FITSFH User's Guide

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1 Overview

The purpose of **fitsfh** is to derive star formation histories from photometry of resolved stellar populations. This is done by populating theoretical isochrones according to a chosen stellar initial mass function (IMF) and searching for the linear combination of isochrones with different ages and metallicities that best matches the data. In comparing the synthetic and real data, observational errors and incompleteness are taken into account, and a rudimentary treatment of the effect of unresolved binaries is also implemented. The code also allows for an age-dependent range of extinction values to be included in the modelling. It is important to realise, however, that there are a very large number of effects that may affect the appearance of a CMD.

User must supply: distance modulus, extinction (possible age dependent), photometric errors, completeness function, isochrones.

Photometric errors, extinction may vary across a field.

In addition, any approach to this problem based on synthetic CMDs will be limited in accuracy by the available isochrones.

Isochrones are uncertain, especially for high-mass stars.

The **fitsfh** code is written in IDL (Interactive Data Language).

2 Running fitsfh

```
fitsfh, DATAM1, $
        DATAM2, $
        loga_iso=LOGA_ISO,
        errm1=ERRM1,
        errm2=ERRM2,
        cmpl=CMPL,
        noshow=NOSHOW,
        pfile=PFILE,
```

where:

Parameter	Data type	Description
Parameters that cannot be specified in parameter file:		
DATAM1, DATAM2	Float[N_{data}]	Magnitude measurements in two bands (e.g. V and I). These two arrays must have the same number of elements.
LOGA_ISO	Float[N_{iso}]	Log(age) values of the isochrones to be read from the library
ERRM1, ERRM2	Float[2, N_{err}]	Photometric errors. `ERRM1[0,*]` should contain N_{err} magnitude values and `ERRM1[1,*]` the corresponding 1-sigma errors, and equivalently for `ERRM2`. The errors by which the isochrones are broadened will be obtained by interpolation in these arrays.
CMPL	Float[3, N_{cmpl}]	Completeness of the data. `CMPL[0,*]` should contain the $M1$ values and `CMPL[1,*]` the $M2$ values at which completeness data are available, and `CMPL[2,*]` the corresponding completeness (a number between 0 and 1) at each $M1, M2$ combination. Example: For V and I photometry, `CMPL = [[-1.0, -2.0, 0.8],[-2.0, -3.0, 0.95]]` specifies an 80% completeness at $(M_V, M_I) = (-1.0, -2.0)$ and a 95% completeness at $(M_V, M_I) = (-2.0, -3.0)$.
NOSHOW	Int	Set to 1 if no graphics should be shown
PFILE	String	Name of file containing default parameter values
The parameter file can contain default values for the following parameters:		
XR	Float[2]	X-range (colour) over which to construct Hess diagrams
YR	Float[2]	Y-range (absolute magnitude) over which to construct Hess diagrams
YMAG	Int	Specifies which magnitude to use on Y-axis (0 = M1, 1 = M2). Example: To make a $(V - I, V)$ Hess diagram, set $M1 = V$, $M2 = I$ and `YMAG=0`. To make a $(B - V, V)$ Hess diagram, set $M1 = B$, $M2 = V$ and `YMAG=1`.
MRNG	Float[2]	Mass range over which IMF is normalised.
KTYPE	String	Type of kernel used when generating Hess diagrams (SQUARE / GAUSS / DISC / DELTA)
KWIDTH	Float	With of kernel in same units as X-axis. For KTYPE=SQUARE: dimension of kernel. For KTYPE=DISC: radius of the disc. For KTYPE=GAUSS: Sigma of Gaussian kernel.
HDIM	Int	Resolution of Hess diagram in pixels.
AB	Float/Float[2]	Extinction (normalised to $B-$band) or range of extinction values to be simulated. E.g. AB=0.5 will apply a constant extinction of $A_B = 0.5$ mag (normalised to each actual band) while AB=[0.5,1.0] will apply a range of extinctions between $A_B = 0.5$ mag and $A_B = 1.0$ mag.

NAB	Int	Number of discrete extinction values to sample (if AB is a range)
AM_AB	Float[2]	Ratios $[A_{M1}, A_{M2}]/A_B$
AABFILE	String	Name of a text file containing (age-dependent) extinction values. This file should contain three columns: log(age), A_B(min) and A_B(max). The extinction applied to each isochrone will be obtained by interpolation in the values read from this file.
ISOFILE	Strarr[$N_{\rm iso}$]	Array with name(s) of text files containing the isochrones to be used for the modelling. Each file should contain columns specifying, as a minimum, the age, initial mass, and magnitudes $M1$ and $M2$. In the simplest case this is just the name of a single file, but multiple isochrone files can be included, e.g. for different metallicities.
ACOL	Int	Column in ISOFILE containing the log(age/years)
MCOL	Int	Column in ISOFILE containing the initial mass
MAGCOL	Int[2]	Columns in ISOFILE containing the M1 and M2 magnitudes
BINS	Float[$N_{\rm bins}$]	Age intervals used for binning of isochrones
NITER	Int	The fitting procedure will be repeated NITER times, each with different initial guesses for the star formation history. Setting NITER>1 reduces the risk that the algorithm will stop at a local rather than global minimum
BOXES	String	
BMODE	Int	
CMODE	Int	
AMOEBA_ITMAX	Int	
FBIN	Float	
DBIN	String	
NQSUB	Int	
QMIN	Float	
QMAX	Float	

3 Generation of synthetic Hess diagrams

3.1 Isochrone binning

3.2 Populating isochrones

3.3 Error broadening

3.4 Extinction modelling

3.5 Completeness

3.6 Binary stars

4 Searching for the best fit

4.1 Boxes

4.2 Best-fit criteria

5 Output

5.1 Errors

Not provided. Random errors typically small compared to systematic effects, such as isochrone library used, assumptions about binarity (Silva Villa & Larsen 2010).

6 Requirements

IDL, ASTRON library, COYOTE library