

Forecasting the detection capabilities of third-generation gravitational-wave detectors using GWFAST

Francesco Iacovelli

Based on [arXiv:2207.02771](https://arxiv.org/abs/2207.02771) and [arXiv:2207.06910](https://arxiv.org/abs/2207.06910), in collaboration with:
Michele Mancarella, Stefano Foffa, Michele Maggiore

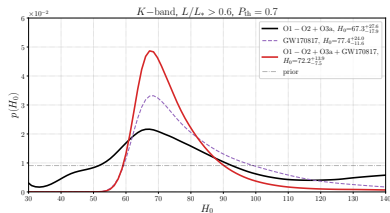
University of Geneva (UNIGE) – Department of Theoretical Physics

Young researchers' day – Geneva 2022

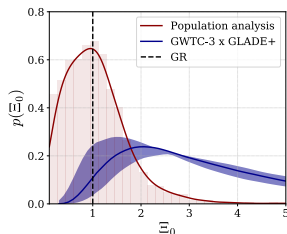
Introduction: Physics with GWs

GWs opened a new window on our Universe:

- Cosmology, e.g. H_0 and modified GW propagation
- Astrophysics, e.g. formation and evolution of compact objects
- Nuclear Physics, e.g. NS EoS



Finke et al. JCAP08(2021)026 (2021)

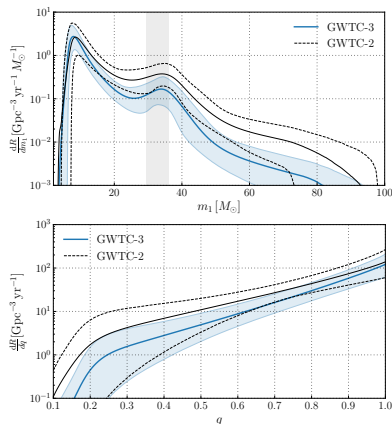


Mancarella et al. PRD105,064030 (2022)

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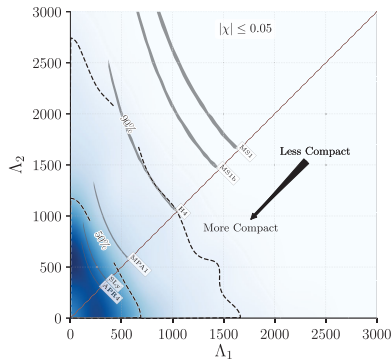


LVK Collaboration, 2111.03634 (2021)

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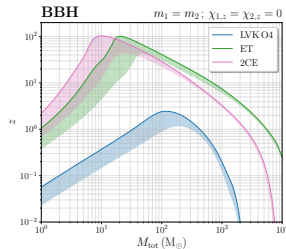
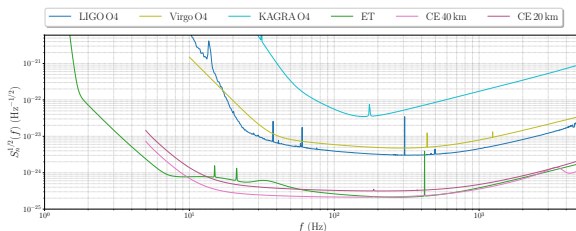
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LVC Collaboration, PRL119,161101 (2017)

3G GW detectors: ET and CE

2G detectors offer outstanding possibilities... but the potential of 3G detectors is unprecedented



Network	BBH/yr	BNS/yr	NSBH/yr
LVK-O4	$\mathcal{O}(10^2)$	$\mathcal{O}(1 - 10)$	$\mathcal{O}(1 - 10)$
ET	$\mathcal{O}(10^4)$	$\mathcal{O}(10^3 - 10^5)$	$\mathcal{O}(10^3 - 10^4)$

Assessing the scientific capabilities of 3G detectors is fundamental!

Forecasts with GWFAST: why and how

Current GW Bayesian PE codes, like `bilby`, need $\mathcal{O}(1 \text{ day/ev})$:

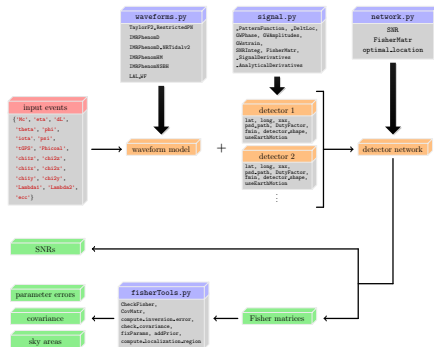
⇒ computationally unfeasible to use them on 10^5 events

GWFAST:

⇒ use Fisher matrix approach to approximate the likelihood

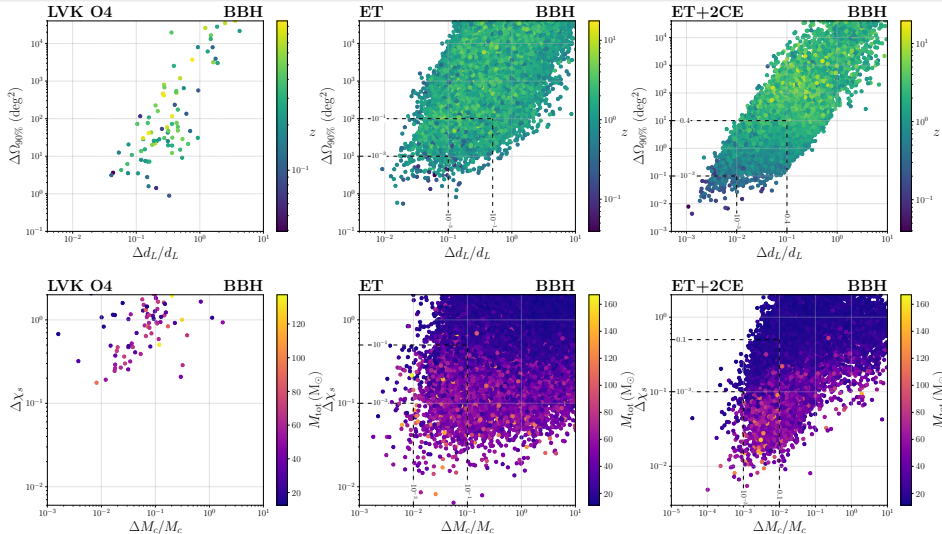
⇒ compute derivatives using automatic differentiation with JAX

⇒ write a pure Python vectorized code to handle multiple events at a time

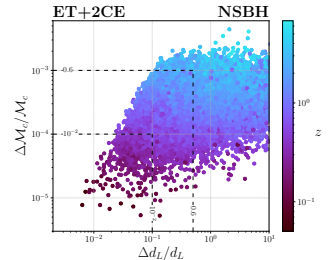
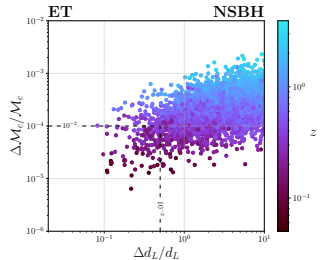
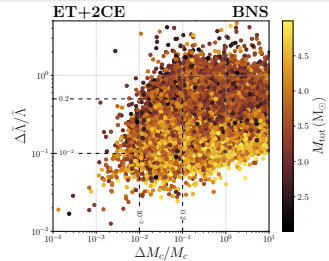
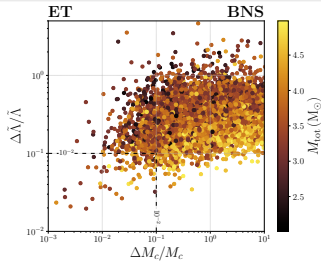


GWFAST needs $\mathcal{O}(1 \text{ day})$ to run the PE on 10^5 events!

Forecasts with GWFAST: GWFAST for 3G detectors



Forecasts with GWFAST: GWFAST for 3G detectors



Thanks for your attention, questions?

I am also available at Francesco.lacovelli@unige.ch