressure. For more information about these models, see Groves et al. 2008, ApJS, 176, 438.

To be done.

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