NEWS FROM COSMIC EXPLORER AND SYNERGY WITH EINSTEIN TELESCOPE

B. S. Sathyaprakash

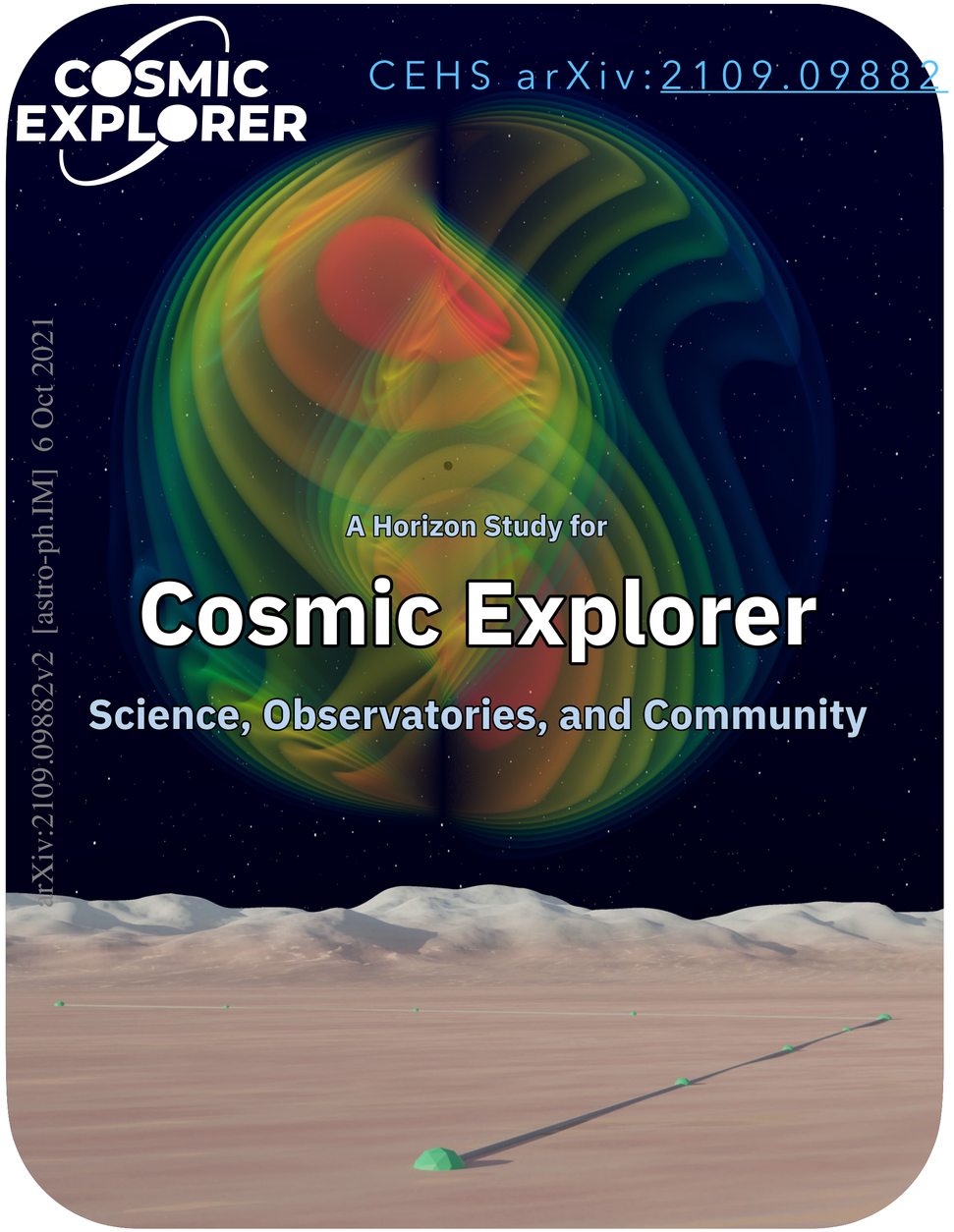
Penn State and Cardiff University

Einstein Telescope Symposium XII, May 8-12 2024, Calgary, Italy

Cosmic Explorer

COSMIC EXPLORER

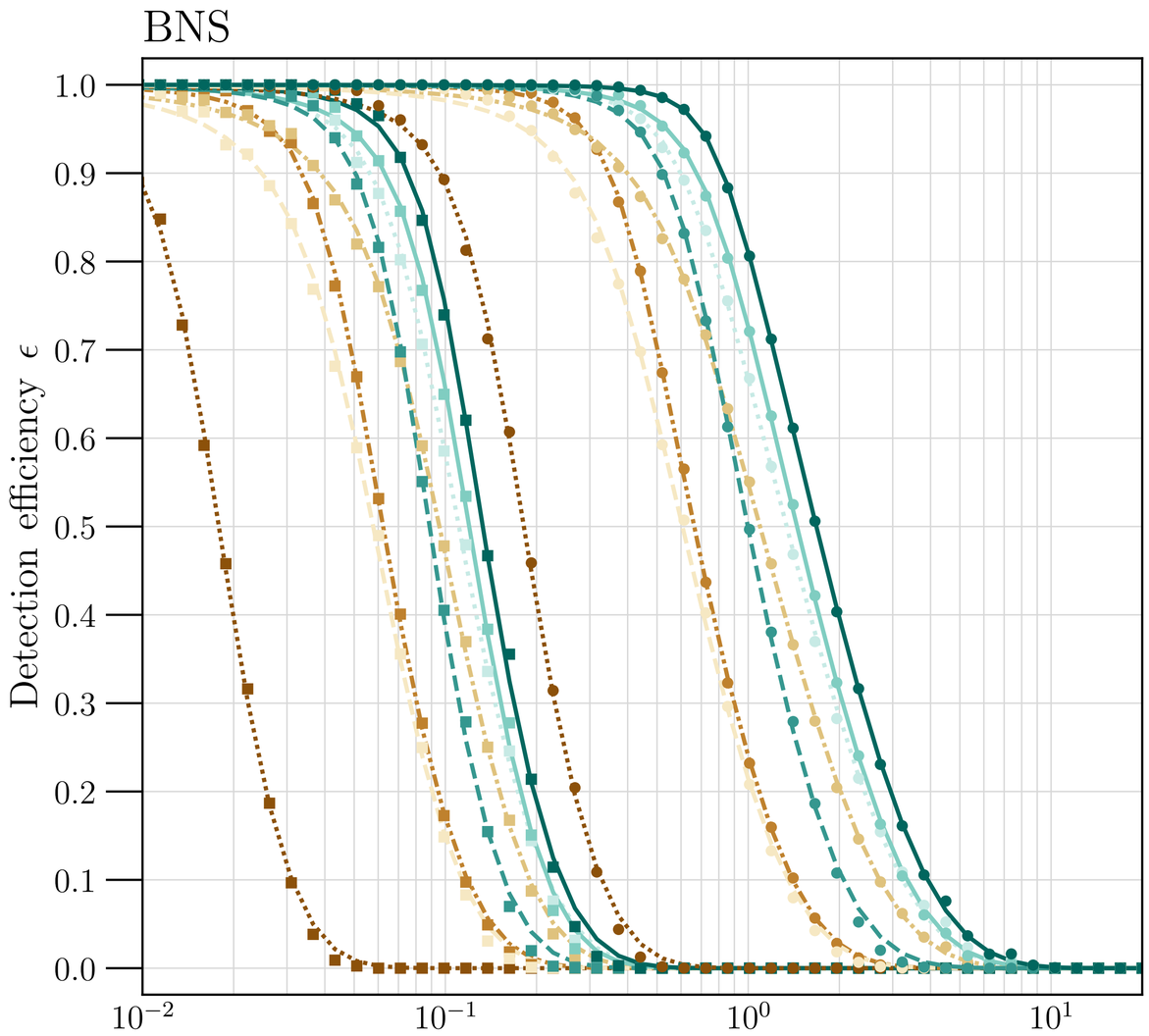
- Cosmic Explorer is the US concept for a next-gen gravitational-wave observatory
  - 40 km and 20 km L-shaped surface observatories
  - roughly 10x sensitivity of today's observatories
  - Will operate as part of a global network together with Einstein Telescope, LISA, and others
- CE is as envisioned an NSF-funded Project
  - 7 proposals submitted to start work on aspects of CE conceptual design
  - NSF MPSAC (Mathematical and Physical Sciences Advisory Committee) sub-committee is charged to report on the path forward for next-gen GW observatory in the US. Outputs expected this year.

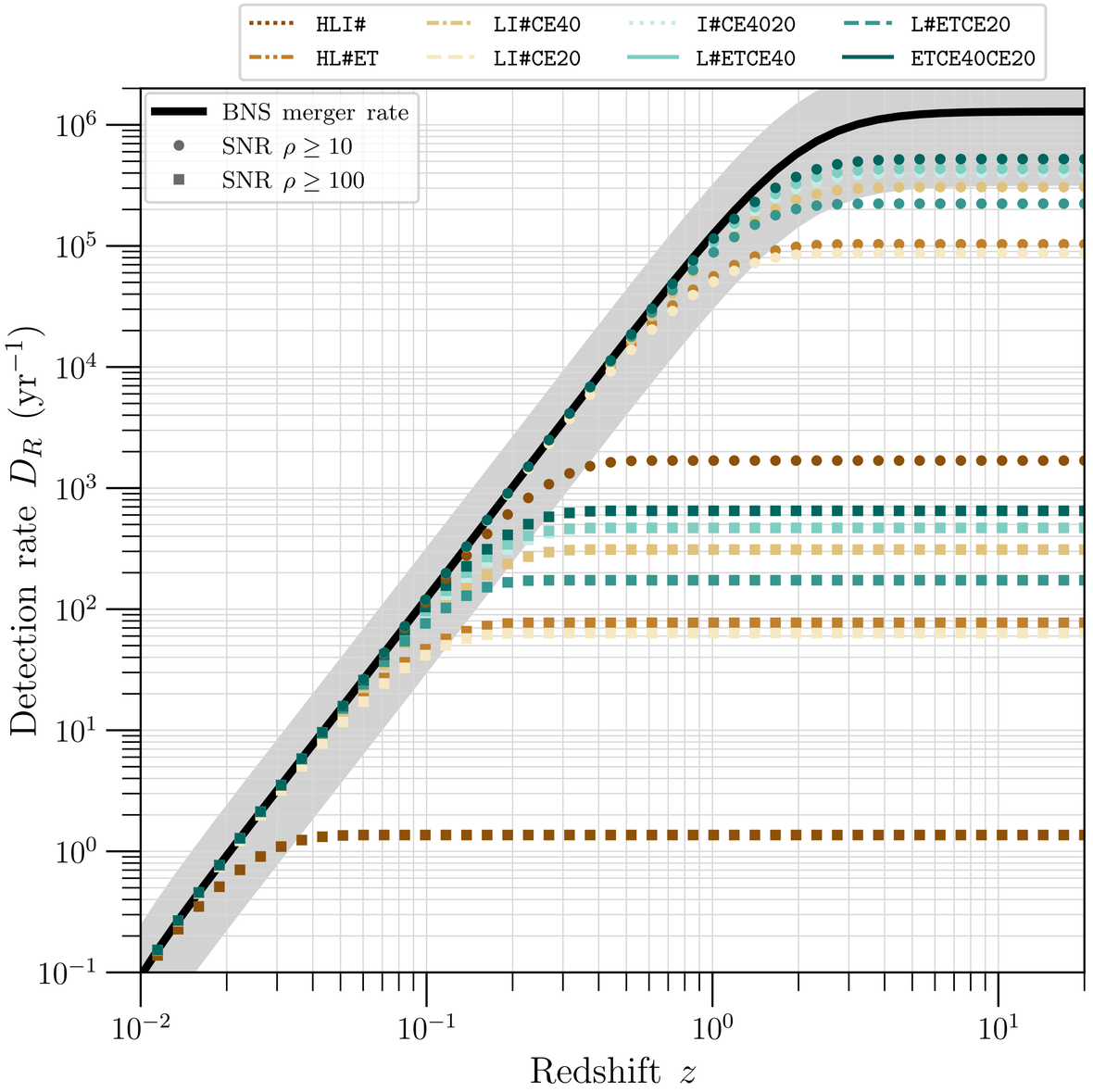


Number of XG Observatories	Network Name	Detectors in the network
None	HLI	LHO, LLO, LIO
1 XG	CE40LI	CE A 40 km, LLO, LIO
	CE20LI	CE A 20 km, LLO, LIO
2 XG	CE4020I	CE A 40 km, CE B 20 km, LIO
	CE40LET	CE A 40 km, LLO, ET
	CE20LET	CE A 20 km, LLO, ET
3 XG	CE4020ET	CE A 40 km, CE B 20 km, ET

Many thanks to Ish Gupta, Penn State, for all the evaluations

DETECTION EFFICIENCY AND RATE





LOUD EVENTS

Cosmic Rate	$1.2^{+2.0}_{-0.9} \times 10^6$ yr^{-1}		
SNR ρ	> 10	> 30	> 100
HLI	$1.3^{+1.9}_{-1.0} \times 10^3$	$2.7^{+6.6}_{-2.3} \times 10^1$	0
HLET	$8.5^{+13.0}_{-6.4} \times 10^4$	$2.5^{+3.9}_{-1.9} \times 10^3$	$4.8^{+7.4}_{-3.7} \times 10^1$
CE40LI	$2.7^{+4.1}_{-2.0} \times 10^5$	$1.1^{+1.7}_{-0.8} \times 10^4$	$2.2^{+3.3}_{-1.8} \times 10^2$
CE20LI	$7.1^{+11.0}_{-5.4} \times 10^4$	$2.1^{+3.1}_{-1.6} \times 10^3$	$3.9^{+6.7}_{-3.3} \times 10^1$
CE4020I	$3.6^{+5.5}_{-2.7} \times 10^5$	$1.7^{+2.6}_{-1.3} \times 10^4$	$3.5^{+5.6}_{-2.9} \times 10^2$
CE40LET	$3.9^{+5.9}_{-2.9} \times 10^5$	$1.7^{+2.6}_{-1.2} \times 10^4$	$3.5^{+5.5}_{-2.9} \times 10^2$
CE20LET	$1.9^{+2.9}_{-1.4} \times 10^5$	$5.9^{+9.0}_{-4.4} \times 10^3$	$1.2^{+1.9}_{-1.0} \times 10^2$
CE4020ET	$4.7^{+7.2}_{-3.5} \times 10^5$	$2.3^{+3.6}_{-1.8} \times 10^4$	$4.8^{+7.7}_{-3.9} \times 10^2$

SKY LOCALIZATION

Metric	Ω_{90} $(\mathrm{deg})^2$				
Quality	≤ 100	≤ 10	≤ 1	≤ 0.1	≤ 0.01
HLI	$1.2^{+1.8}_{-0.9} \times 10^3$	$3.2^{+4.7}_{-2.5} \times 10^2$	$5.0^{+11.0}_{-5.0} \times 10^0$	0	0
HLET	$2.8^{+4.4}_{-2.1} \times 10^4$	$1.2^{+1.8}_{-0.9} \times 10^3$	$2.4^{+4.7}_{-2.1} \times 10^1$	$0.0^{+3.0}_{-0.0} \times 10^0$	0
CE40LI	$3.4^{+5.3}_{-2.6} \times 10^4$	$9.8^{+14.7}_{-7.6} \times 10^2$	$1.8^{+3.8}_{-1.6} \times 10^1$	0	0
CE20LI	$2.5^{+3.9}_{-1.9} \times 10^4$	$8.7^{+12.9}_{-6.8} \times 10^2$	$1.7^{+3.3}_{-1.5} \times 10^1$	0	0
CE4020I	$1.1^{+1.8}_{-0.9} \times_7 10^5$	$4.0^{+6.3}_{-3.0} \times 10^3$	$9.7^{+15.7}_{-7.7} \times 10^1$	$0.0^{+4.0}_{-0.0} \times 10^0$	0
CE40LET	$2.4^{+3.6}_{-1.8} \times 10^5$	$9.4^{+14.4}_{-7.1} \times 10^3$	$2.5^{+3.8}_{-2.0} \times 10^2$	$1.0^{+9.0}_{-1.0} \times 10^0$	0
CE20LET	$1.5^{+2.3}_{-1.1} \times 10^5$	$6.2^{+9.5}_{-4.7} \times 10^3$	$1.6^{+2.4}_{-1.3} \times 10^2$	$1.0^{+6.0}_{-1.0} \times 10^0$	0
CE4020ET	$3.6^{+5.6}_{-2.7} \times 10^5$	$2.8^{+4.3}_{-2.1} \times 10^4$	$7.5^{+11.4}_{-5.8} \times 10^2$	$1.3^{+2.9}_{-1.2} \times 10^1$	$0.0^{+2.0}_{-0.0} \times 10^0$

DISTANCE ERRORS

Metric	$\Delta D_L/D_L$	
Quality	≤ 0.1	≤ 0.01
HLI	$2.6^{+4.2}_{-2.3} \times 10^{1}$	0
HLET	$2.6^{+3.9}_{-1.9} \times 10^{3}$	$1.0^{+2.0}_{-1.0} \times 10^{0}$
CE40LI	$4.1^{+6.9}_{-3.2} \times 10^{2}$	$0.0^{+2.0}_{-0.0} \times 10^{0}$
CE20LI	$2.7^{+4.6}_{-2.1} \times 10^{2}$	0
CE4020I	$1.0^{+1.6}_{-0.8} \times 10^{4}$	$4.0^{+11.0}_{-4.0} \times 10^{0}$
CE40LET	$8.8^{+13.5}_{-6.7} \times 10^{3}$	$2.0^{+9.0}_{-2.0} \times 10^{0}$
CE20LET	$6.3^{+9.6}_{-4.7} \times 10^{3}$	$2.0^{+6.0}_{-2.0} \times 10^{0}$
CE4020ET	$2.5^{+3.7}_{-1.8} \times 10^{4}$	$1.2^{+2.2}_{-1.2} \times 10^{1}$

EARLY WARNING

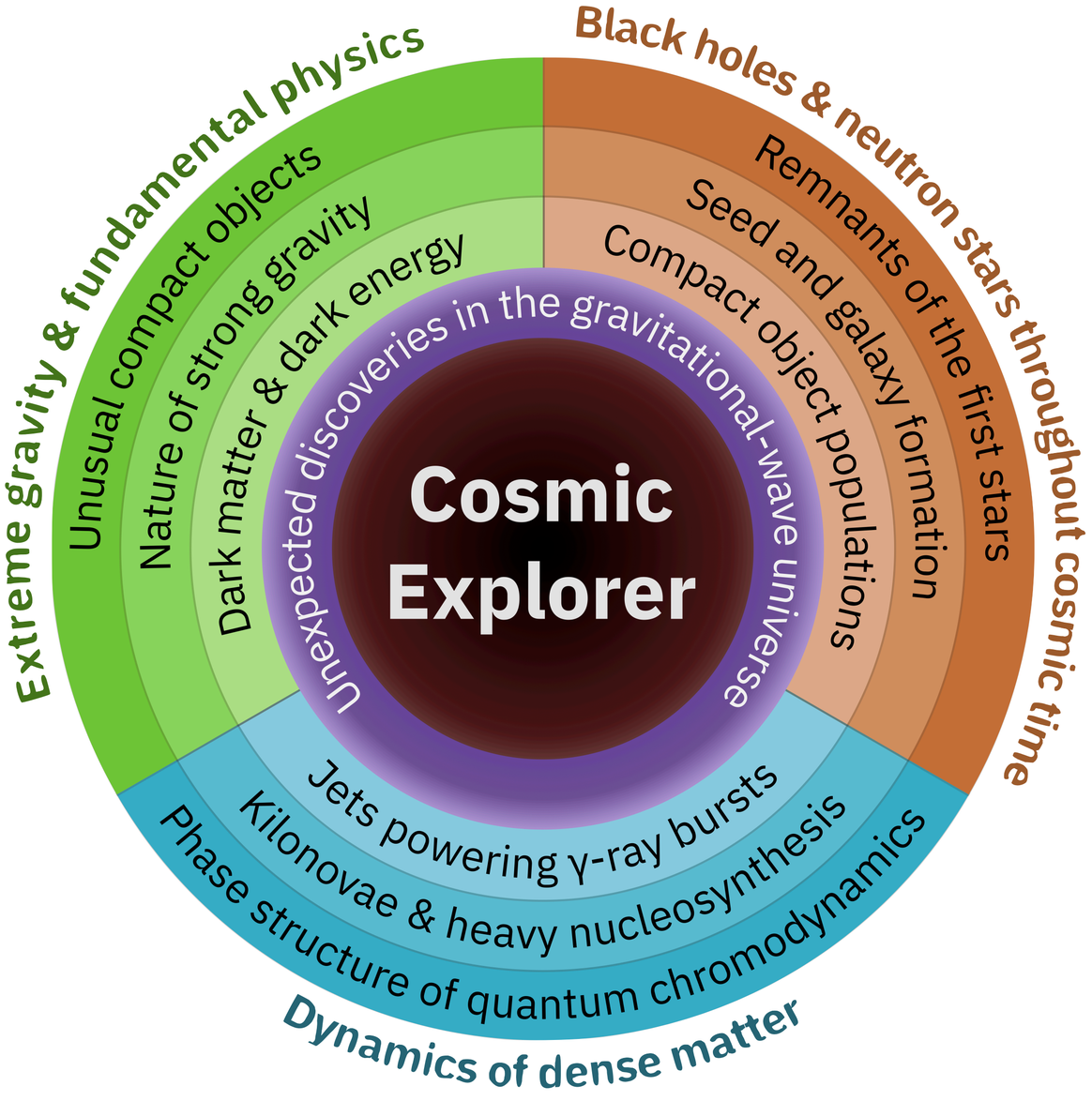
EW Time	$\tau_{\rm EW} = 60$ s		
Ω_{90} (deg^2)	≤ 100	≤ 10	≤ 1
HLI	$0.0^{+1.0}_{-0.0} \times 10^0$	0	0
HLET	$1.3^{+2.4}_{-1.1} \times 10^2$	$1.0^{+10.0}_{-1.0} \times 10^0$	0
CE40LI	$7.0^{+19.0}_{-6.0} \times 10^0$	0	0
CE20LI	$5.0^{+10.0}_{-4.0} \times 10^0$	0	0
CE4020I	$3.7^{+6.2}_{-2.8} \times 10^2$	$1.5^{+2.3}_{-1.2} \times 10^1$	0
CE40LET	$3.4^{+5.2}_{-2.6} \times 10^3$	$1.2^{+1.9}_{-0.9} \times 10^2$	$2.0^{+4.0}_{-2.0} \times 10^0$
CE20LET	$2.0^{+3.2}_{-1.6} \times 10^3$	$4.9^{+9.7}_{-4.0} \times 10^1$	$1.0^{+3.0}_{-1.0} \times 10^0$
CE4020ET	$6.3^{+9.4}_{-4.7} \times 10^3$	$2.7^{+4.5}_{-2.1} \times 10^2$	$5.0^{+12.0}_{-4.0} \times 10^0$

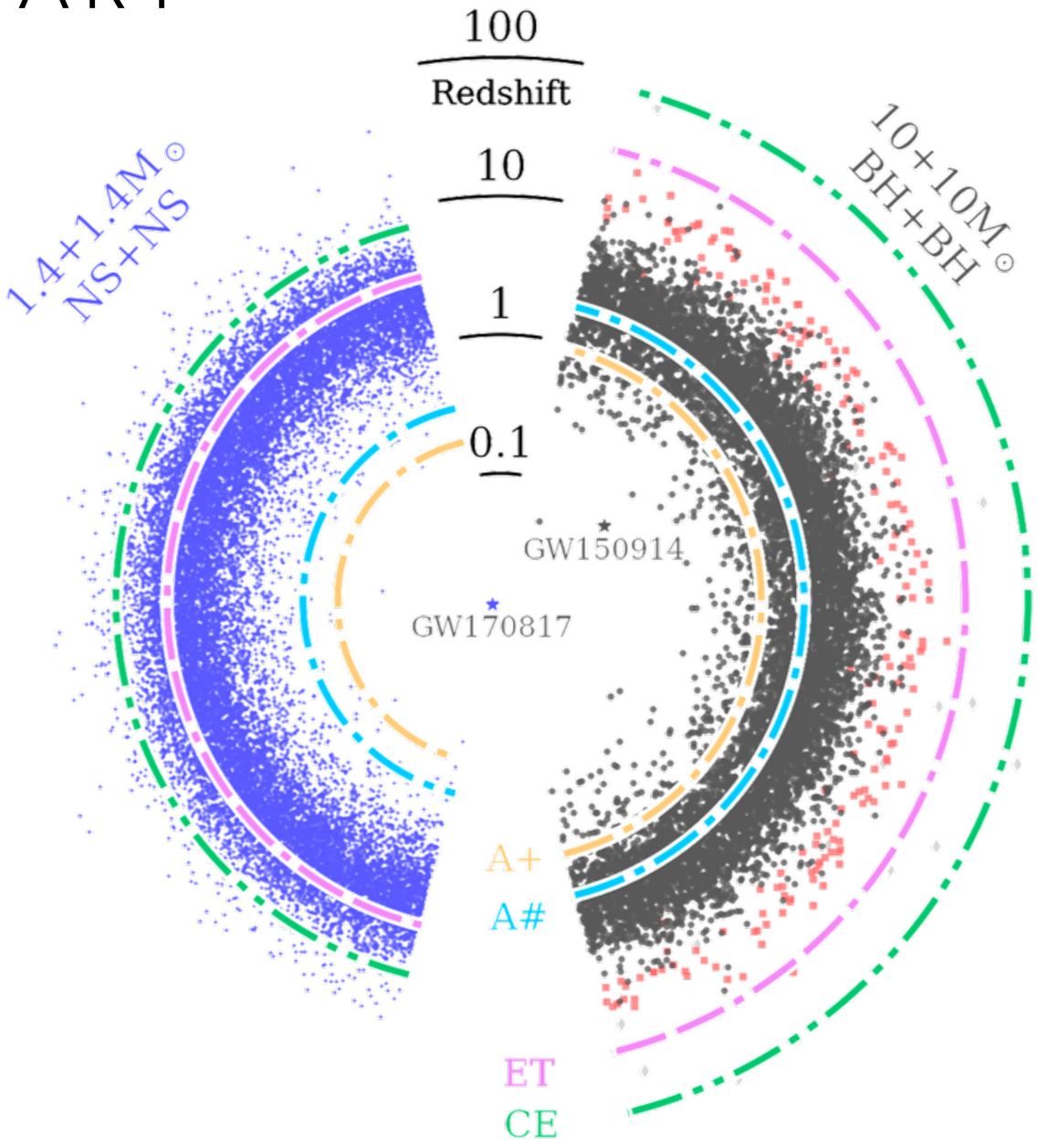
EARLY WARNING

EW Time	$\tau_{\rm EW} = 300$ s		
Ω_{90} (deg^2)	≤ 100	≤ 10	≤ 1
HLI	0	0	0
HLET	$4.2^{+7.9}_{-3.5} \times 10^1$	$0.0^{+2.0}_{-0.0} \times 10^0$	0
CE40LI	0	0	0
CE20LI	0	0	0
CE4020I	$6.2^{+8.5}_{-5.2} \times 10^1$	$2.0^{+0.0}_{-2.0} \times 10^0$	0
CE40LET	$1.0^{+15.9}_{-0.8} \times 10^3$	$2.2^{+53.0}_{-1.7} \times 10^1$	$0.0^{+1.0}_{-0.0} \times 10^0$
CE20LET	$4.7^{+7.6}_{-3.6} \times 10^2$	$7.0^{+26.0}_{-6.0} \times 10^0$	0
CE4020ET	$1.8^{+28.6}_{-1.4} \times 10^3$	$5.2^{+9.3}_{-4.3} \times 10^1$	$0.0^{+2.0}_{-0.0} \times 10^0$

SYNERGISTIC AREAS

SUMMARY


Extreme gravity & fundamental physics
Unusual compact objects
Nature of strong gravity
Dark matter & dark energy
Black holes & neutron stars throughout cosmic time
Remnants of the first stars
Seed and galaxy formation
Compact object populations
Unexpected discoveries in the gravitational-wave universe
Cosmic Explorer
Jets powering γ-ray bursts
Kilonovae & heavy nucleosynthesis
Phase structure of quantum chromodynamics
Dynamics of dense matter


100
Redshift
10
1
0.1
1.4+1.4M⊙
NS+NS
10+10M⊙
BH+BH
GW150914
GW170817
A+
A#
ET
CE