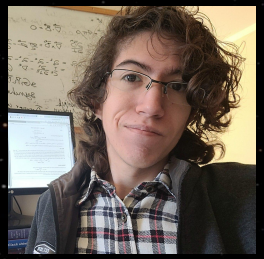

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# Effects of a non-universal IMF and binary parameter correlations on compact binary mergers

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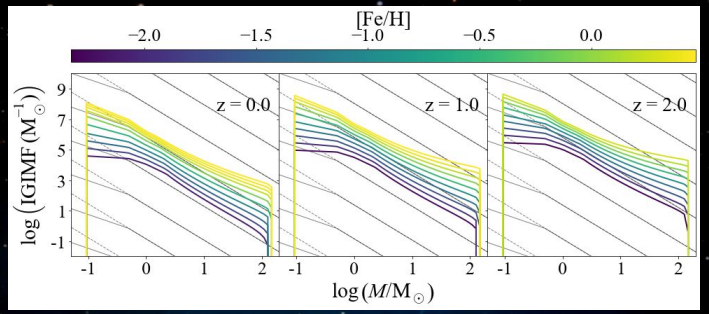
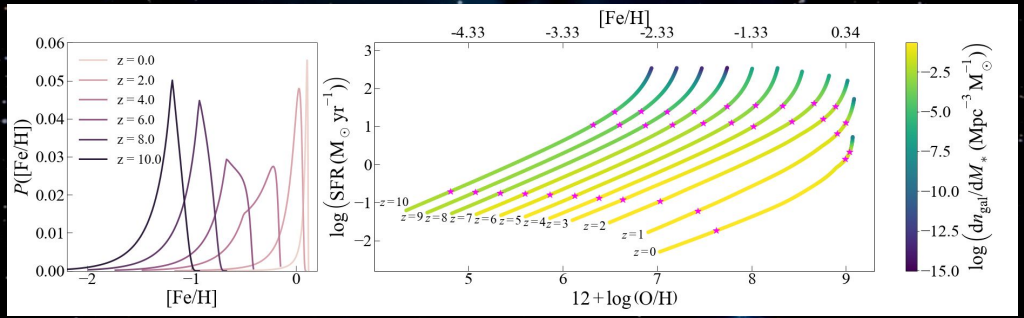
Binary population synthesis provides a direct way of studying the effects of different binary evolution models and initial parameter distributions on present-day binary compact merger populations, which can be compared to their observed properties, such as merger rates. Samples of zero-age main sequence binaries are typically generated from an universal IMF and uniform distributions for orbital period (*P*), mass ratio (*q*) and eccentricity (*e*). Recently, however, observational evidence has suggested the non-universality of the IMF and the existence of correlations between binary parameters. In this study, we implement a metallicity- and redshift-dependent IMF alongside correlated distributions for *P*, *q* and *e* in order to generate representative populations of binaries at varying redshifts to be evolved with the COMPAS BPS code, in order to study the variations of merger rates and overall population properties.

Binary population synthesis usually samples $M_1$ from an universal IMF, and $P$, $q$ and $e$ from uniform distributions. However…

**Jerabkova et al. (2018), Chruślińska et al. (2020): IGIMF(Z, SFR) and SFRD(Z, *z*)**




From the SFRD(Z, *z*) grid, we effectively treat the IGIMF as IGIMF(Z, *z*).

**Moe & Di Stefano (2017): correlated binary parameters**

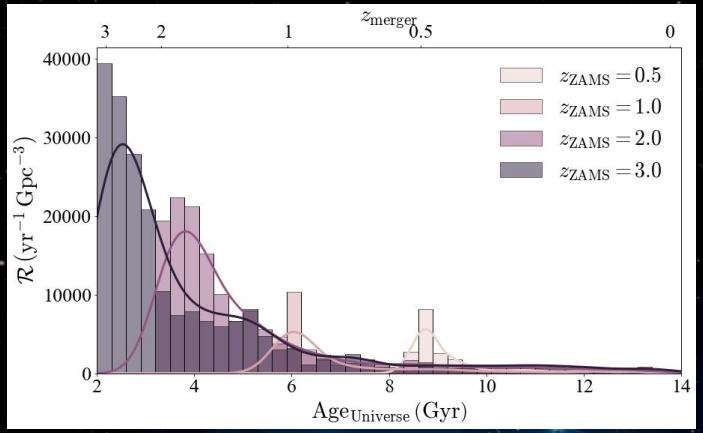
- Orbital period: $f_{\log P;q>0.1}(M_1)$
- Mass ratio: $p_q(M_1, \log P)$
- Eccentricity: $p_e(M_1, \log P)$

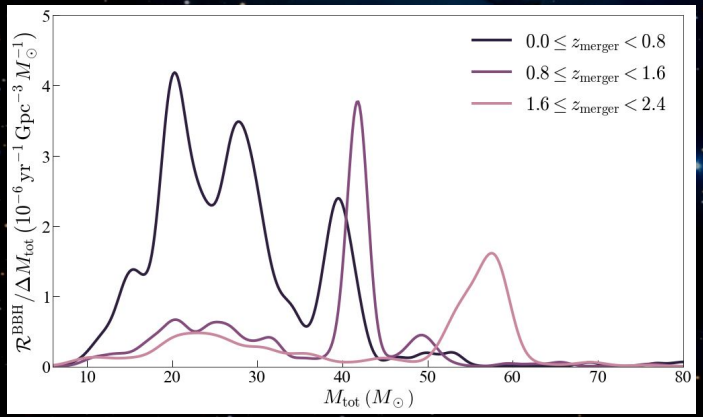
For $M_1 > 0.8$, $q > 0.1$ and $0.2 < \log P < 8.0$

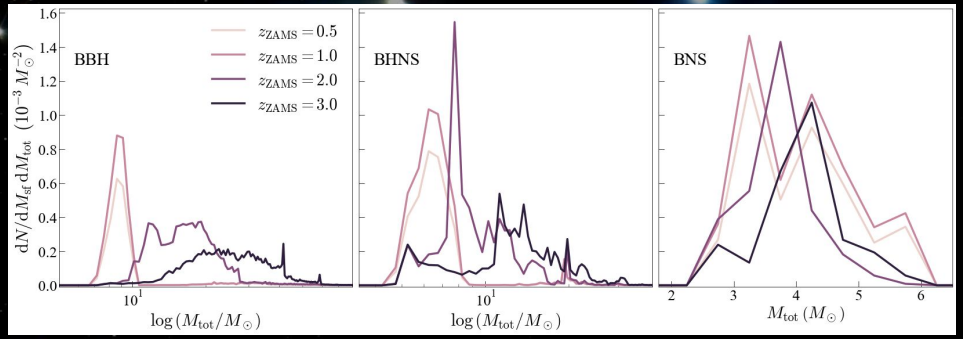
**How do these distributions affect BCM populations?**

We have employed the IGIMF, SFRD and correlated *P, q, e* distributions in generating ZAMS binary samples for evolution with COMPAS.

For 12 samples of ~$10^6$ binaries each, across $z_{\rm ZAMS} = 0.5, 1, 2, 3$ with 3 Z each, we have found that




- Older populations tend to produce heavier BCOs
- Older populations produce up to ~$10^2$ times greater merger rates at large redshifts
- More massive mergers tend to be observed at larger redshifts.

| Source | Local merger rate ($\rm yr^{-1}\,Gpc^{-3}$) | | |
|---|---|---|---|
| | BBH | BHNS | BNS |
| This work | 432 | 124 | 63 |
| GWTC-3 90% credibility | $16-130$ | $7.4-320$ | $13-1900$ |

**Next**: increase sample resolution and study effect of correlated distributions.