COMPAS v02.27.05 output at representative metallicities

Team COMPAS[1]★
[1]Planet Earth, Solar System, Orion–Cygnus Arm, Milky Way.

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1 DESCRIPTION

Our rapid population synthesis simulation is done with COMPAS v02.27.05 (Team COMPAS: J. Riley et al. 2021). The details of the initial conditions and setup are presented in Table 1. This Table was made using the publicly-available template from FloorBroekgaarden/templateForTableBPSsettings. We simulate 5×10^6 binaries for each of our 10 different variations in metallicity. These variations in metallicity are:

1. the lowest metallicity accounted for in our stellar evolution tracks ($Z = 0.0001$, Hurley et al. 2000; Team COMPAS: J. Riley et al. 2021);
2. a representative metallicity for I Zwicky 18 ($Z = 0.0002$, Szécsi et al. 2015);
3. $Z = 0.001$;
4. a representative metallicity for the Small Magellanic Cloud ($Z = 0.0021$, Brott et al. 2011);
5. a representative metallicity for the Large Magellanic Cloud ($Z = 0.0047$, Brott et al. 2011);
6. $Z = 0.01$;
7. a representative metallicity for the Sun ($Z = 0.0142$, Asplund et al. 2009);
8. a super-solar metallicity $Z = 0.02$;
9. the maximum metallicity accounted for in our stellar evolution tracks ($Z = 0.03$, Hurley et al. 2000; Team COMPAS: J. Riley et al. 2021);
10. additionally, we include a simulation that samples uniformly in log-space the metallicities accounted for in our stellar evolution tracks.

This results in a population with a total of 50 million binaries.

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Table 1. Initial values and default settings of the population synthesis simulation with COMPAS.

Description and name	Value/range	Note / setting
		Initial conditions
Initial mass $m_{1,\mathrm{i}}$	$[5, 150]\,\mathrm{M}_\odot$	Kroupa (2001) IMF $\propto {m_{1,\mathrm{i}}}^{-\alpha}$ with $\alpha_{\mathrm{IMF}} = 2.3$ for stars above $5\,\mathrm{M}_\odot$
Initial mass ratio $q_\mathrm{i} = m_{2,\mathrm{i}}/m_{1,\mathrm{i}}$	$[0.01, 1]$	Flat mass ratio distribution $p(q_\mathrm{i}) \propto 1$ with $m_{2,\mathrm{i}} \geq 0.1\,\mathrm{M}_\odot$
Initial semi-major axis a_i	$[0.01, 1000]$ AU	Flat-in-log distribution $p(a_\mathrm{i}) \propto 1/a_\mathrm{i}$
Initial metallicity Z_i	$[0.0001, 0.03]$	Representative metallicities (Section 1)
Initial orbital eccentricity e_i	0	Binaries circular at birth
		Fiducial parameter settings:
Stellar winds for hydrogen rich stars	Belczynski et al. (2010a)	Based on Vink et al. (2000, 2001), including LBV wind mass loss with $f_{\mathrm{LBV}} = 1.5$
Stellar winds for hydrogen-poor helium stars	Belczynski et al. (2010b)	Based on Hamann & Koesterke (1998) and Vink & de Koter 2005
Max transfer stability criteria	ζ-prescription	Based on Vigna-Gómez et al. (2018) and references therein
Mass transfer accretion rate	thermal timescale	For stars Vigna-Gómez et al. (2018); Vinciguerra et al. (2020)
	Eddington-limited	For compact objects
Non-conservative mass loss	isotropic re-emission	Massevitch & Yungelson (1975); Bhattacharya & van den Heuvel (1991); Soberman et al. (1997) Tauris & van den Heuvel (2006)
Case BB mass transfer stability	always stable	Based on Tauris et al. (2015, 2017); Vigna-Gómez et al. (2018)
CE prescription	$\alpha - \lambda$	Based on Webbink (1984); de Kool (1990)
CE efficiency α-parameter	1.0	
CE λ-parameter	$\lambda_{\mathrm{Nanjing}}$	Based on Xu & Li (2010a,b) and Dominik et al. (2012)
Hertzsprung gap (HG) donor in CE	pessimistic	Defined in Dominik et al. (2012): HG donors don't survive a CE phase
SN natal kick magnitude v_k	$[0, \infty)\,\mathrm{km\,s^{-1}}$	Drawn from a Maxwellian distribution with an user-defined standard deviation ($\sigma_{\mathrm{rms}}^{\mathrm{1D}}$)
SN natal kick polar angle θ_k	$[0, \pi]$	$p(\theta_\mathrm{k}) = \sin(\theta_\mathrm{k})/2$
SN natal kick azimuthal angle ϕ_k	$[0, 2\pi]$	Uniform $p(\phi) = 1/(2\pi)$
SN mean anomaly of the orbit	$[0, 2\pi]$	Uniformly distributed
Core-collapse SN remnant mass prescription	delayed	From Fryer et al. (2012), which has no lower BH mass gap
USSN remnant mass prescription	delayed	From Fryer et al. (2012)
ECSN remnant mass presciption	$m_\mathrm{f} = 1.26\,\mathrm{M}_\odot$	Baryonic to gravitational mass relation using the equation-of-state from Timmes et al. (1996)
Core-collapse SN velocity dispersion $\sigma_{\mathrm{rms}}^{\mathrm{1D}}$	$265\,\mathrm{km\,s^{-1}}$	1D rms value based on Hobbs et al. (2005)
USSN and ECSN velocity dispersion $\sigma_{\mathrm{rms}}^{\mathrm{1D}}$	$30\,\mathrm{km\,s^{-1}}$	1D rms value based on e.g., Pfahl et al. (2002); Podsiadlowski et al. (2004)
PISN / PPISN remnant mass prescription	Marchant et al. (2019)	As implemented in Stevenson et al. (2019)
Maximum NS mass	$\mathrm{max_{NS}} = 2.5\,\mathrm{M}_\odot$	Following Fryer et al. (2012)
Tides and rotation		Not included
		Simulation settings
Total number of binaries sampled per metallicity	5×10^6	
Sampling method	Monte Carlo	
Binary fraction	$f_{\mathrm{bin}} = 1$	
Binary population synthesis code	COMPAS	Team COMPAS: J. Riley et al. (2021)