OCAAT
(Open Cluster Automated Analysis Tool)

Manual v1.0.0 (September 2, 2014)

1 Introduction

This is the manual of operation for the `OCAAT` code.

2 Synthetic clusters

2.1 IMF sampling

The initial mass function (IMF) is the distribution of initial masses for a population of stars. For a population of N stars with masses m_i and a total mass of M_T:

$$IMF \rightarrow \xi(m) = \frac{dn}{dm} \rightarrow dn = \xi(m)dm$$

$$M_T = \sum_{i=1}^{N} m_i \rightarrow M_T = C \int_{m_l}^{m_h} m(n)dn =$$

$$= C \int_{m_l}^{m_h} m\xi(m)dm$$

where m_l and m_h are the mass limits for the IMF (m_h is fixed to $100M_\odot$ in the code) and C is a normalization constant. Setting the total mass to unity, $M_T = 1M_\odot$, allows us to obtain the normalization constant C_1 and treat the normalized IMF as a PDF:

$$M_T = 1M_\odot \rightarrow C_1 = \frac{1}{\int_{m_l}^{m_h} m\xi(m)dm}$$

and thus the normalized IMF can be written as:

$$PDF(m) = \xi(m)_{norm} = C_1\xi(m)$$

This is the first step, performed by the `get-IMF-PDF` function for a given selected IMF (Chabrier 2001, Kro"upa et al. 1993, Kroupa 2002)

Once the PDF is generated, every time a new synthetic cluster is created the `get-mass-dist` function is called from within `synth-cluster`. This former function takes the PDF and samples a number of masses randomly from it, following the probabilities distribution given by the PDF, until the mass fixed by the `total-mass` parameter is achieved.

The `get-mass-dist` function thus returns a distribution of masses probabilistically sampled from a certain IMF, whose masses sum up to a total cluster mass.

3 Adding CMD support

In order to add support for a new CMD the following functions should be modified:

1. `get-in-params`, add names of filters and positions needed to form the color

2. `get-isoch-params`, add the columns in the theoretical isochrone where the code should look for the filters used.

3. `move-isochrone`, add the extinction equations that define how this effect along with the distance modulus affect the magnitude and color in the CMD.

4 Integrated magnitudes

To obtain the integrated magnitude for the cluster region *cleaned* from field stars contamination, the following equations are used.

First, assume:

$$I_{cl+fl} = I_{cl} + I_{fl} \tag{1}$$

then:

$$V^*_{cl} - V^*_{cl+fl} = -2.5\log(I_{cl}/I_{cl+fl}) \tag{2}$$

using Eq. 1 we have:

$$V^*_{cl} - V^*_{cl+fl} = -2.5\log(1 - I_{fl}/I_{cl+fl}) \tag{3}$$

and given:

$$V^*_{fl} - V^*_{cl+fl} = -2.5\log(I_{fl}/I_{cl+fl}) \Rightarrow \frac{I_{fl}}{I_{cl+fl}} = 10^{(V^*_{fl}-V^*_{cl+fl})/-2.5} \tag{4}$$

we can combine now Eqs. 3 and 4 to obtain:

$$V^*_{cl} = -2.5\log(1 - 10^{(V^*_{fl}-V^*_{cl+fl})/-2.5}) + V^*_{cl+fl} \tag{5}$$