

Earth and Sky: Synergies Between LISA and 3G Gravitational Wave Detectors

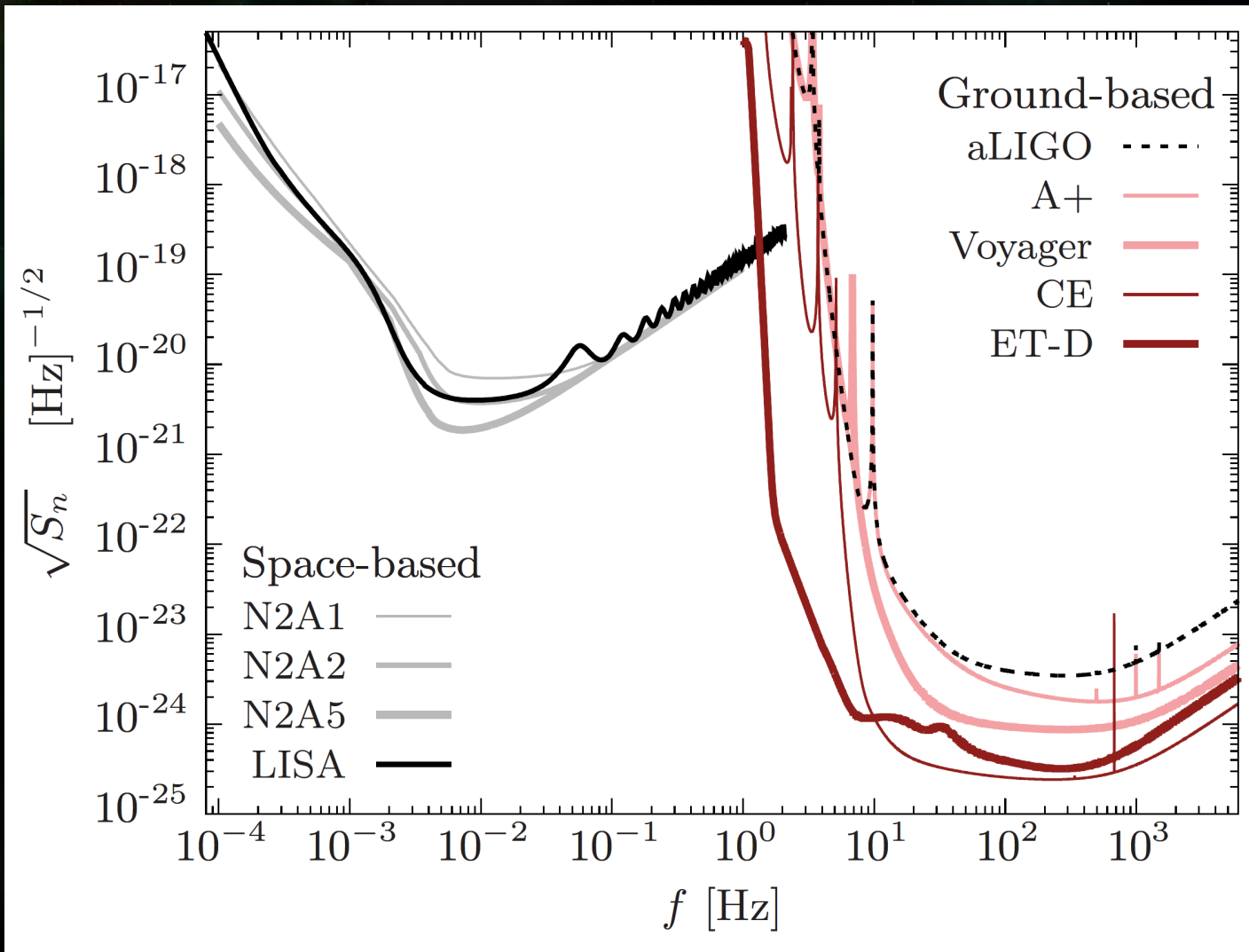
Kent Yagi
University of Virginia

AAS Meeting, Seattle

Jan. 10th 2019

Future Ground & Space-borne GW Interferometers

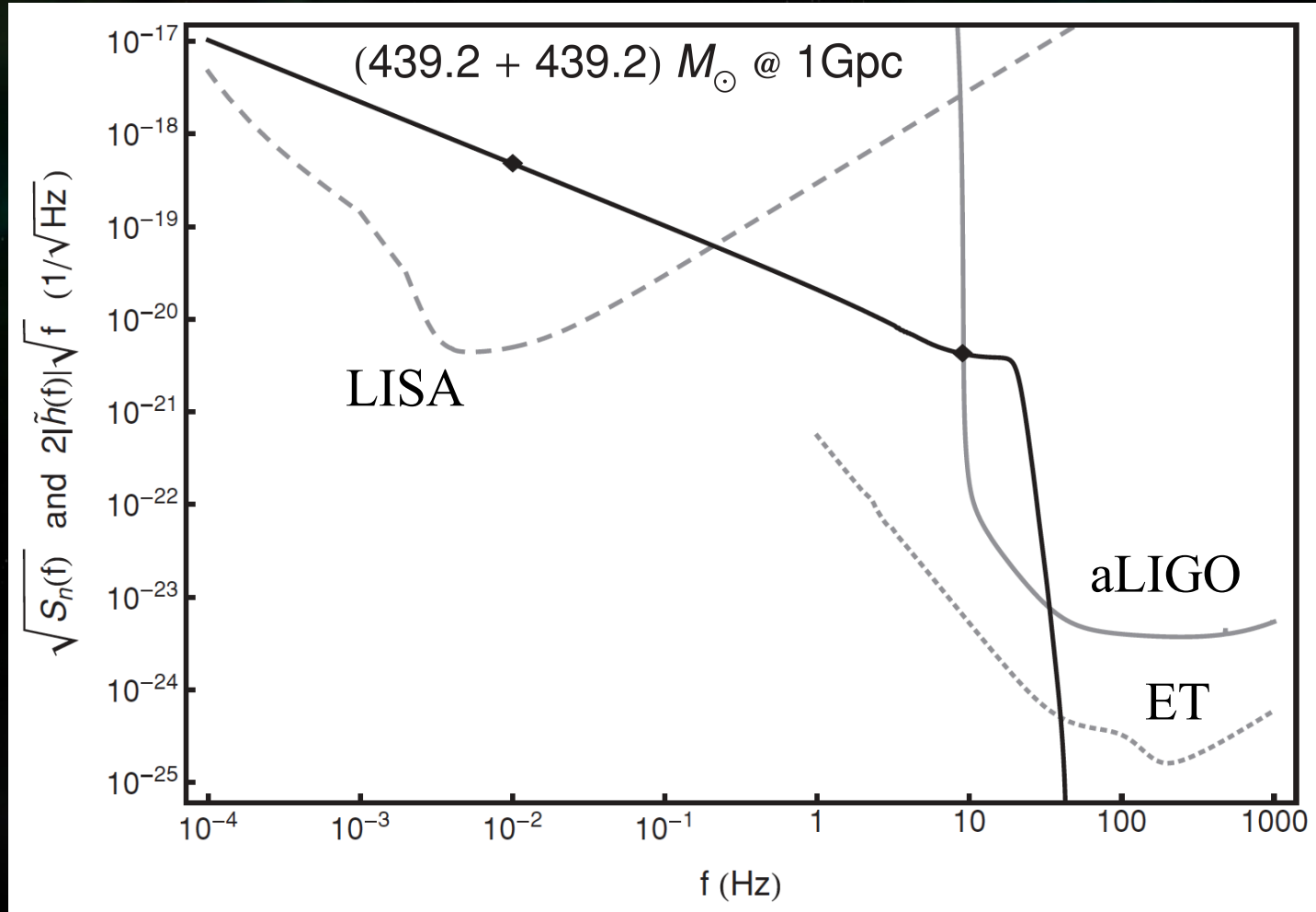
[Chamberlain & Yunes (2017)]



Multiband GW Observations: IMBH Binary

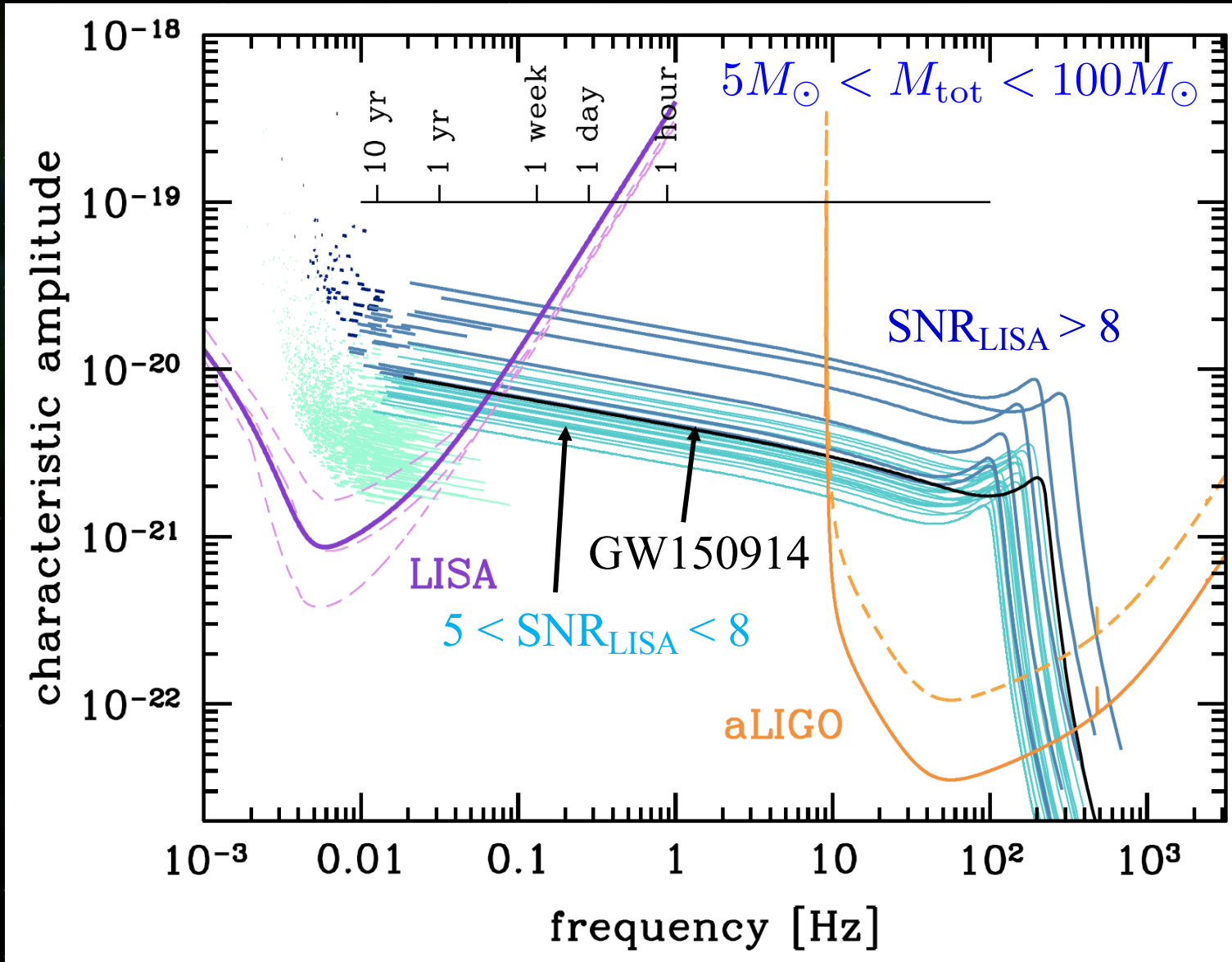
[Amaro-Seone & Santamaria (2010)]

Intermediate-mass BH (IMBH) Binary

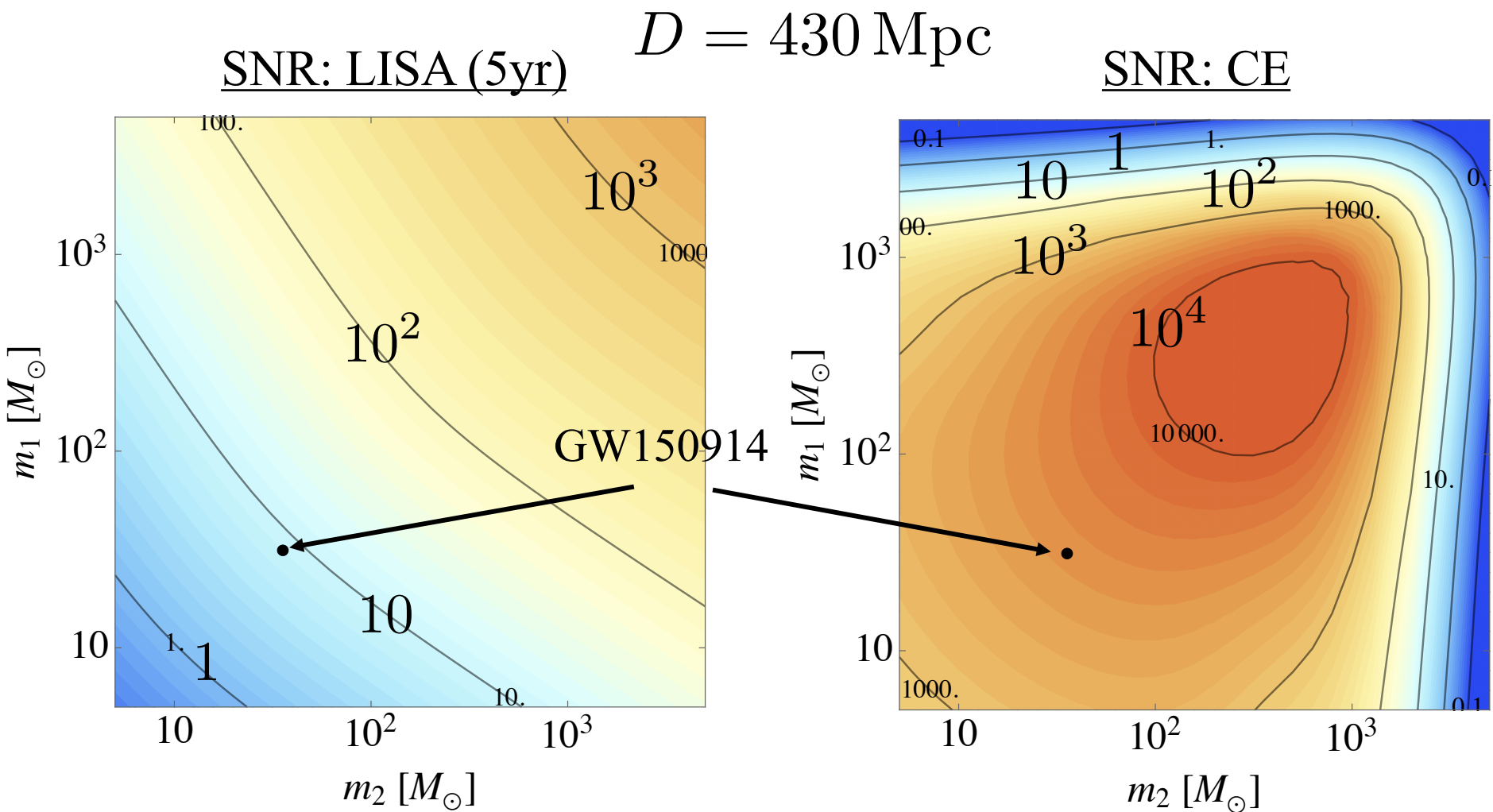


GW150914-like Events

[Sesana (2016,2017)]



SNR for LISA & Cosmic Explorer (CE) [KY (in prep.)]



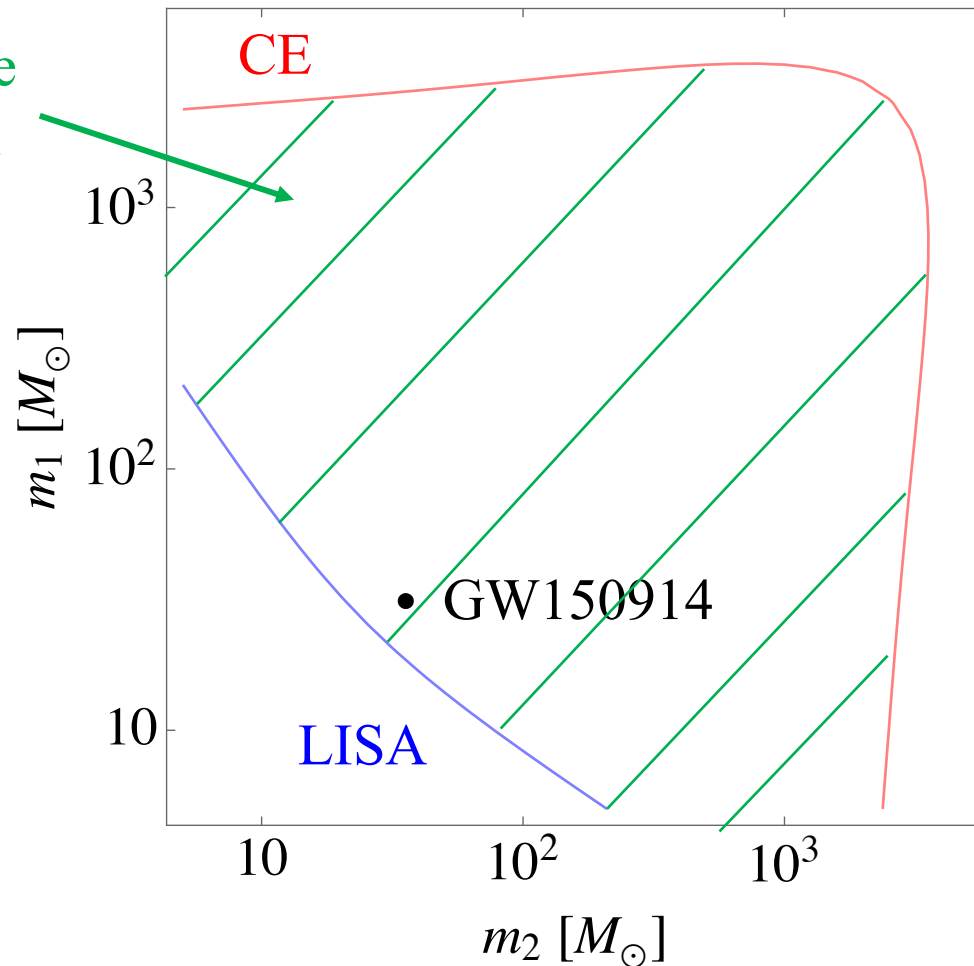
Multiband GW Source Candidates

[KY (in prep.)]

threshold SNR = 5

$D = 430 \text{ Mpc}$

multiband source
candidate region



Outline

Detection & Parameter Estimation

Tests of General Relativity

Outline

Detection & Parameter Estimation

Tests of General Relativity

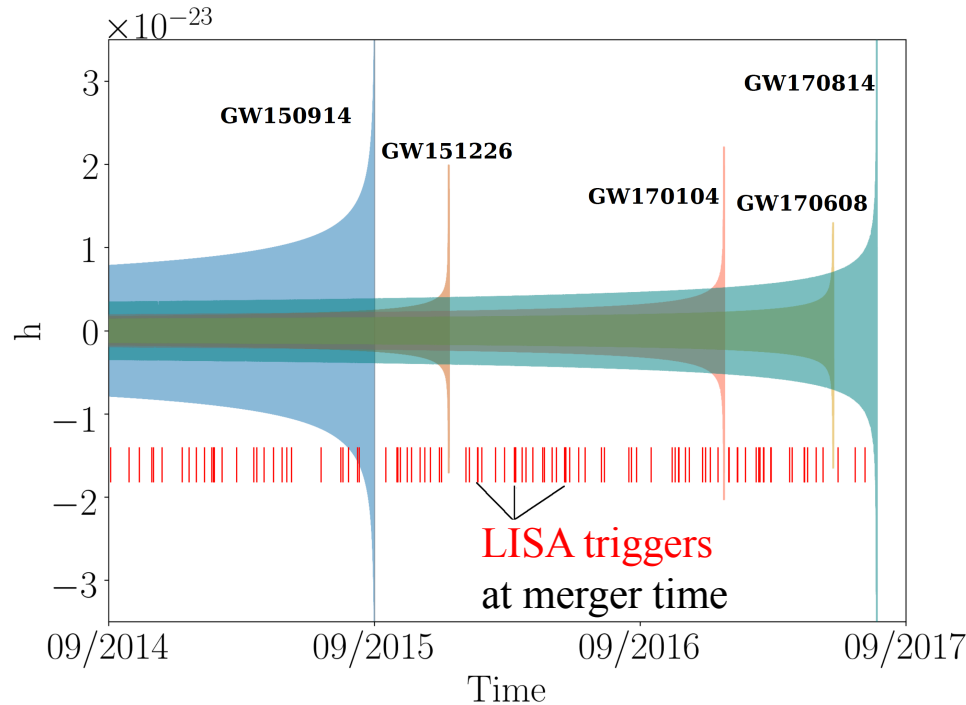
Expanding the LISA Horizon

[Wong et al. (2018)]

ground-based detection



can lower the detection
SNR threshold for LISA



$$\rho_{\text{thr}} = 4 - 5$$



boost in the detection
rate by a factor of 4-8

Number of Events & Parameter Estimation

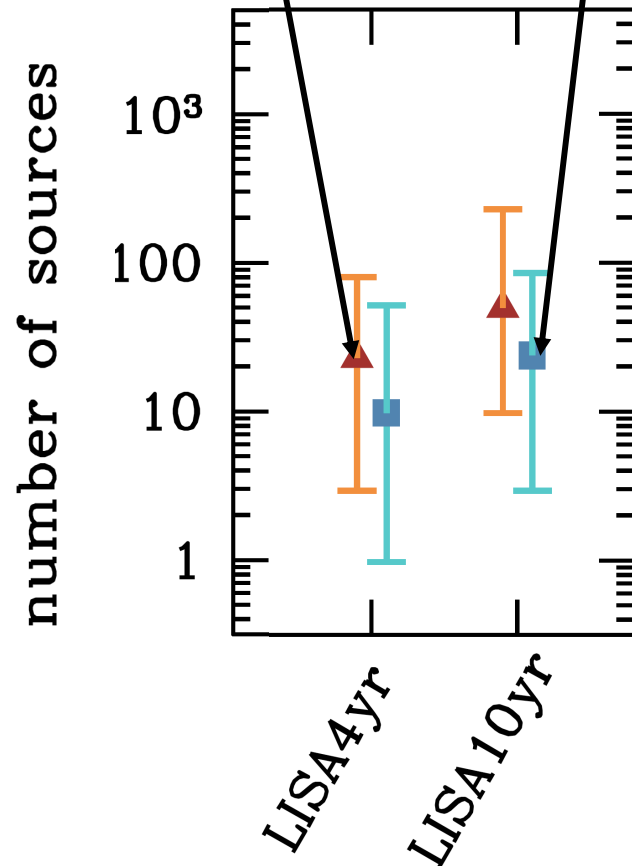
$$5M_{\odot} < M_{\text{tot}} < 100M_{\odot}$$

[Sesana (2016,2017)]

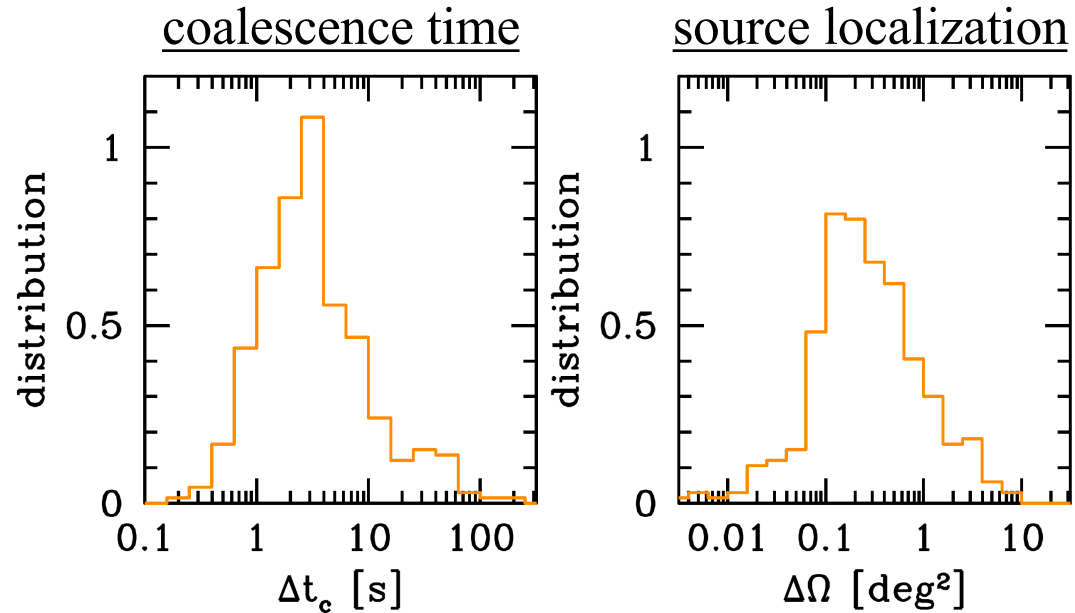
log-flat mass distribution

Salpeter mass distribution

$$\propto M^{-2.35}$$



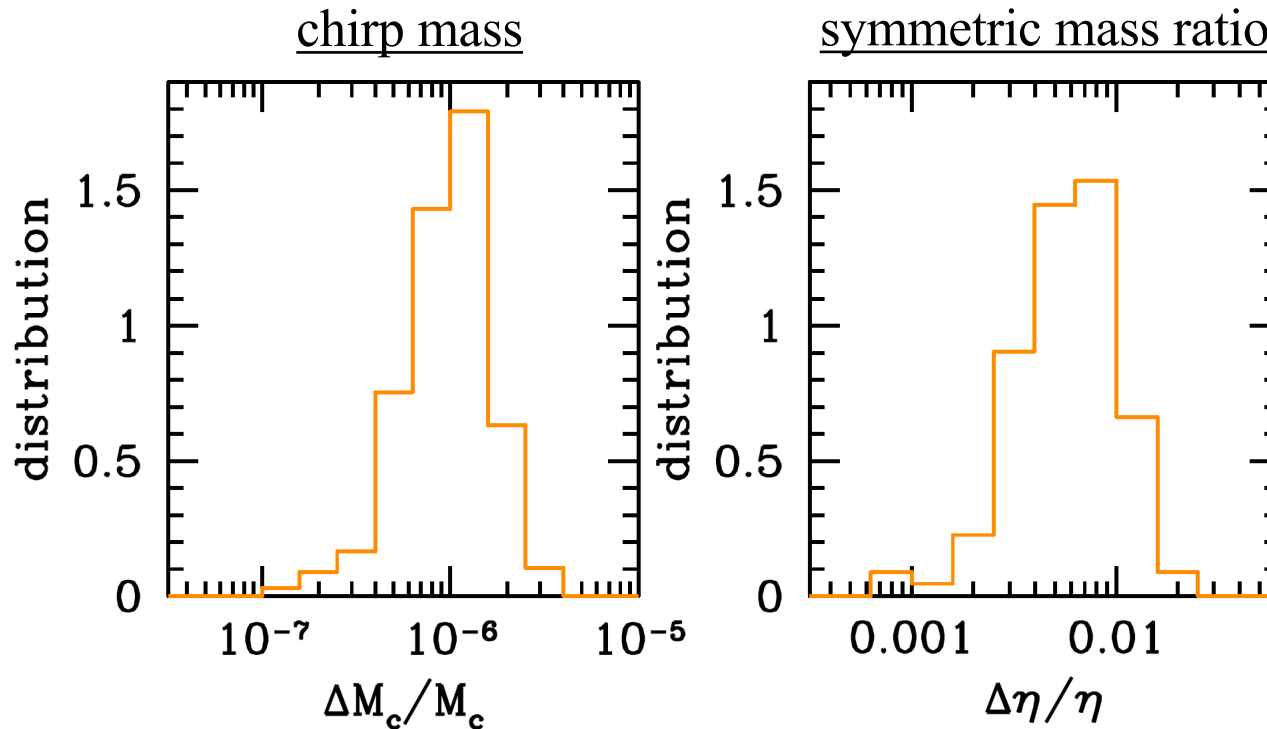
LISA Parameter Estimation



Can give alert to 3G and EM telescopes weeks prior to merger!

Mass & Spin Measurement

[Sesana (2016,2017)]



cf) GW150914: ~ 0.07 ~ 0.24

- ✓ spin measurement improve typically
by $\sim 20\%$ from ground-based alone [Vitale (2016)]

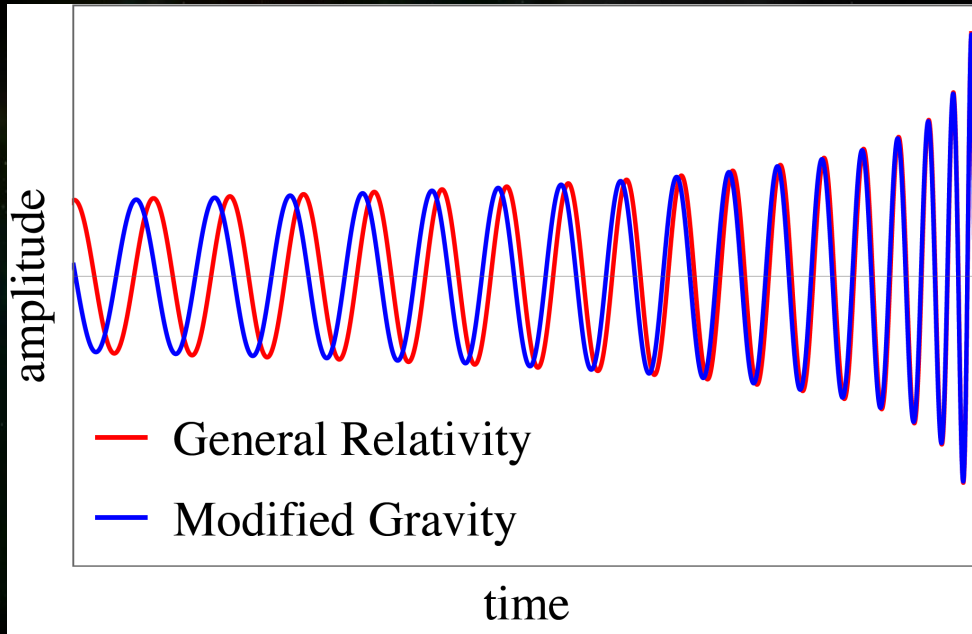
Outline

Detection & Parameter Estimation

Tests of General Relativity

parameterized post-Einsteinian (ppE) Formalism

[Yunes & Pretorius (2009)]



waveform phase: ppE parameter

$$\Psi^{(\text{insp})} = \Psi_{\text{GR}}^{(\text{insp})} + \beta (v/c)^{2n-5}$$

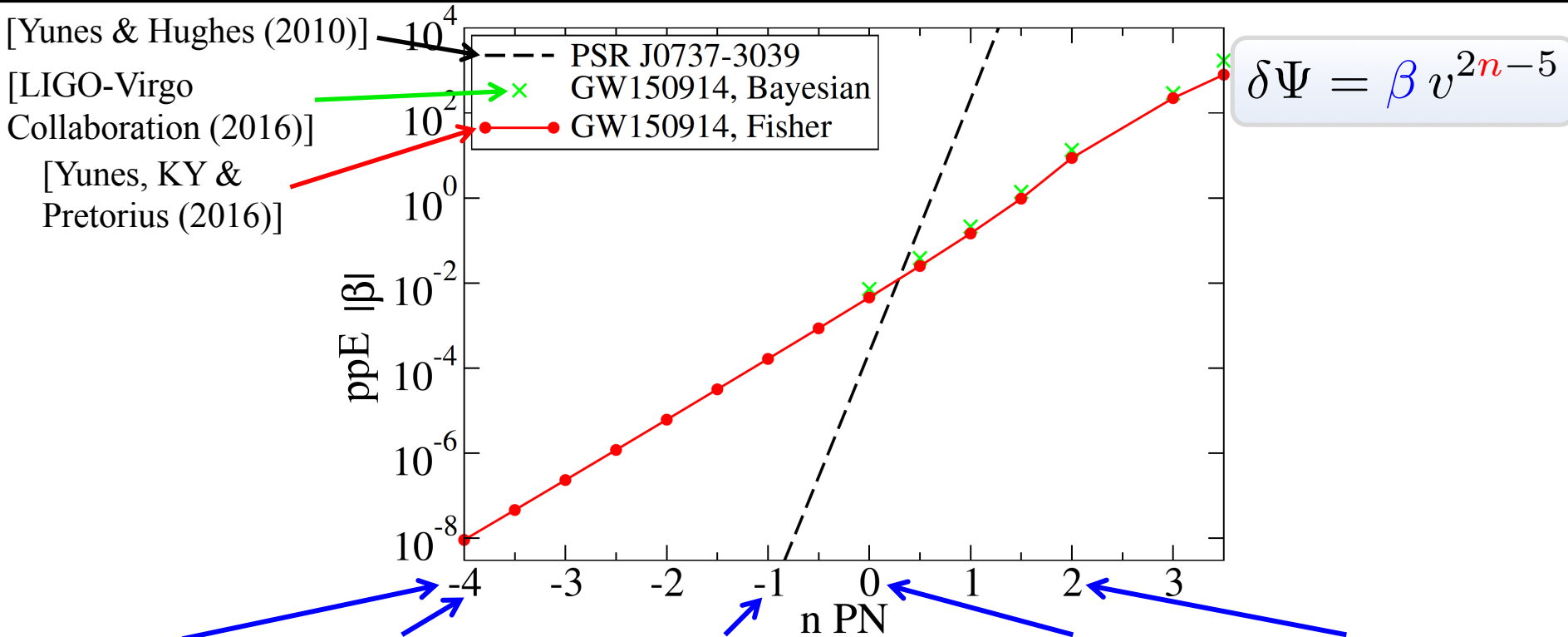
relative velocity

n th post-Newton (PN) correction

PN approximation:

$$v/c \ll 1$$

Constraining GR Fundamental Pillars

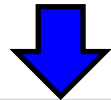


extra
dimension



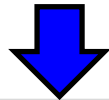
4D

time
varying G



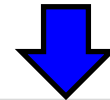
equivalence
principle

scalar monopole
activation



equivalence
principle

vector field
activation



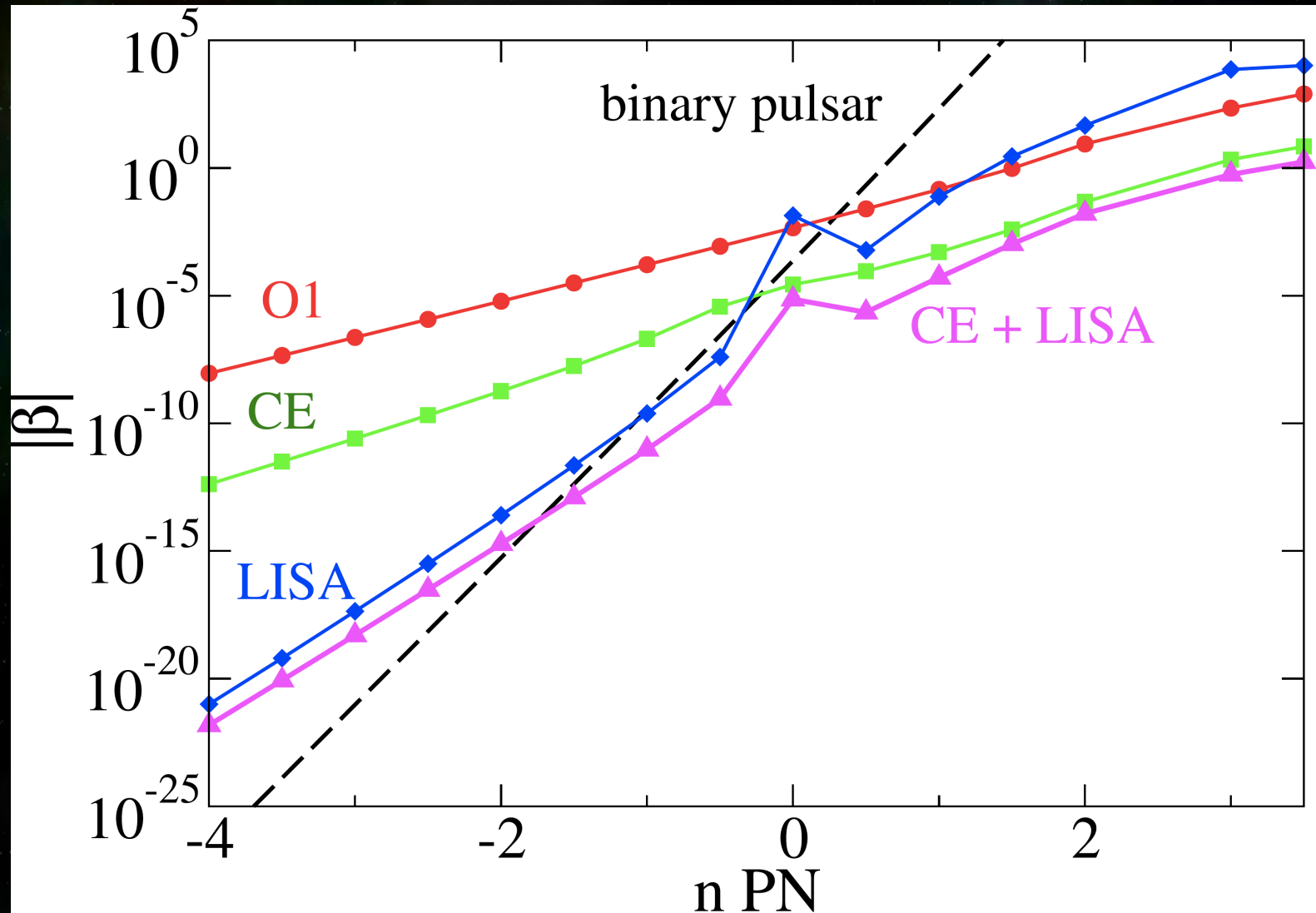
Lorentz
invariance

scalar dipole
activation



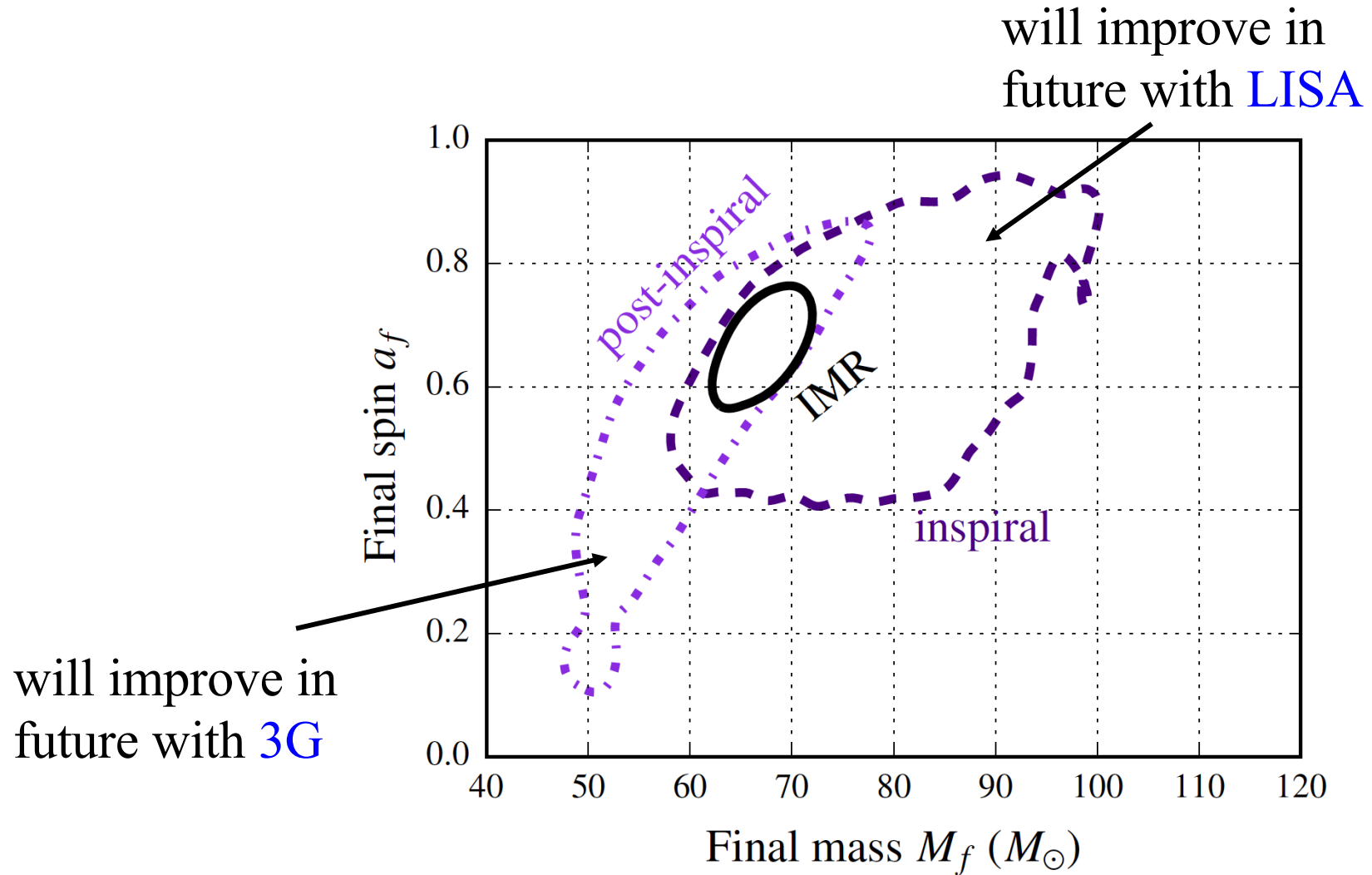
parity
invariance

Future PPE Bounds (GW150914-like) [KY (in prep.)]



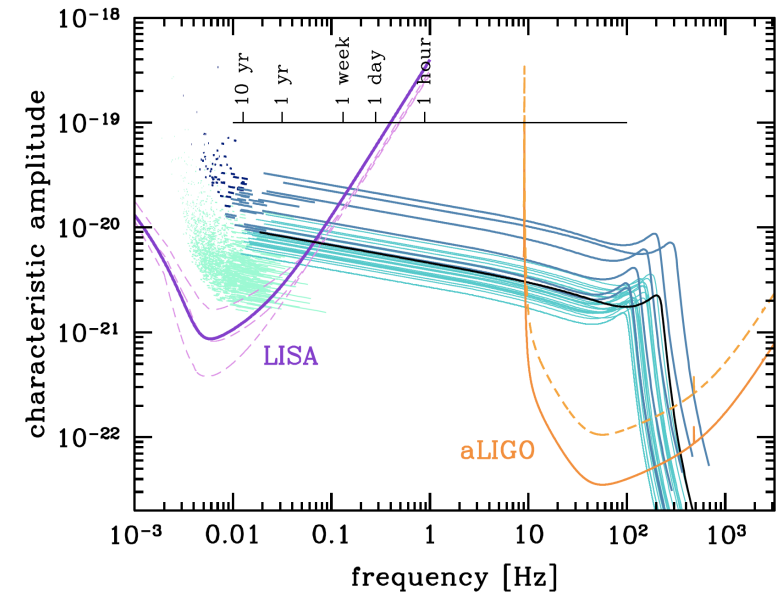
Consistency Test of GR

[LVC GW150914 Testing GR]



Conclusions

Takeaway



- ✓ Improve tests of GR
- ✓ Interesting to consider science that can only be done by synergy of LISA & 3G

Thank You!

- ✓ GW150914-like events detectable for both ground-based and space-borne detectors
- ✓ LISA can give alert to 3G & EM telescopes
- ✓ Improved mass & spin measurement

