Australian Government
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OzGrav

ARC Centre of Excellence for Gravitational Wave Discovery

Highlights from the OzGrav Population Modelling program

Simon Stevenson

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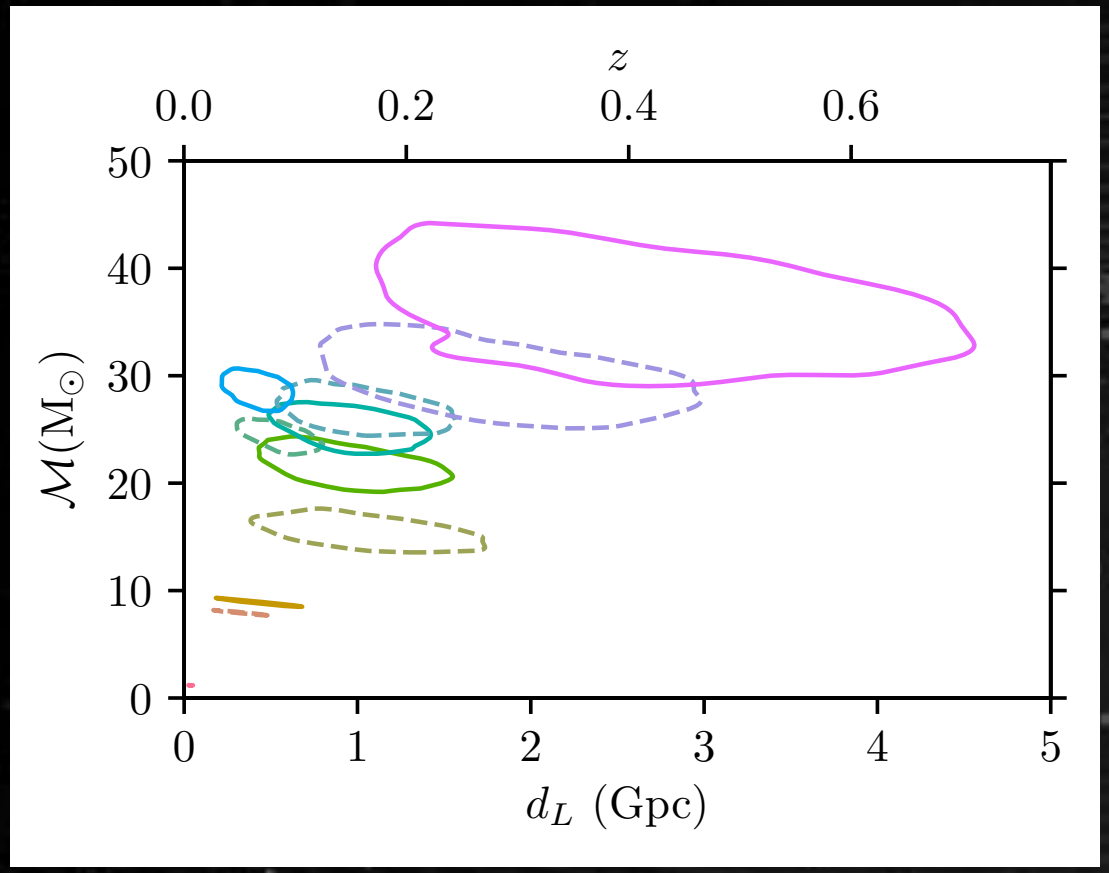
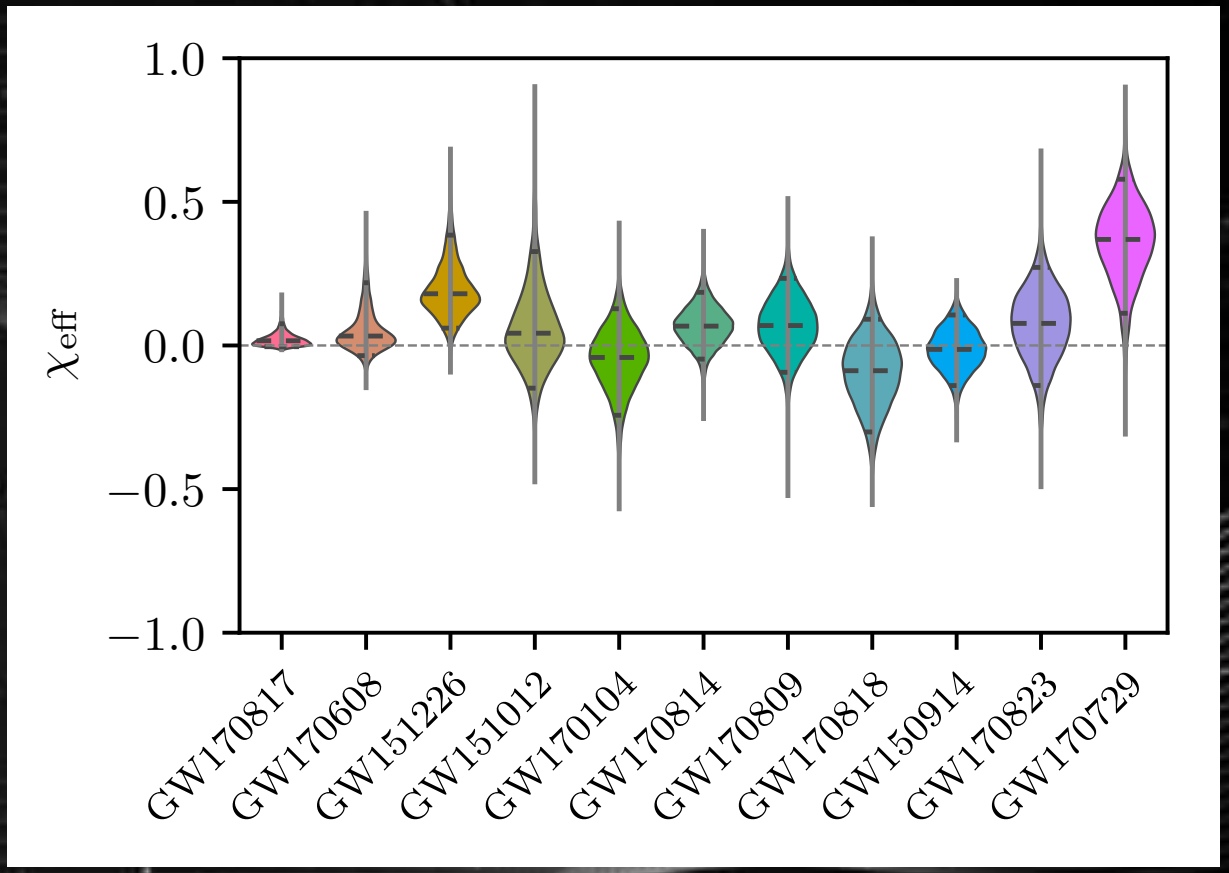
SWINBURNE UNIVERSITY OF TECHNOLOGY
Australian National University
MONASH University
THE UNIVERSITY of ADELAIDE
THE UNIVERSITY OF MELBOURNE
THE UNIVERSITY OF WESTERN AUSTRALIA
AAO
CSIRO

We now have a population!

10 binary black hole observations
1 binary neutron star

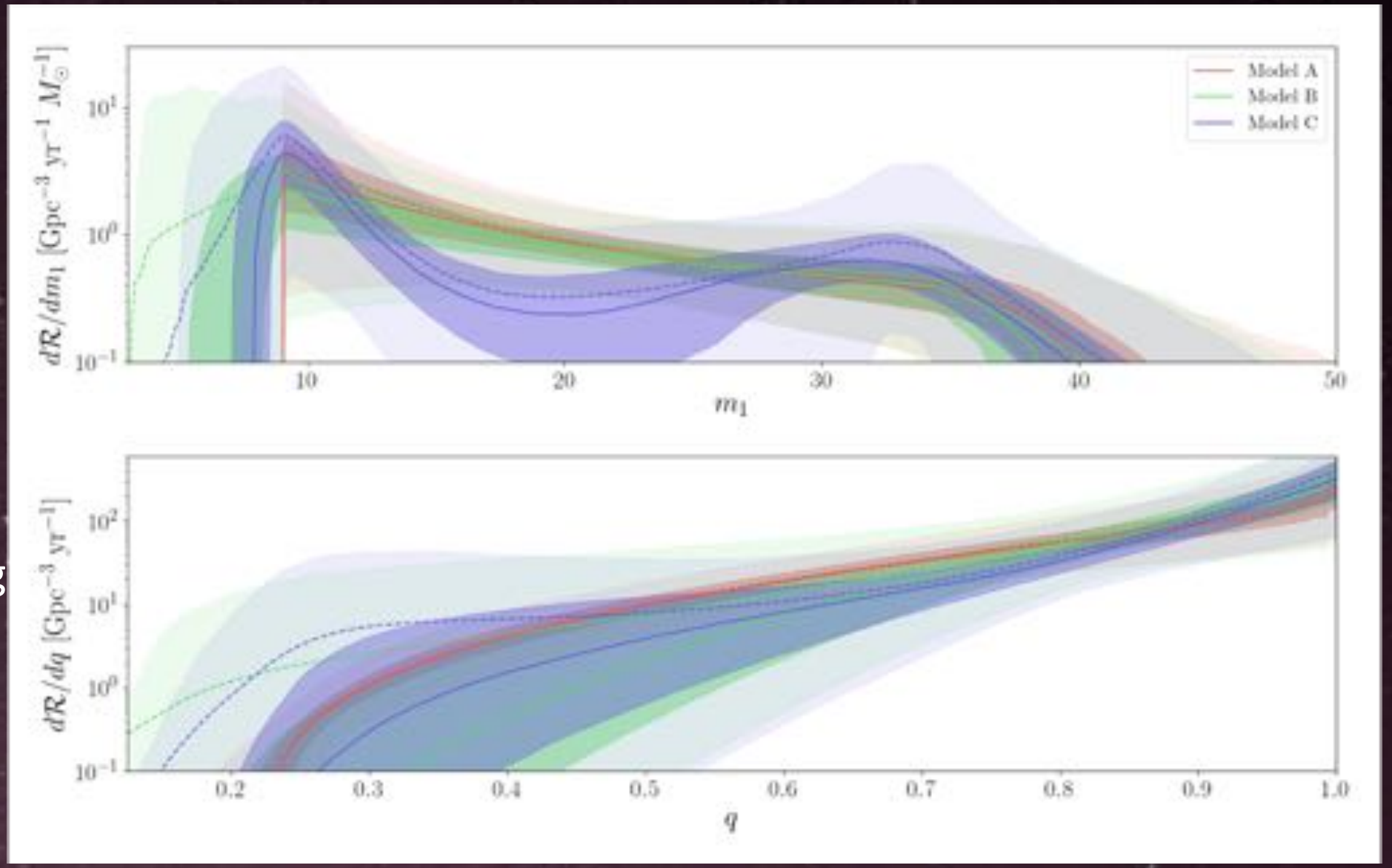




O1 + O2 Catalog paper
LVC 2018 https://arxiv.org/abs/1811.12907

The Population

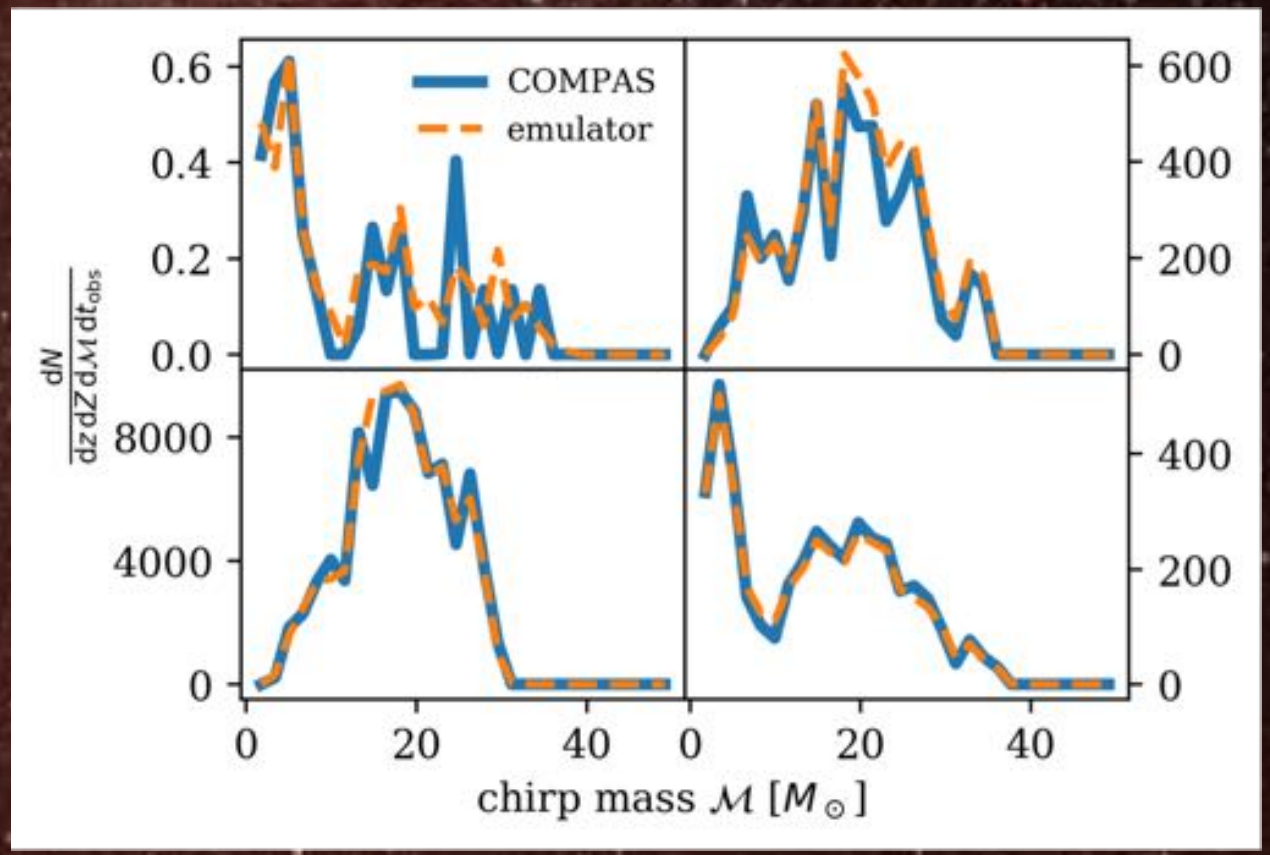
- Maximum mass < 45 Msol
- Rate 10-100 Gpc^{-3} yr^{-1}
- Favour rate increasing with redshift
- Spins are not both large and aligned

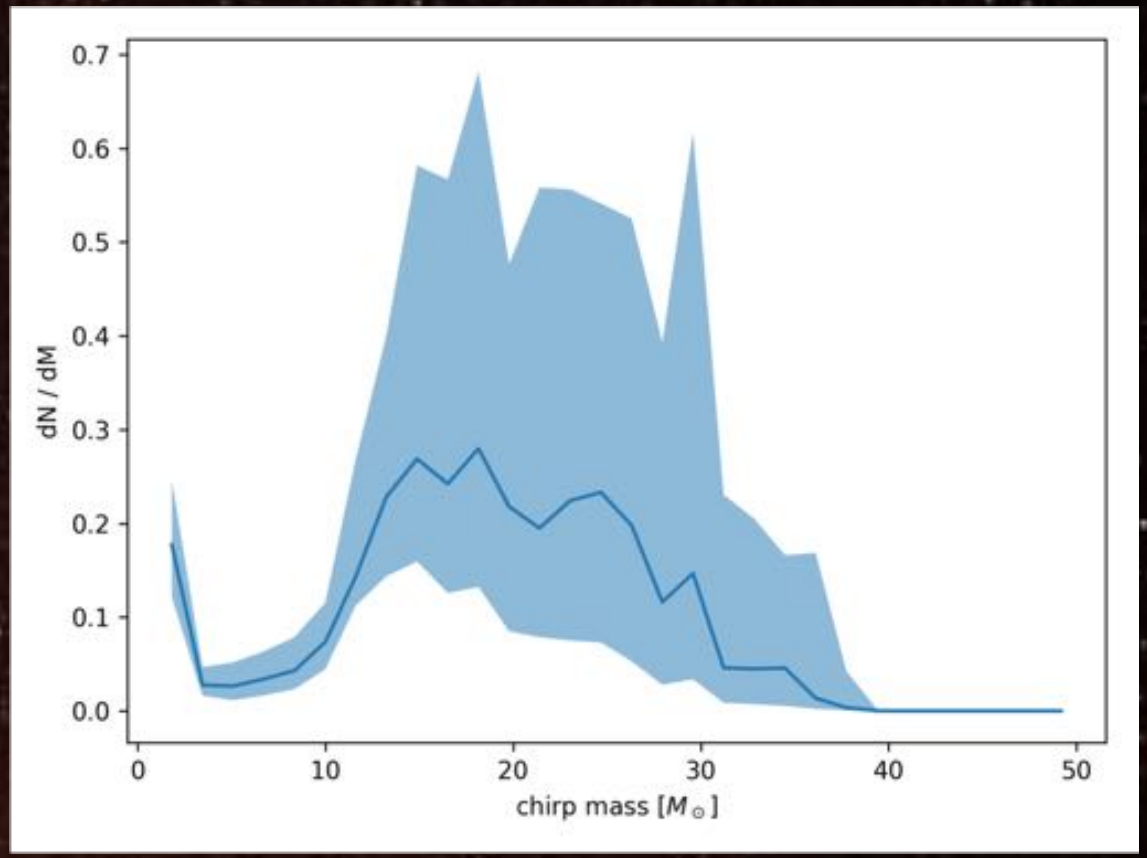


O1 + O2 Catalog paper
LVC 2018 https://arxiv.org/abs/1811.12907

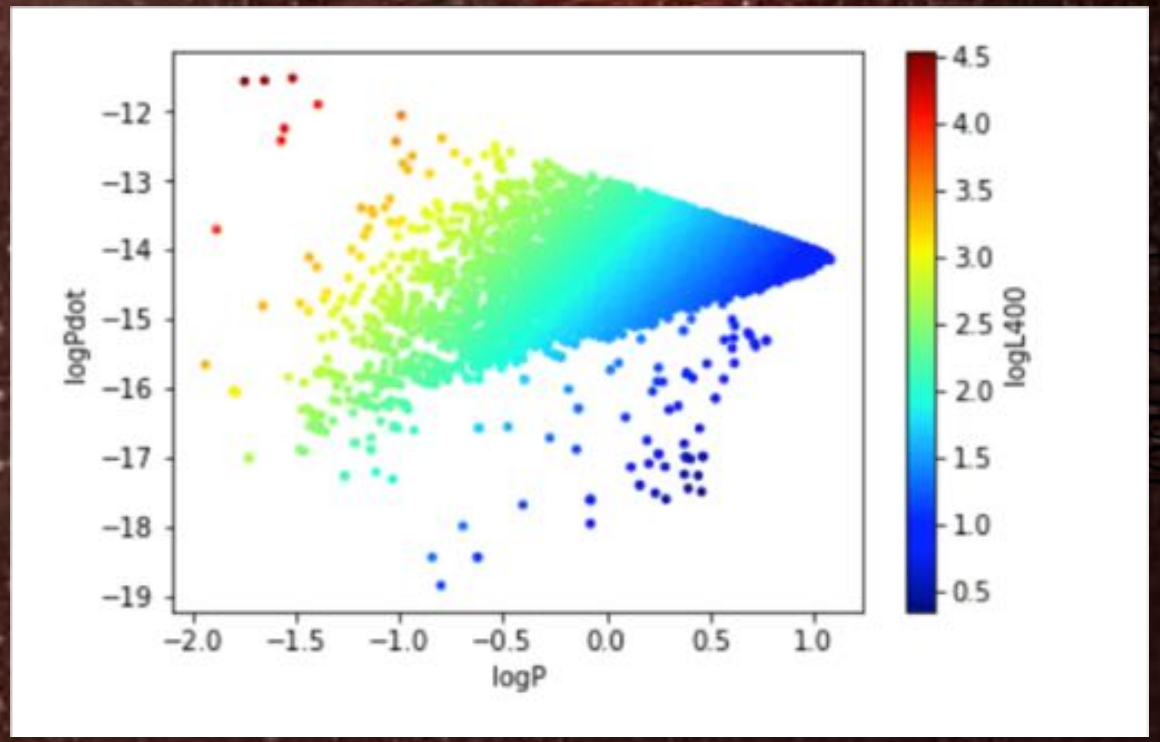
O1 + O2 BBH Population paper
LVC 2018 https://arxiv.org/abs/1811.12940

Inferring the population using COMPAS
Stevenson et al in prep - PRELIMINARY

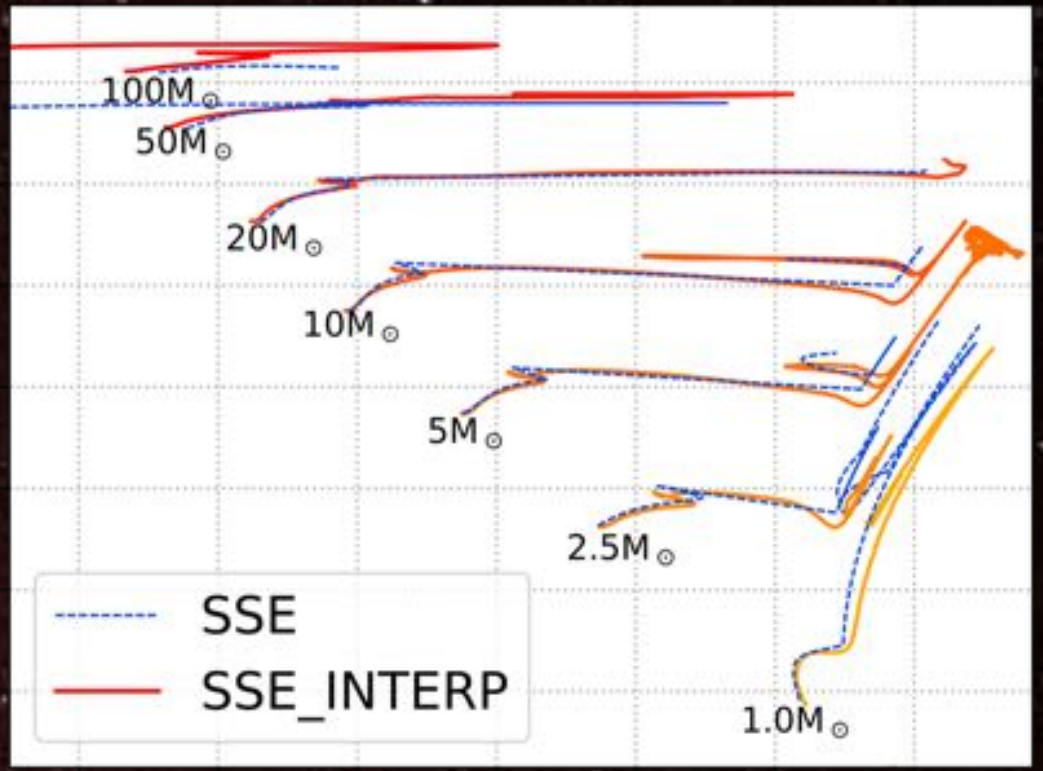




Ongoing COMPAS Projects 1

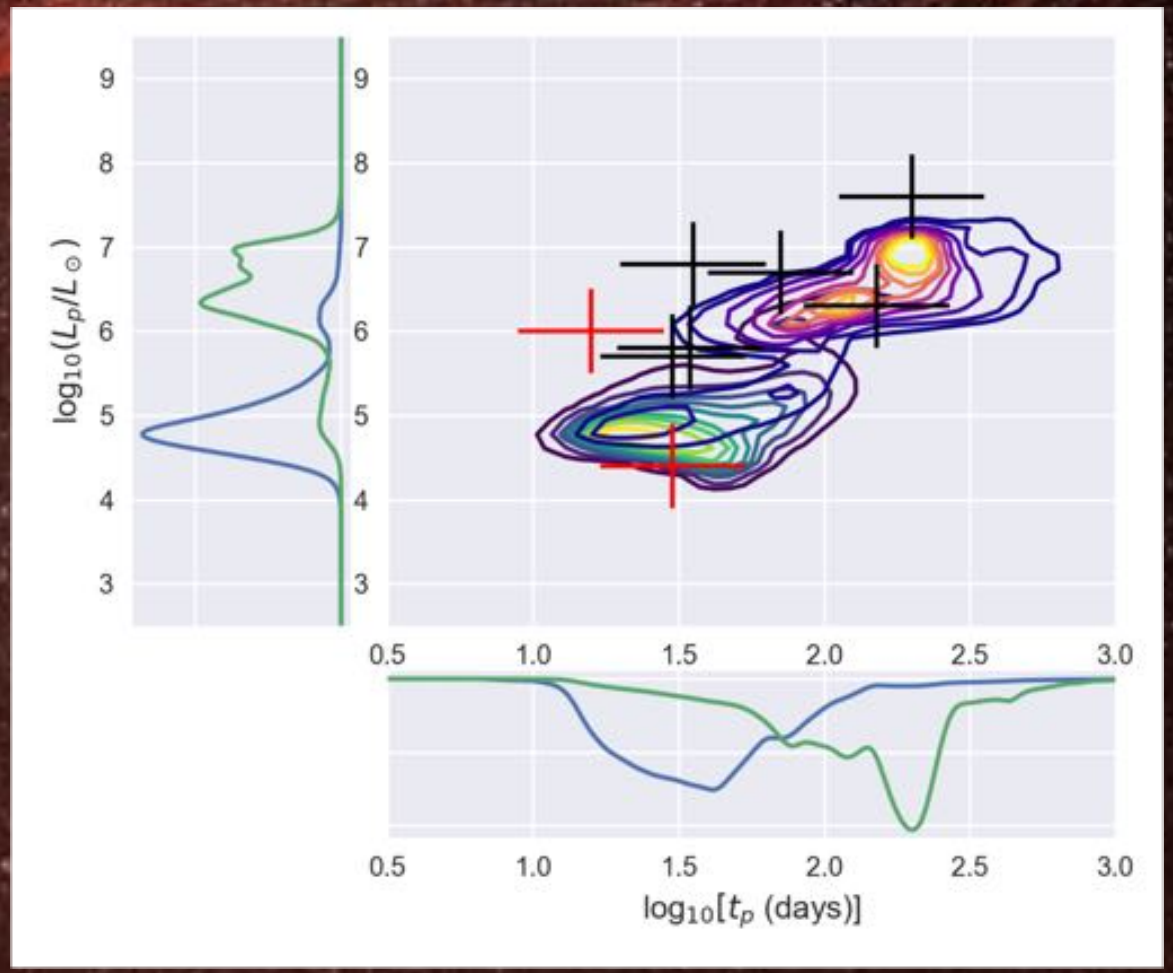


Debatri Chattopadhyay
Comparing observed pulsar populations

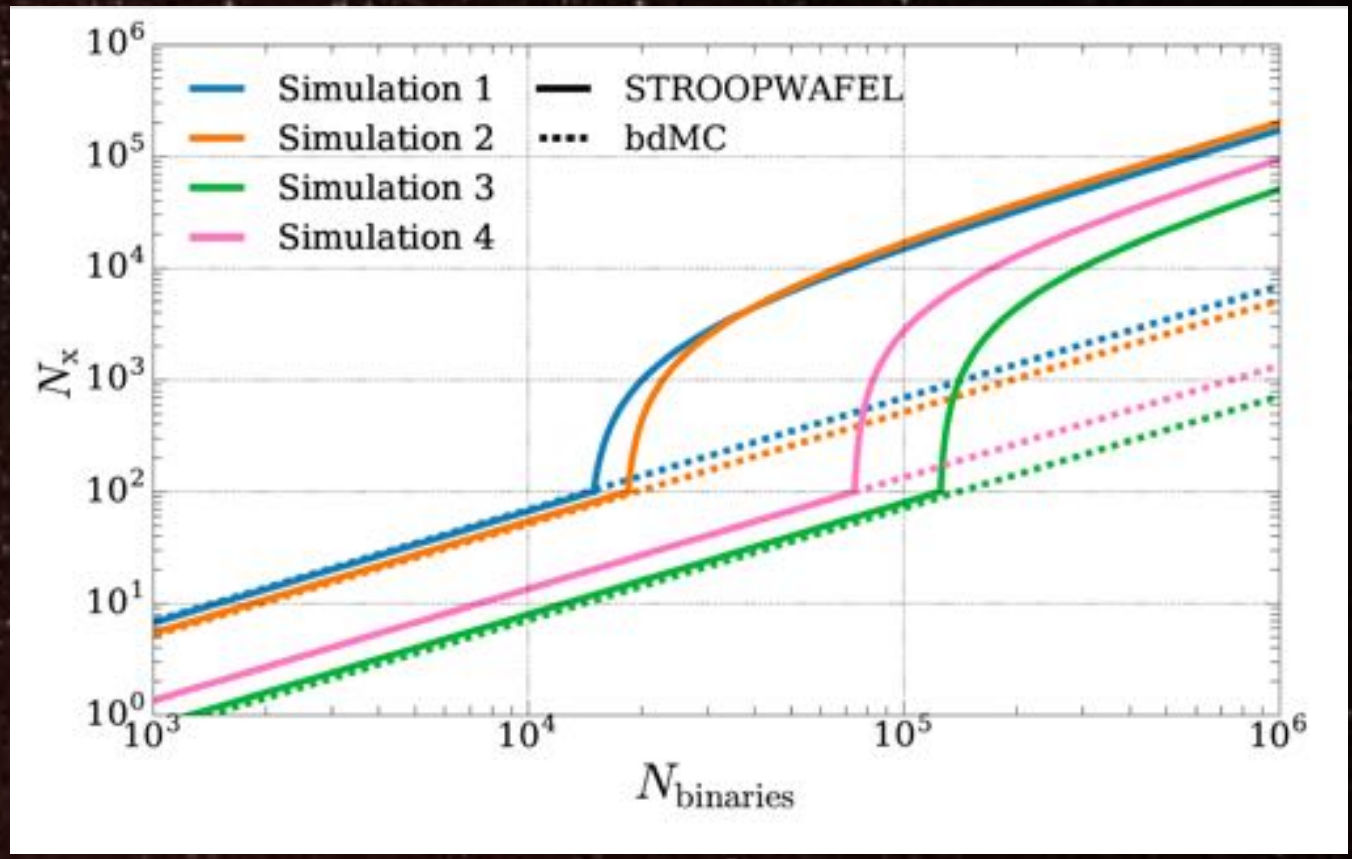


Poojan Agrawal
Improved single star evolution – see her poster

Ongoing COMPAS Projects 2

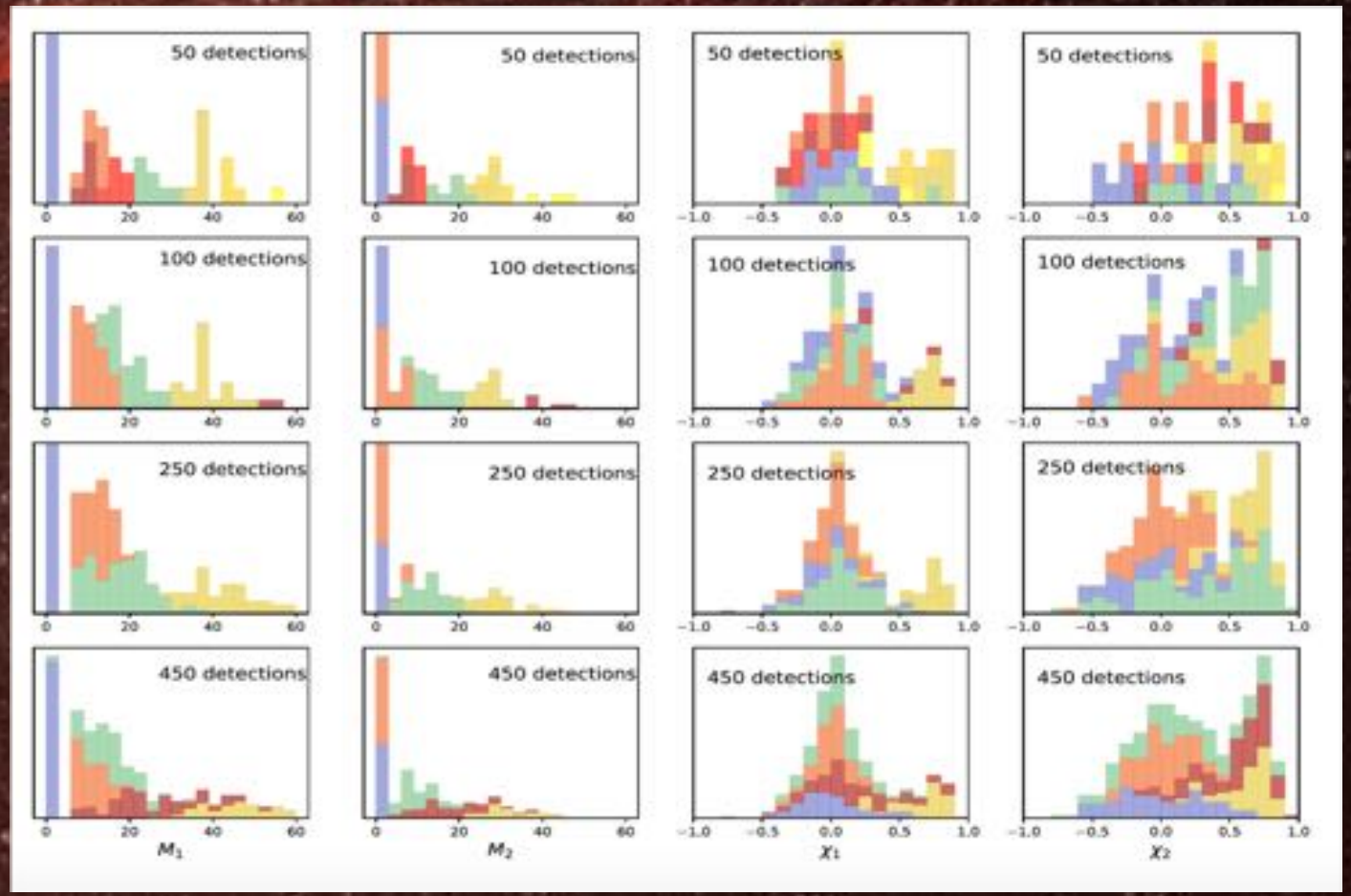


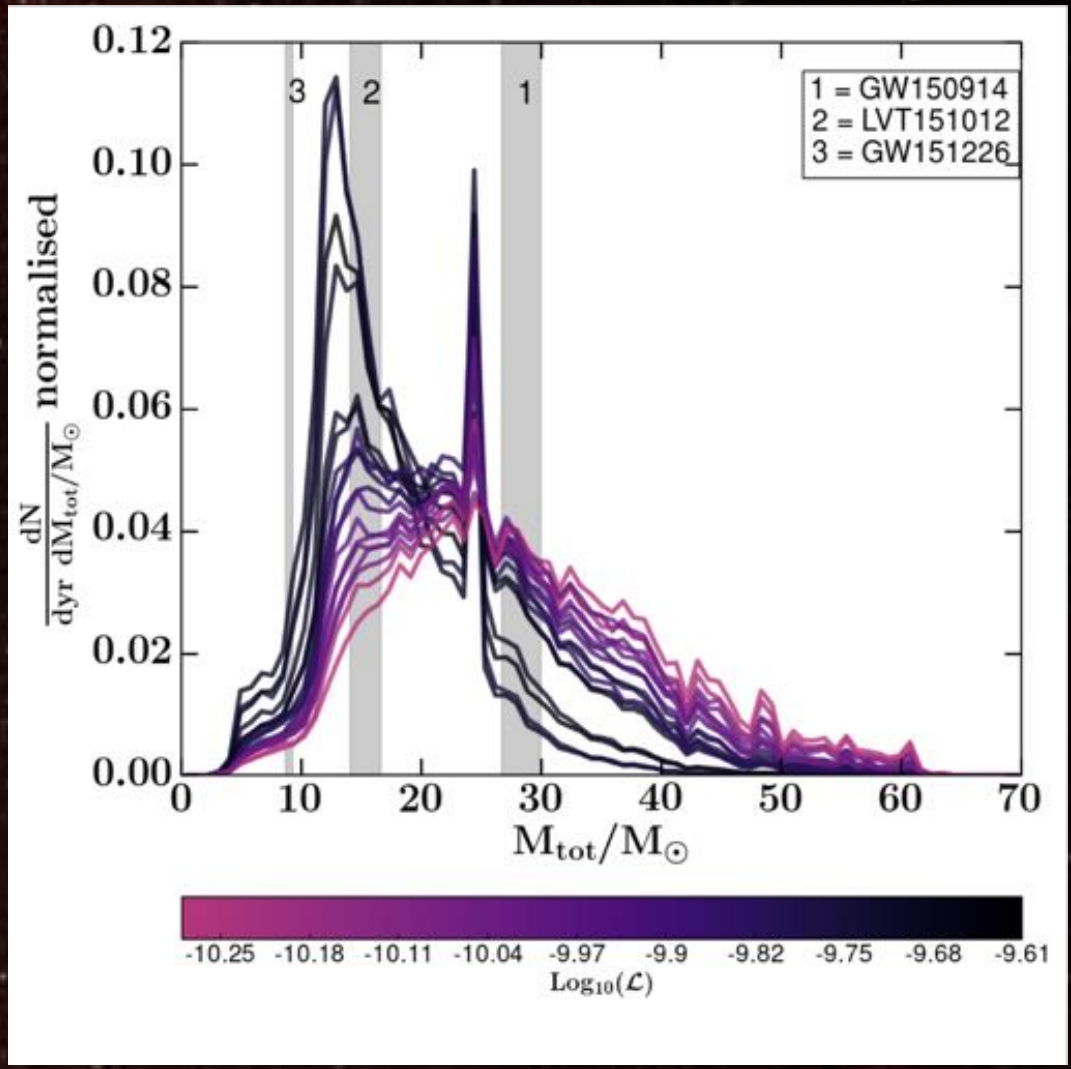
George Howitt
Luminous red novae as common envelope events



Floor Broekgaarden
Speeding up COMPAS calculations using importance sampling STROOPWAFEL

Ongoing COMPAS Projects 3





Jade Powell
Model independent inference

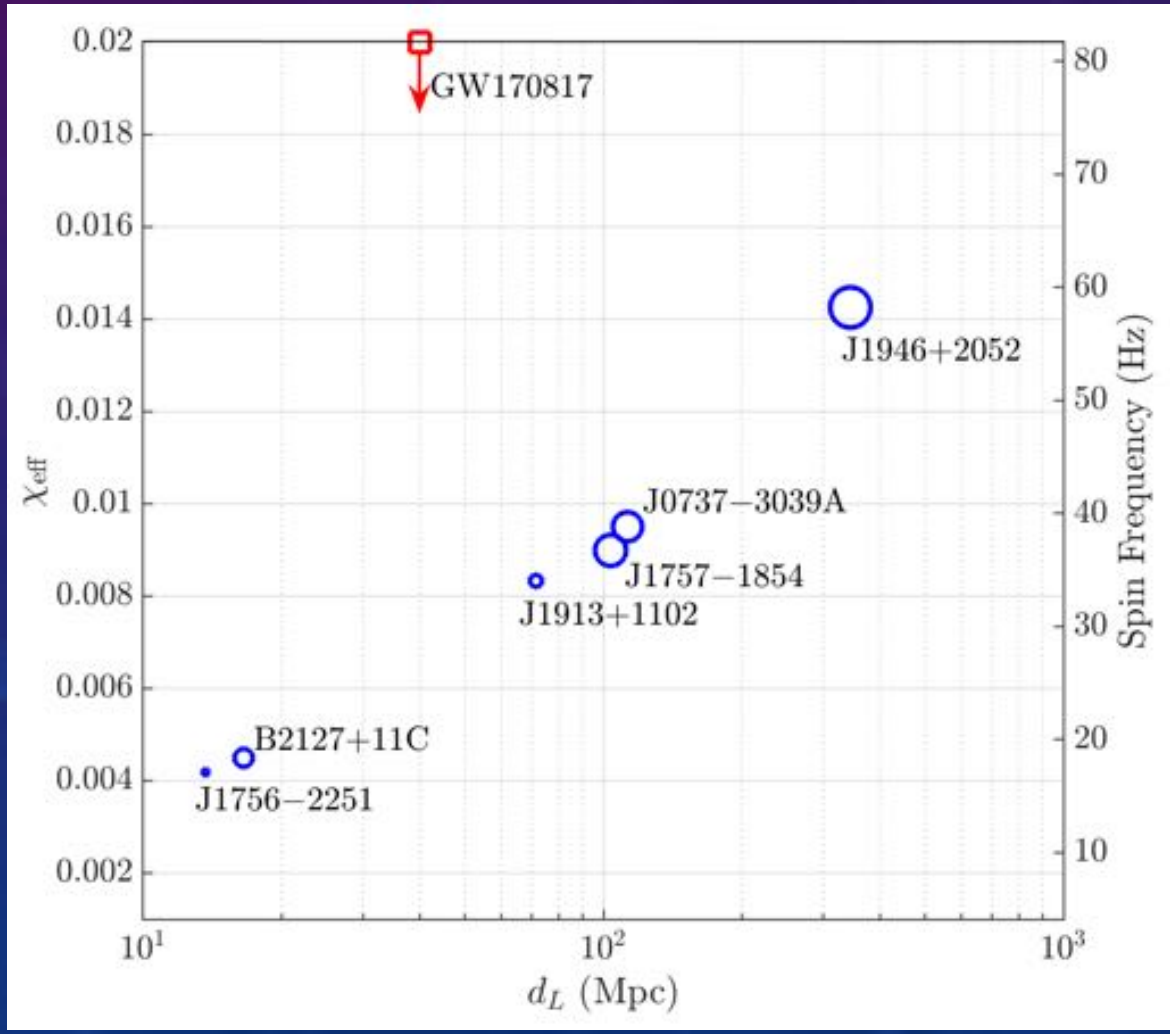
COMPAS

Coen Neijssel
Impact of uncertainties in cosmic star formation rate on binary evolution predictions

Inferring BNS population properties with GWs

- **Zhu, Thrane, Osłowski, Levin, & Lasky 2018**

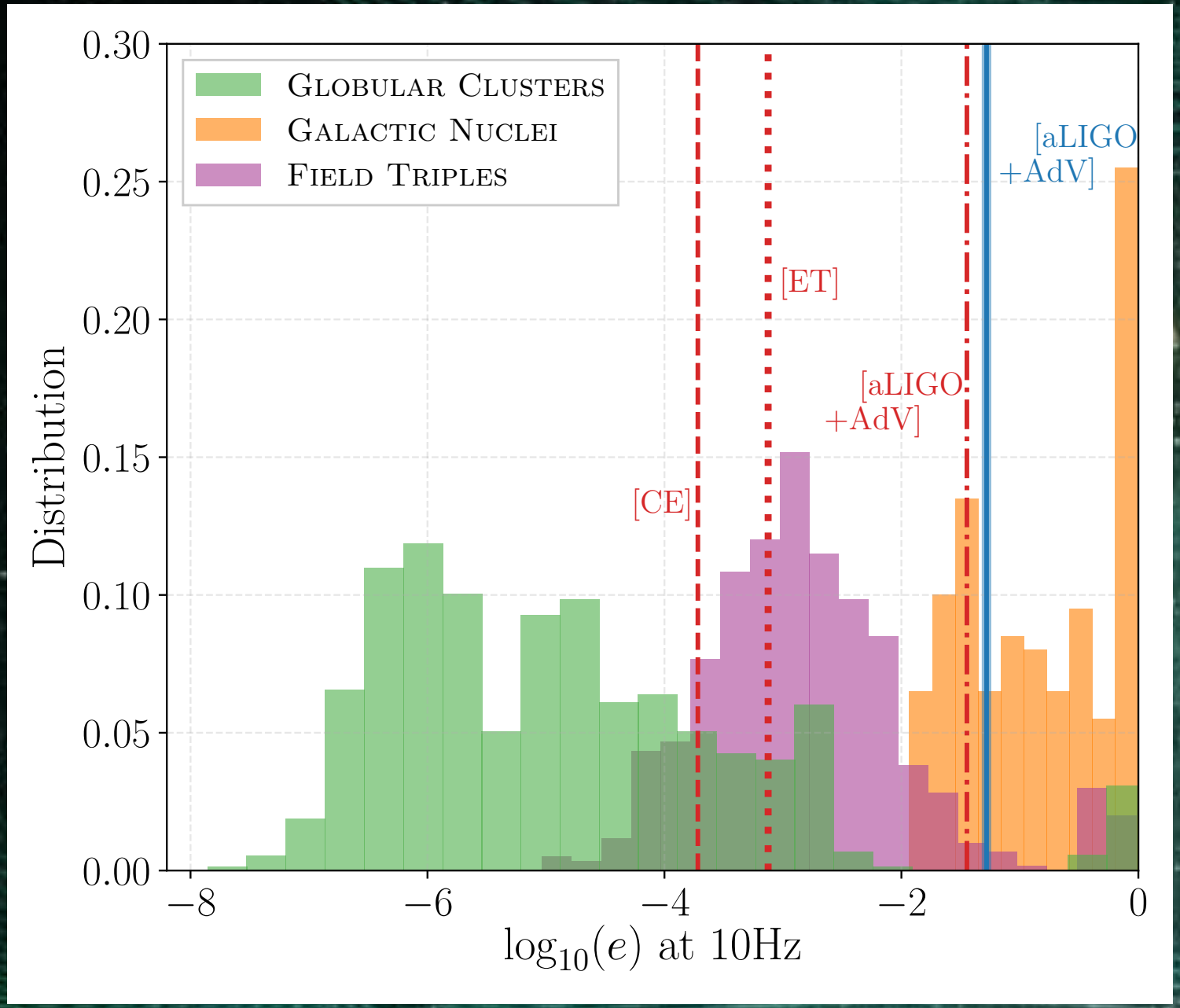
- **GW170817** implies tens to hundreds of binary neutron star (BNS) inspiral events to be detected by LIGO/Virgo/KAGRA in the coming ~ 5 years
- We find a significant fraction ($\approx 15 - 30\%$) of future BNS events will have measurable spins.
- GW measurements of spin will have implications for the *typical spin tilt angle* after tens of detections and for the *NS magnetic field evolution* or *EOS* after hundreds of observations.
- We focused on BNSs formed from isolated binaries and found that nearly all events will have $|\chi_{\rm eff}| < 0.05$. Measurements of spins outside our fiducial model predictions will have interesting implications about their formation history.



Measuring Eccentricity

- Additional observable
- Can be a signature of formation
- Technical difficulties – require a full eccentric, precessing, IMR waveform

Lower et al 2018
https://arxiv.org/abs/1806.05350



Future opportunities

- O3 beginning in a few months, lasting for approximately 1 year
- Expect many more BBH observations, and potentially a few more BNS
- NSBH?
- Many COMPAS papers on the way
- Expansion of group when Ilya Mandel + group (~4 PhD students) join Monash in February 2019


THANK YOU
FROM
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