List of parametrs used in Mcluster

- **Initial number of objects for each sub-population** n_1 , n_2 , ... with $n_i = n_{singles} + n_{binaries}$, where n_i is the total number of stars in the simulation
- **Primoridal binary fraction** fb_1 , fb_2 , ... with $n_{binaries} = fb_i \cdot n_i$
- **Initial density distribution** (could be different for sub-populations) *initialModel*

  0 **- Homogeneous sphere**

  1 **- Plummer**

  2 **- King**

  3 **- Subr**

- **King model parameter** (could be different for sub-populations) w_0 for w_0 in range of $(1.0 - 12.0)$ - DEFAULT $w_0 = 5.0$
- **Mass segregation parameter** S in range of $(0.0 - 1.0)$ - $S = 0.0 \rightarrow$ unsegregated, $S = 1.0 \rightarrow$ completely segregated
  For King model take $S = 0.99$ maximally - DEFAULT $S = 0.0$
- **Fractal dimensions** *fractal* (2^D children per parent) (could be different for sub-populations)

  A - $fractal > 0$: boxy distribution (Goodwin & Whitworth 2004)

  B - $fractal < 0$: spherical distribution (Alex Livernois 2021)

  C - DEFAULT $fractal = 3.0$ (unfractal)

- **Virial ratio** *qvir*, $qvir > 0.5 \rightarrow$ expanding, $qvir > 0.5 \rightarrow$ equilibrium, $qvir > 0.5 \rightarrow$ collapsing - DEFAULT $q = 0.5$
- **Stellar mass function** *mfunc*

  0 **- equal masses equivalent to a set to parameter single mass**

  A - DEFAULT single_mass= 1.0

  1 **- [Kroupa (2001)] IMF** - DEFAULT model

  A - lower mass limit - default mlow m_low = 0.08

  B - upper mass limit - default mup m_up = 100.00

  2 **- multi-power law (Subr)**

  A - alpha slopes - DEFAULT alpha_imf = $[-1.35, -2.35, -2.7, 0.0, 0.0]$

  B - mass limits - DEFAULT mlim_imf = $[0.08, 0.5, 4.0, 100, 0.0, 0.0]$

  4 **- L3 IMF [Maschberger (2012)]**

  A - lower mass limit - default mlow m_low = 0.08

  B - upper mass limit - default mup m_up = 100.00

  C - $\alpha-$slope for mass function - default alpha_L3 = 2.3

  D - $\beta-$slope for mass function - default beta_L3 = 1.4

  E - $\mu-$parameter - default mu_L3 = 0.2

- **Pairing of binary components** *pairing*

  0 **- random pairing**

  1 **- ordered pairing for components with masses** $M > 5M_\odot$

2 **- random but separate pairing for components with masses** $M > 5M_{\odot}$

3 **- uniform distribution of mass ratio (**$0.1 < q < 1.0$**) for** $M > 5M_{\odot}$ **and random pairing for remaining** [Kiminki & Kobulnicky (2012); Sana et al., (2012); Kobulnicky et al., (2014)] - DEFAULT

- **Semi-major axis distribution** *adis*

0 **- uniform distribution in log(a), between amin and amax**

1 **- lognormal distribution distribution for a**

2 **- based on [Kroupa (1995)] period distribution**

3 **- based on [Kroupa (1995)] period distribution for** $M < 5M_{\odot}$**; based on [Sana et al.(2012); Oh, S., Kroupa, P., & Pflamm-Altenburg, J. (2015)] period distribution for** $M > 5M_{\odot}$ - DEFAULT distribution

4 **- flat uniform distribution in a ranging from amin to amax**

5 **- based on [Duquennoy & Mayor (1991)] period distribution**

6 **- uniform distribution in log(a), between amin and amax for** $M < 5M_{\odot}$**; Sana et al. (2012) period distribution for** $M > 5M_{\odot}$
ALERT: *this will generate uniform distribution of mass ratio (*$0.1 < q < 1.0$*) for* $M > 5M_{\odot}$ *and also for* $M < 5M_{\odot}$ *indipendently from pairing !*

- **Eigenevolution** *eigen*

0 **- Off** - DEFAULT

1 **- [Kroupa (1995)] eigenevolution for pre-main sequence short-period binaries and feeding algorithm**
ALERT: *This will set adis = 2 and pairing = 1 !*

2 **- New eigenevolution and feeding algorithm [Kroupa (2013), rewieved in Belloni et al. (2017)]**
ALERT: *This will set adis = 3 and pairing = 3 !*

- **Minimum binary semi-major axis** *amin* - defined in Solar radii $[R_{\odot}]$:

A - $amin > 0 \rightarrow amin = amin$

B - $amin < 0 \rightarrow amin = -amin \cdot R_{least}$, where R_{least} is the stellar radius of the least massive star in the system

C - DEFAULT $amin = -1.0$

- **Maximum binary semi-major axis** *amax* - defined in Solar radii $[R_{\odot}]$:

A - $amax > 0 \rightarrow amax = amax$

B - $amax < 0 \rightarrow amax = -amax \cdot 2.5 \cdot R_h/N$, where R_h is the total half-mass radius

C - DEFAULT $amax = 50\ [a.u.] = 10747.0$

- **Tidal field** *tf*

0 **- no tidal field**

1 **- point mass galaxy** - DEFAULT tidal field

- **Tidal radius** *rbar* defined in parsec [pc] - DEFAULT $rbar = 35.8$

- **Half mass radius** [pc] *rh_mcl*

  A - if *rh_mcl*> 0.0 it is considered for the whole cluster

  B - if *rh_mcl*< 0.0 it is considered for the first population

  C - if abs(*rh_mcl*)> 1.d9 the model is not underfilled (standard King model, for Plummer model it will set $rh\_mcl = 0.1 \cdot rbar$)

  D - if abs(*rh_mcl*)< 1.d9 the model is underfilled by a rplum factor, defined as $rplum = rbar/abs(rh\_mcl)$

  E - DEFAULT $rh\_mcl = 1.0$

- **Concentration radius parameter** *conc_pop* defined as Rh_i/Rh_1, the ratio between the half-mass radii of the i-th and the first generation (it will be skipped for single stellar population)

  – the first value is Rh_2/Rh_1 (the ratio between the half-mass radii of the second and the first generation)

  – the second value would be Rh_3/Rh_1 (the ratio between the half-mass radii of the third and the first generation)

  – DEFAULT conc_pop= 0.5

- **Potential energy evaluation** *potential_energy*

  0 **- potential energy evaluated as sum of gravitational potential for every object (N^2)**

  1 **- potential energy evaluated in spherical symmetry (N)** - DEFAULT energy evaluation

- **Age of population [Myr]** - DEFAULT $epoch = 0.0\ Myr$

- **Initial metallicity** - DEFAULT $zini = 0.001$

- **Initial integer number to start random number generator for Mcluster initial conditions** - DEFAULT seedmc = 10

- **Output format**

  0 **- single nbody.dat and binary nbody.dat files for MOCCA simulations are generated.** The structure of those files are:

  * **single.dat** - mass [$M_\odot$], x, y, z, Vx, Vy, Vz [N-body units], age, metallicty, index of the population
  * **binary.dat** - e, a [log10(Ro)], m1 [$M_\odot$], m2 [$M_\odot$], x, y, z, Vx, Vy, Vz [binary center of mass, N-body units], age, metallicity, index of the population

  1 **- standard dat.10 file for NBODY simulations is generated.** The structure of the file is: binaries at the beginning of the file (i.e. $2 \cdot NBIN$ lines with the binary individual masses,positions and velocities in the cluster frame) and remaining single star lines (with mass, positions and velocities in the cluster frame)

  2 **- initial files for MOCCA & NBODY simulations will be generated at the same time.**

  – DEFAULT outputf = 0

- **Make energy check at end of Mclusters**

  0 **- off**

1 **- on**

– DEFAULT check_en = 1

- **Activate SSE/BSE for stellar/binary evolution**

  0 **- off**

  1 **- on**
  ALERT: *this will not be activated if outputf = 0 or outputf = 2*

  – DEFAULT BSE = 0