

## List of parametrs used in Mcluster

- **Initial number of objects for each sub-population**  $n_1, n_2, \dots$  with  $n_i = n_{singles} + n_{binaries}$ , where  $n_i$  is the total number of stars in the simulation
- **Primoridal binary fraction**  $fb_1, fb_2, \dots$  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) - DEFAULT *fractal* = 3.0 (unfractal)
- **Virial ratio**  $q_{vir}$ ,  $q_{vir} > 0.5 \rightarrow$  expanding,  $q_{vir} < 0.5 \rightarrow$  equilibrium,  $q_{vir} > 0.5 \rightarrow$  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 m\_low m\_low = 0.08
    - B - upper mass limit - default m\_up 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 m\_low m\_low = 0.08
    - B - upper mass limit - default m\_up 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  $a_{\min}$  and  $a_{\max}$
  - 1 - lognormal 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  $a_{\min}$  to  $a_{\max}$
  - 5 - based on [Duquennoy & Mayor (1991)] period distribution
  - 6 - uniform distribution in  $\log(a)$ , between  $a_{\min}$  and  $a_{\max}$  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  $M < 5M_{\odot}$  independently 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), reviewed in Belloni et al. (2017)]  
ALERT: *This will set  $adis = 3$  and  $pairing = 3$  !*
- **Minimum binary semi-major axis**  $a_{\min}$  - defined in Solar radii [ $R_{\odot}$ ]:
  - A -  $a_{\min} > 0 \rightarrow a_{\min} = a_{\min}$
  - B -  $a_{\min} < 0 \rightarrow a_{\min} = -a_{\min} \cdot R_{\text{least}}$ , where  $R_{\text{least}}$  is the stellar radius of the least massive star in the system
  - C - DEFAULT  $a_{\min} = -1.0$
- **Maximum binary semi-major axis**  $a_{\max}$  - defined in Solar radii [ $R_{\odot}$ ]:
  - A -  $a_{\max} > 0 \rightarrow a_{\max} = a_{\max}$
  - B -  $a_{\max} < 0 \rightarrow a_{\max} = -a_{\max} \cdot 2.5 \cdot R_h/N$ , where  $R_h$  is the total half-mass radius
  - C - DEFAULT  $a_{\max} = 50 [a.u.] = 10747.0$
- **Tidal field** *tf*
  - 0 - no tidal field
  - 1 - point mass galaxy - DEFAULT tidal field
- **Tidal radius**  $r_{\text{bar}}$  defined in parsec [pc] - DEFAULT  $r_{\text{bar}} = 35.8$
- **Half mass radius** [pc] (for the whole system)  $rh_{\text{mcl}}$ 
  - A - if  $rh_{\text{mcl}} > 1.49$  the model is not underfilled (standard King model, for Plummer model it will set  $rh_{\text{mcl}} = 0.1 \cdot r_{\text{bar}}$ )
  - B - if  $rh_{\text{mcl}} < 1.49$  the model is underfilled by a  $r_{\text{plum}}$  factor, defined as  $r_{\text{plum}} = r_{\text{bar}}/rh_{\text{mcl}}$
  - C - DEFAULT  $rh_{\text{mcl}} = 1.0$

- **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 are generated.** The structure of those files are:
    - \* **single.dat** - mass [ $M_\odot$ ], x, y, z, Vx, Vy, Vz [N-body units], age, metallicity, index of the population
    - \* **binary.dat** - e, a [ $\log_{10}(Ro)$ ], 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 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)
    - DEFAULT *outputf* = 0
- **Make energy check at end of Mclusters**
  - 0 - off
  - 1 - on
  - DEFAULT *check\_en* = 1