Searching for Primordial Black Holes with the Einstein Telescope

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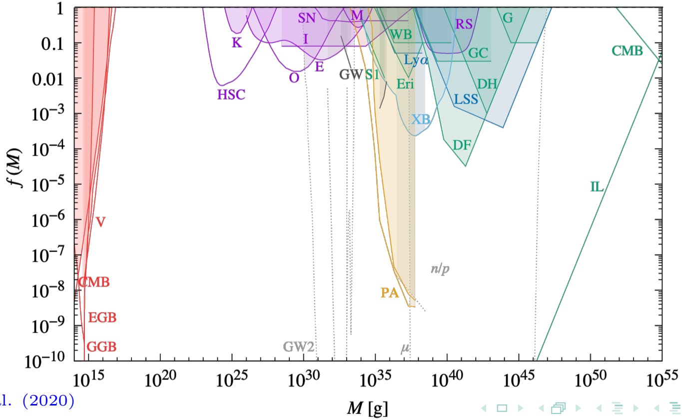
Primordial Black Holes

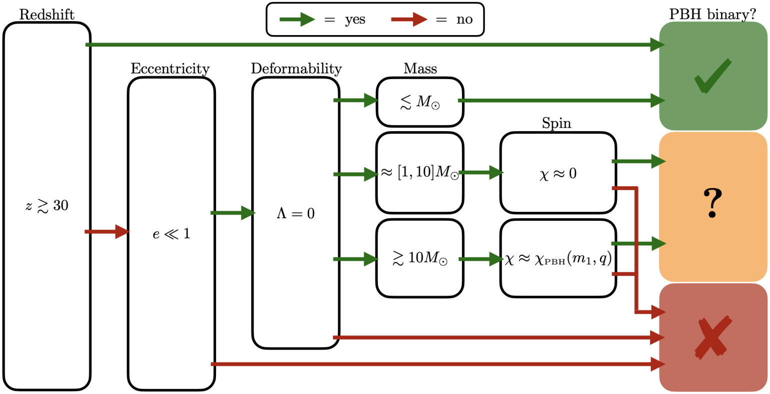
PBHs can form from the collapse of inhomogeneities in the radiation–dominated era. PBHs could explain at least a fraction of the dark matter in our universe, be the seed of SMBHs at high z, and could give rise to CBC events



Carr, et al. (2020)

Primordial Black Hole binaries signatures

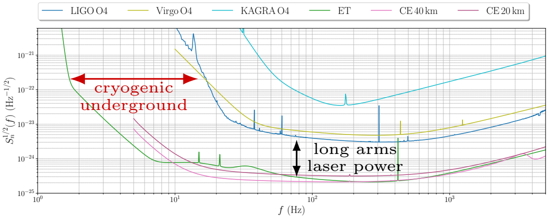
PBHs binaries could be difficult to tell apart from the ABH ones, but they have some characteristic features

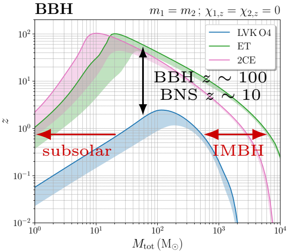


Franciolini, et al. (2021)

3G ground–based GW detectors: ET and CE

Thanks to their technological advancements and the bigger facilities, ET and CE will have a broader frequency range and sensitivities improved more than 10 times compared to LVK



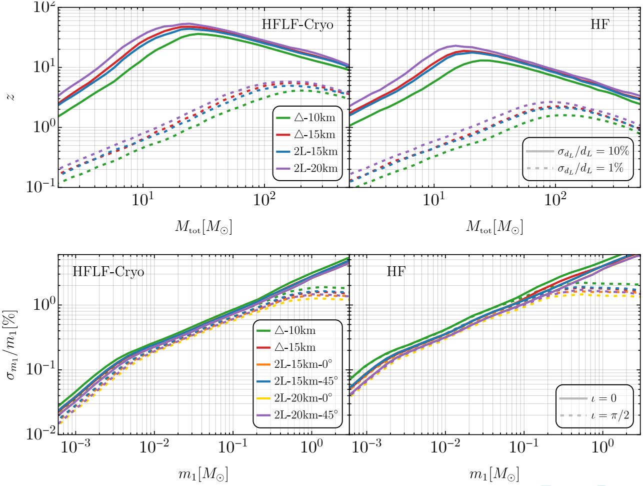


3G detectors have the potential to trigger fundamental discoveries. . . and assessing the capabilities of 3G detectors is crucial to take informed decisions!

FI, et al. (2022), Branchesi, Maggiore, et al. (2023)

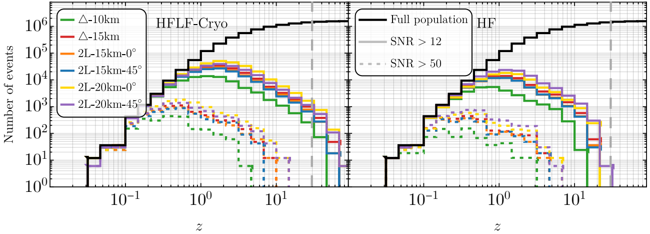
Results: smoking–gun signatures

ET alone could reach an outstanding accuracy in the reconstruction of some relevant source parameters, such as distance and mass



Results: population

We also simulated a PBH population that saturates the upper bounds provided by current GWTC–3 GW data Franciolini, et al. (2022)



	$N^{\rm tot}$	$N^{\rm SS}$	$N^{z>10}$	$N^{z>30}$	$N^{\rm LMG}$	$N^{\rm UMG}$
Intrinsic population	1 920 000	708 487	1 400 384	795 904	300 220	7774
Configuration	$N^{\rm tot}_{\rm det}$	$N^{\rm SS}_{\rm det}$	$N^{z>10}_{\rm det}$	$N^{z>30}_{\rm det}$	$N^{\rm LMG}_{\rm det}$	$N^{\rm UMG}_{\rm det}$
△-10km-HFLF-Cryo	13 347	1650	336	17	2638	235
△-15km-HFLF-Cryo	30 912	4281	1099	91	6443	376
2L-15km-45°-HFLF-Cryo	24 900	3345	824	66	5132	332
2L-15km-0°-HFLF-Cryo	26 585	3580	940	65	5517	356
2L-20km-45°-HFLF-Cryo	35 524	5206	1434	140	7550	374
2L-20km-0°-HFLF-Cryo	45 650	6745	1962	187	9809	465
LVKI-O5	49	7	0	0	10	1

Summary

- PBHs are extremely interesting objects, but observing them is a challenging task…
- …"luckily" 3G detectors have outstanding capabilities
- Thanks to its sensitivity, ET has the potential to shed light on this putative population of objects!
- Some observables remain challenging (z, small Λ, …), and more analyses are yet to be performed (full Bayesian PE, different populations,…)

Thanks for your attention!

For any question or comment, contact me at
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or through Mattermost