

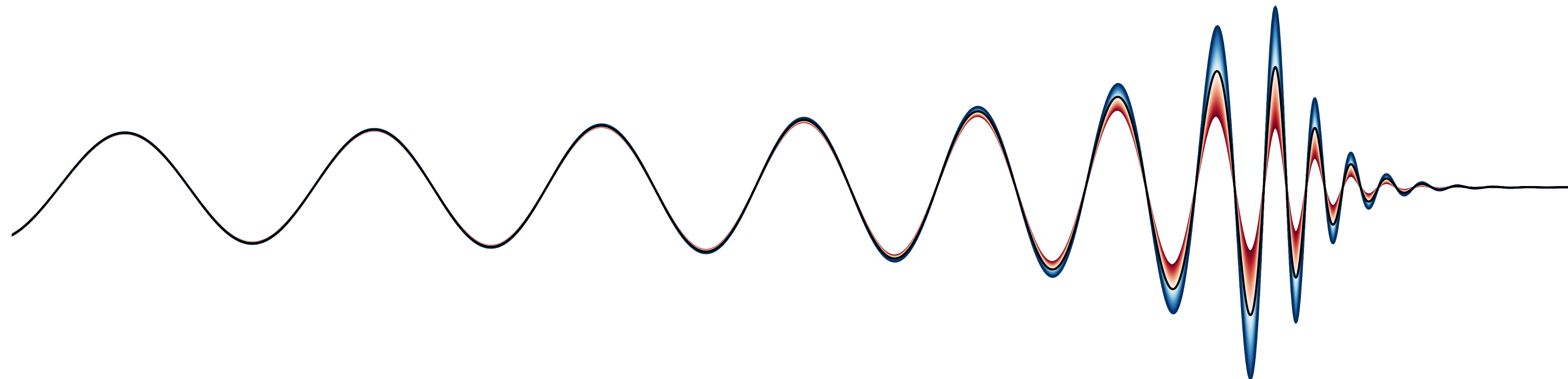
Tests of general relativity in the nonlinear regime with black-hole binaries

Hector O. Silva

Max Planck Institute for Gravitational Physics (Albert Einstein Institute)

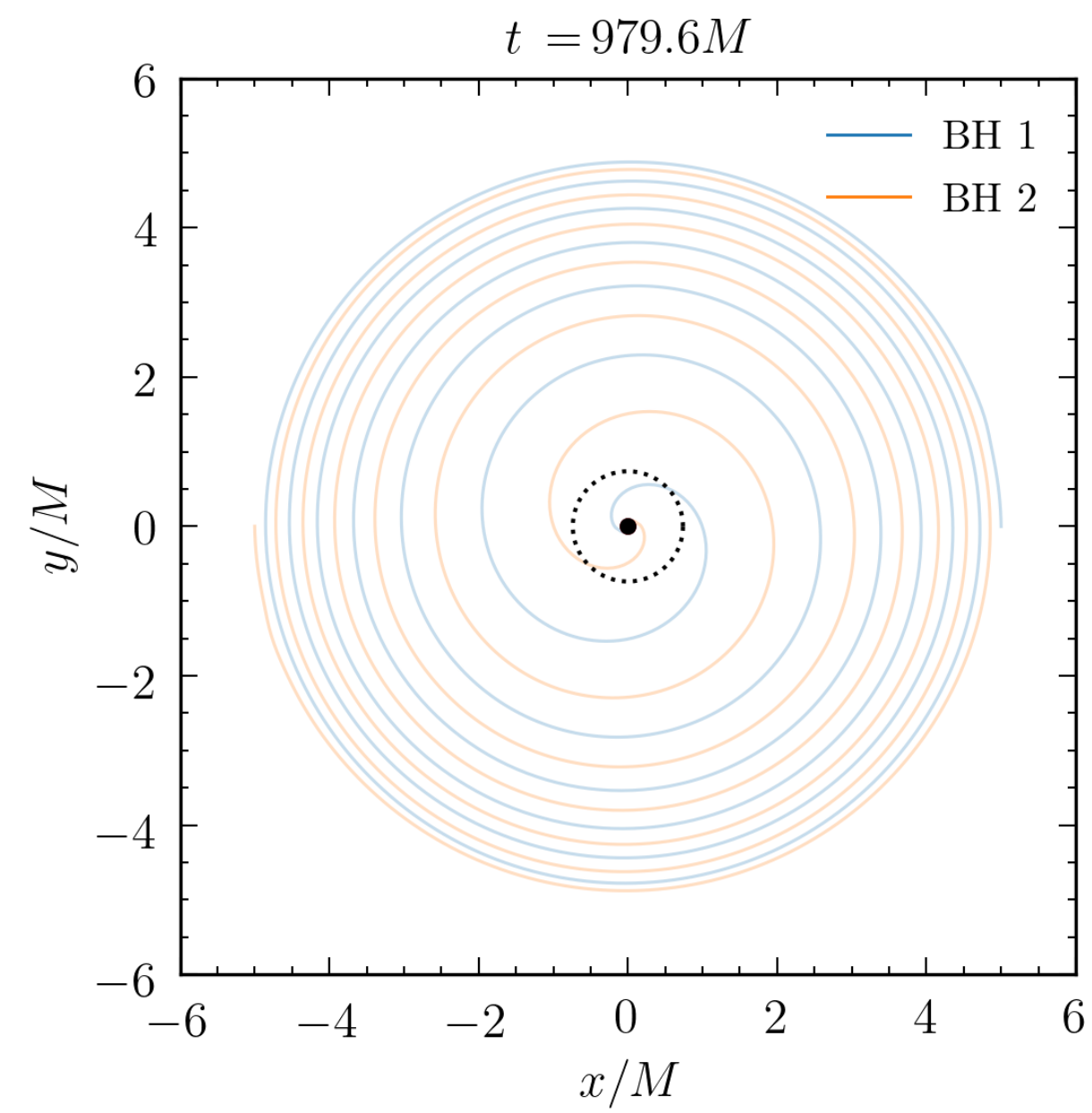
based on work with

Elisa Maggio, Abhirup Ghosh, and Alessandra Buonanno

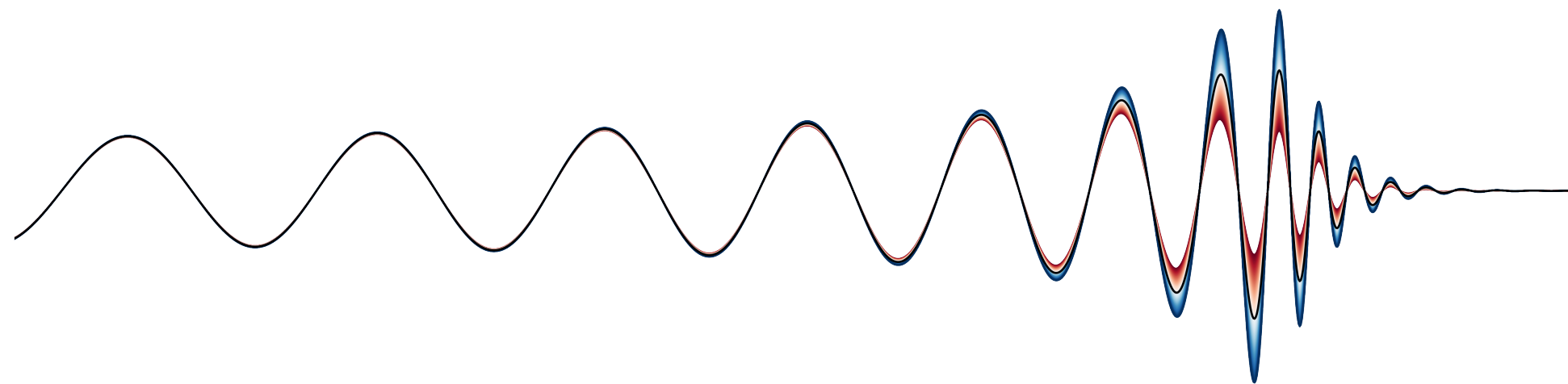
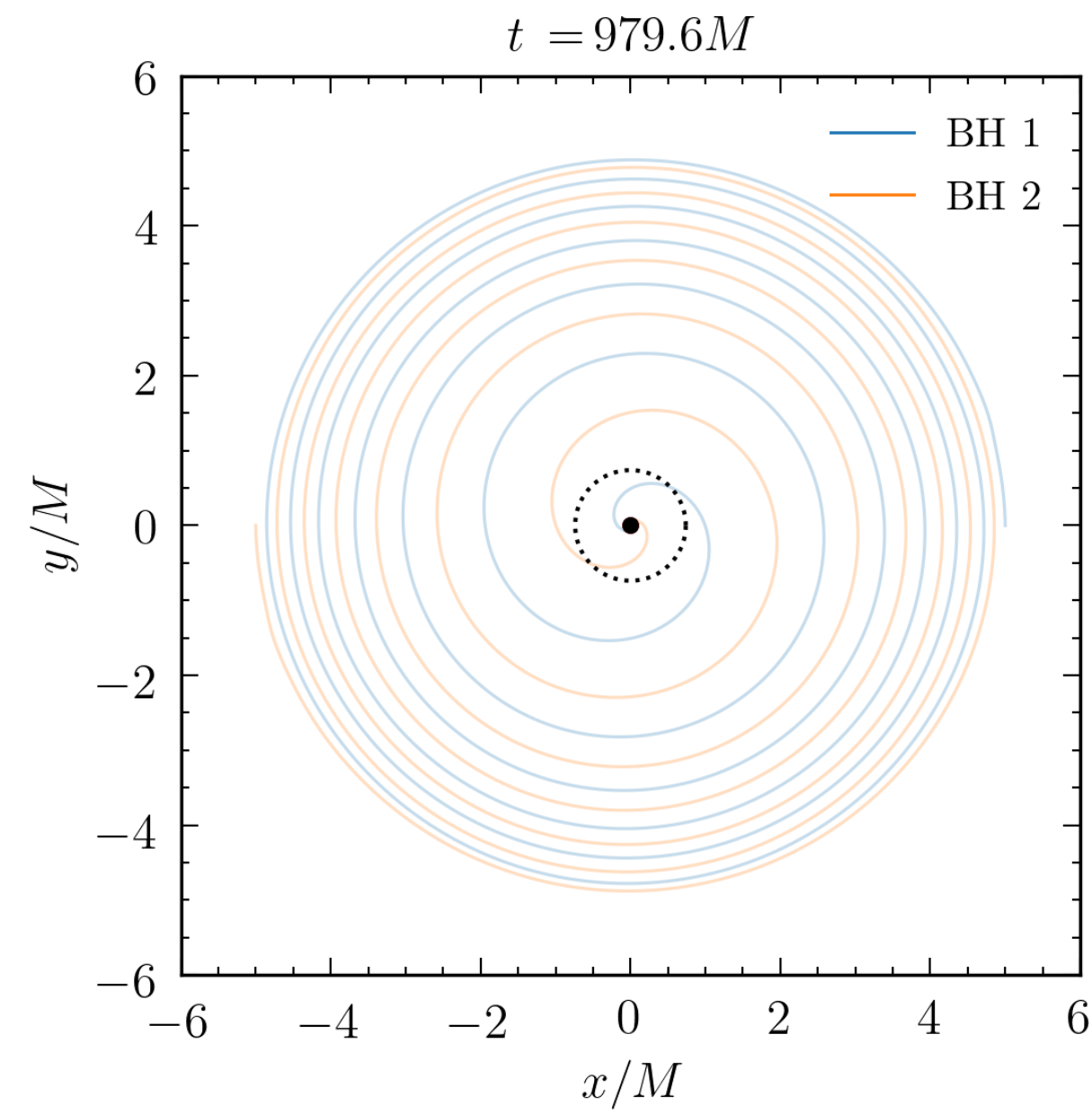


Brief review of the previous talk

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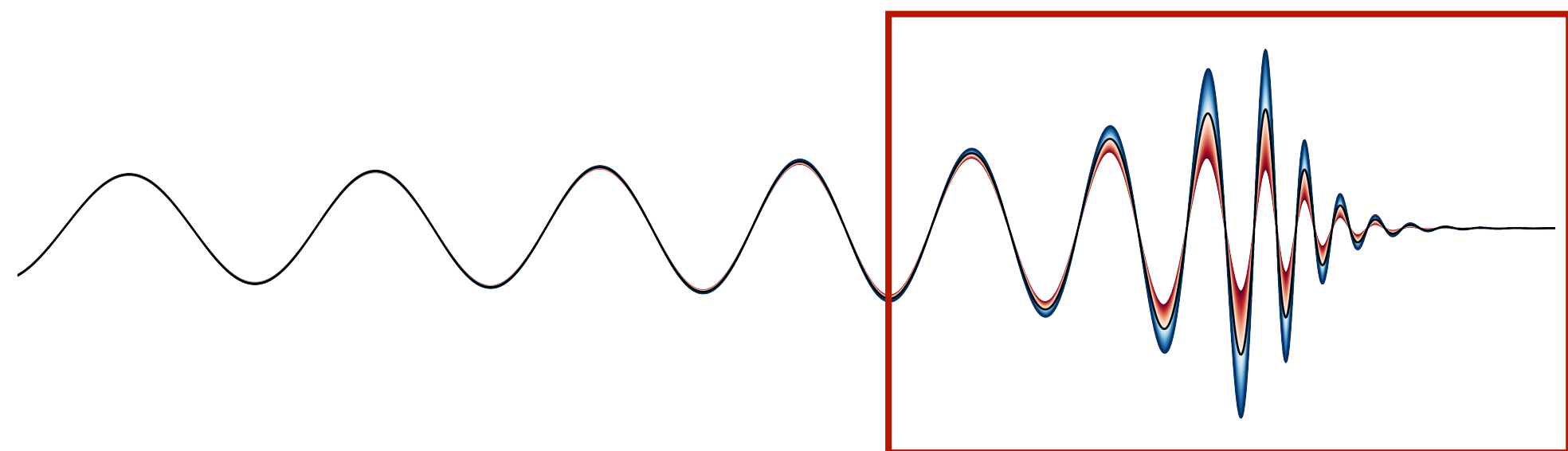
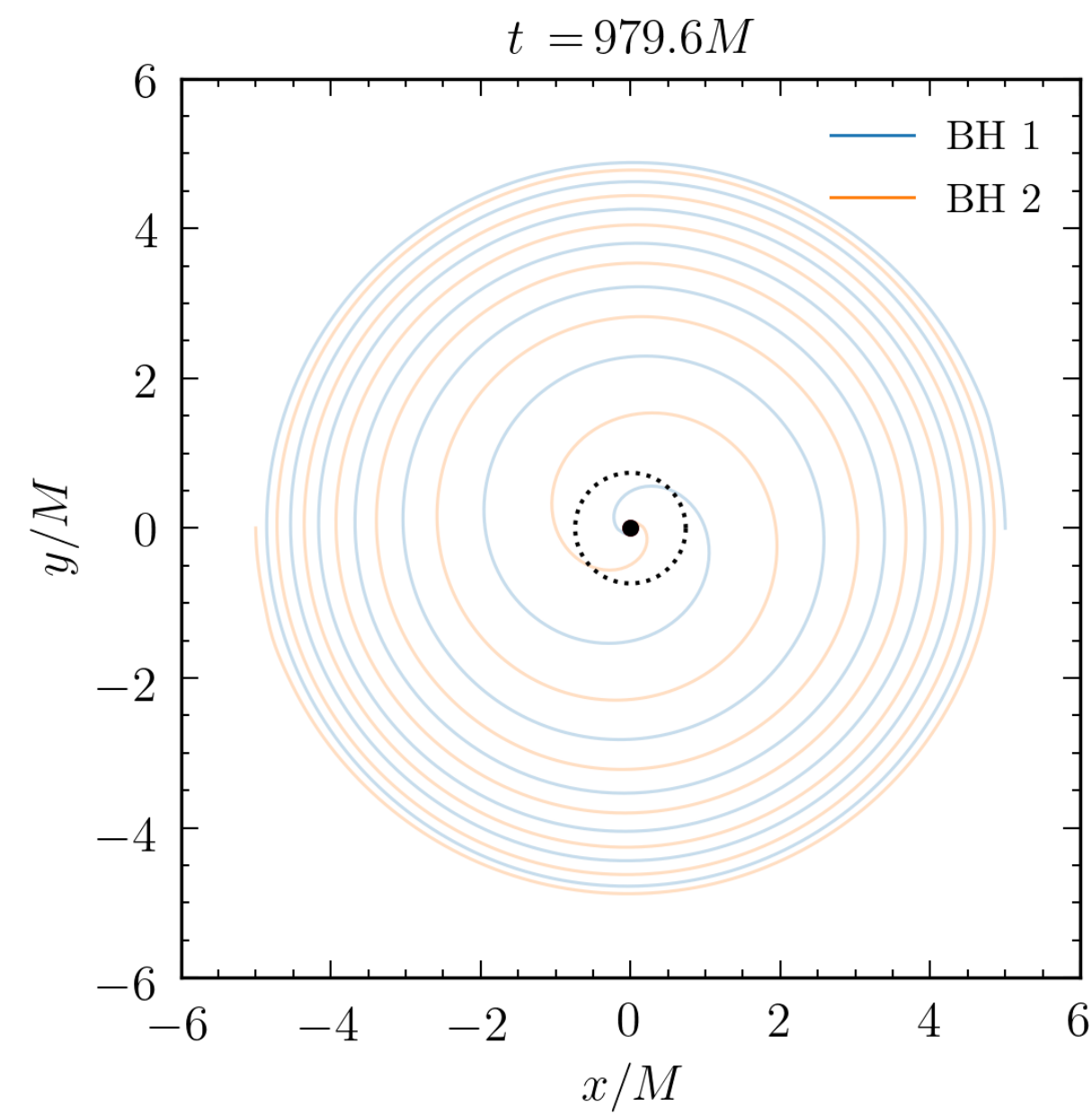


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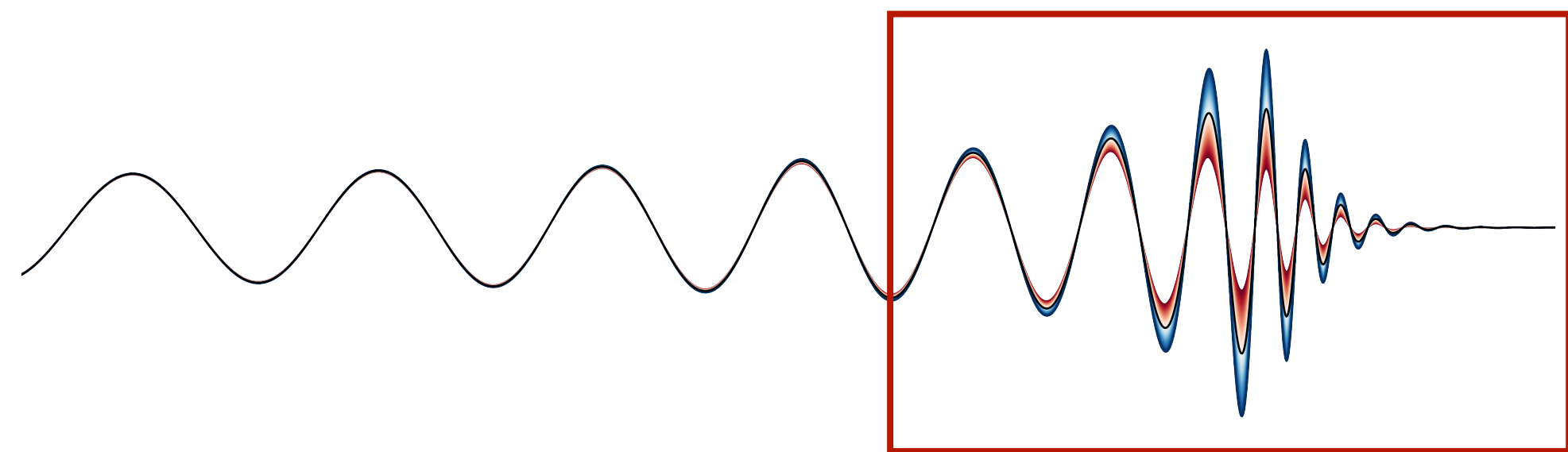
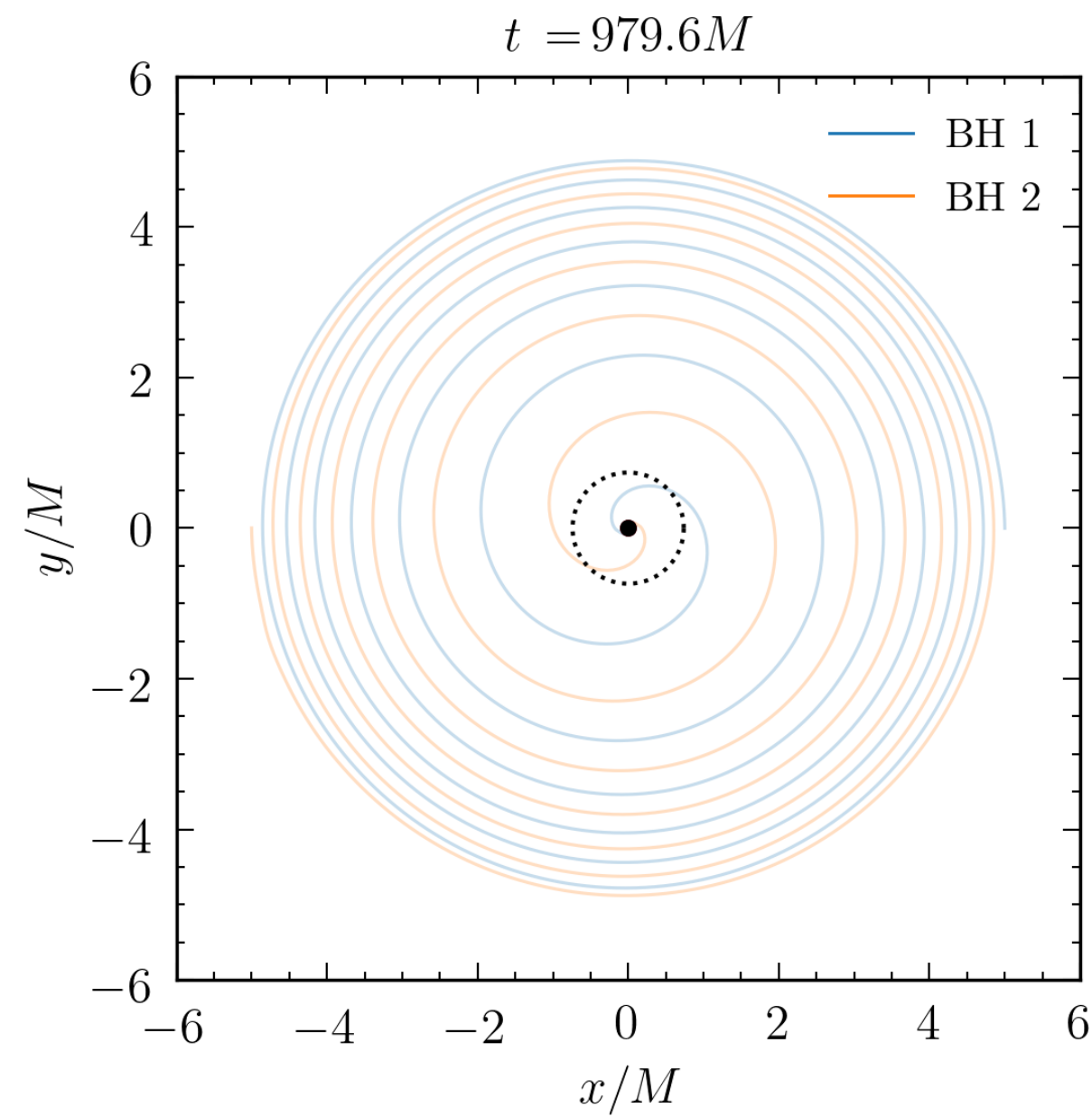
“Parametrized SEOBNR waveform model”

Brief review of the previous talk

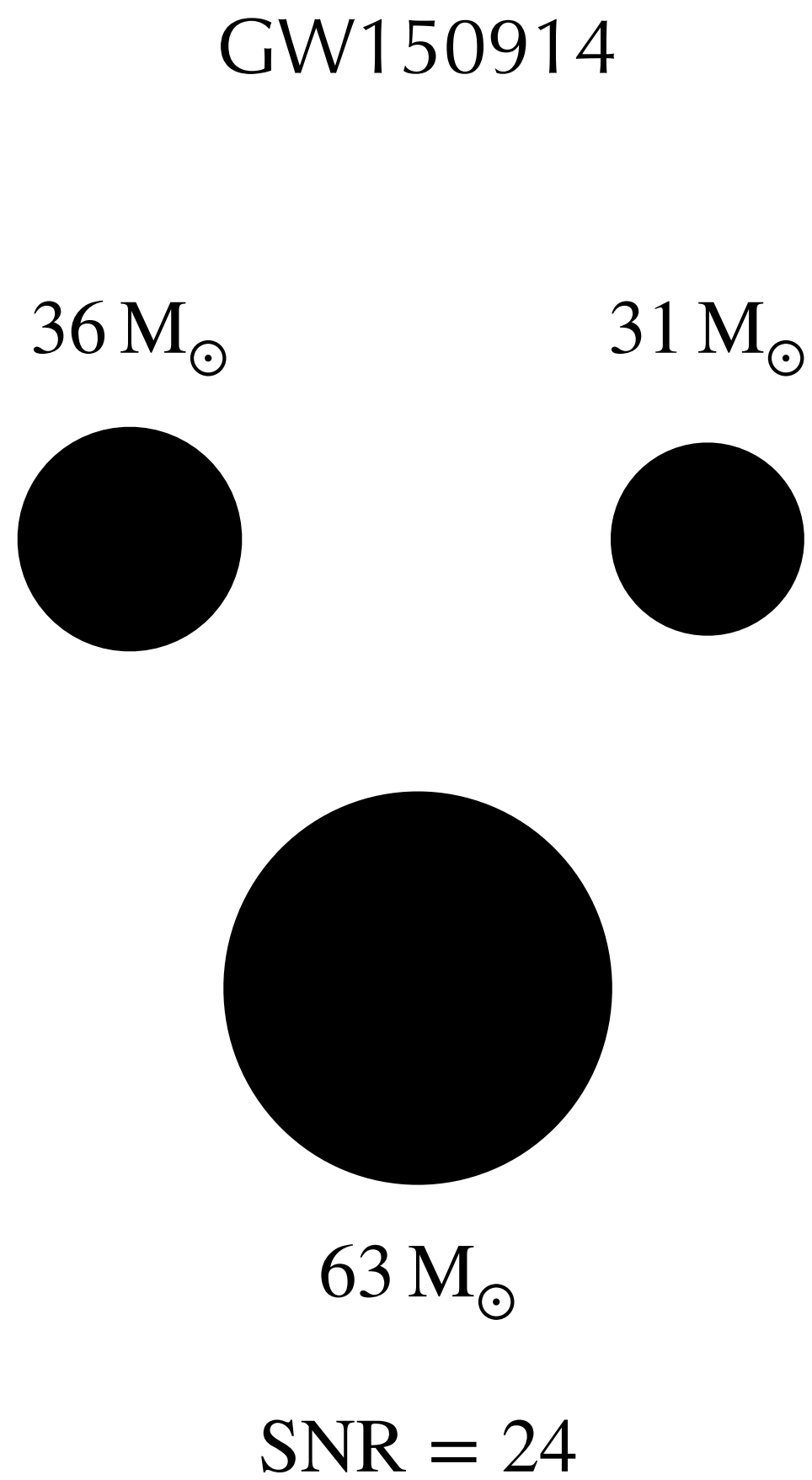


“Parametrized SEOBNR waveform model”

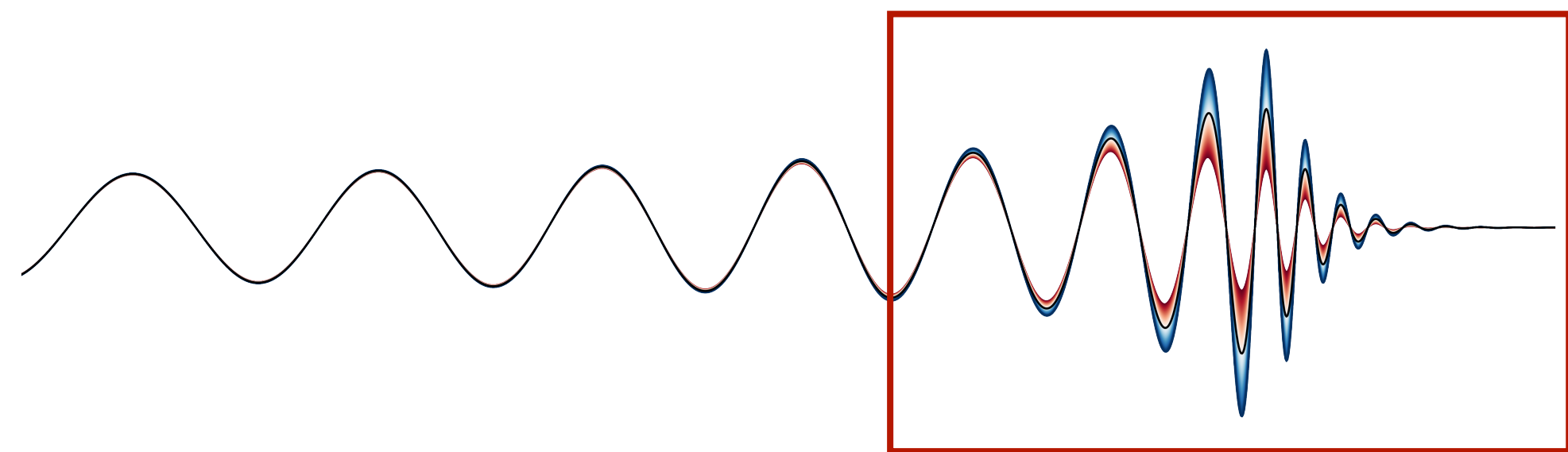
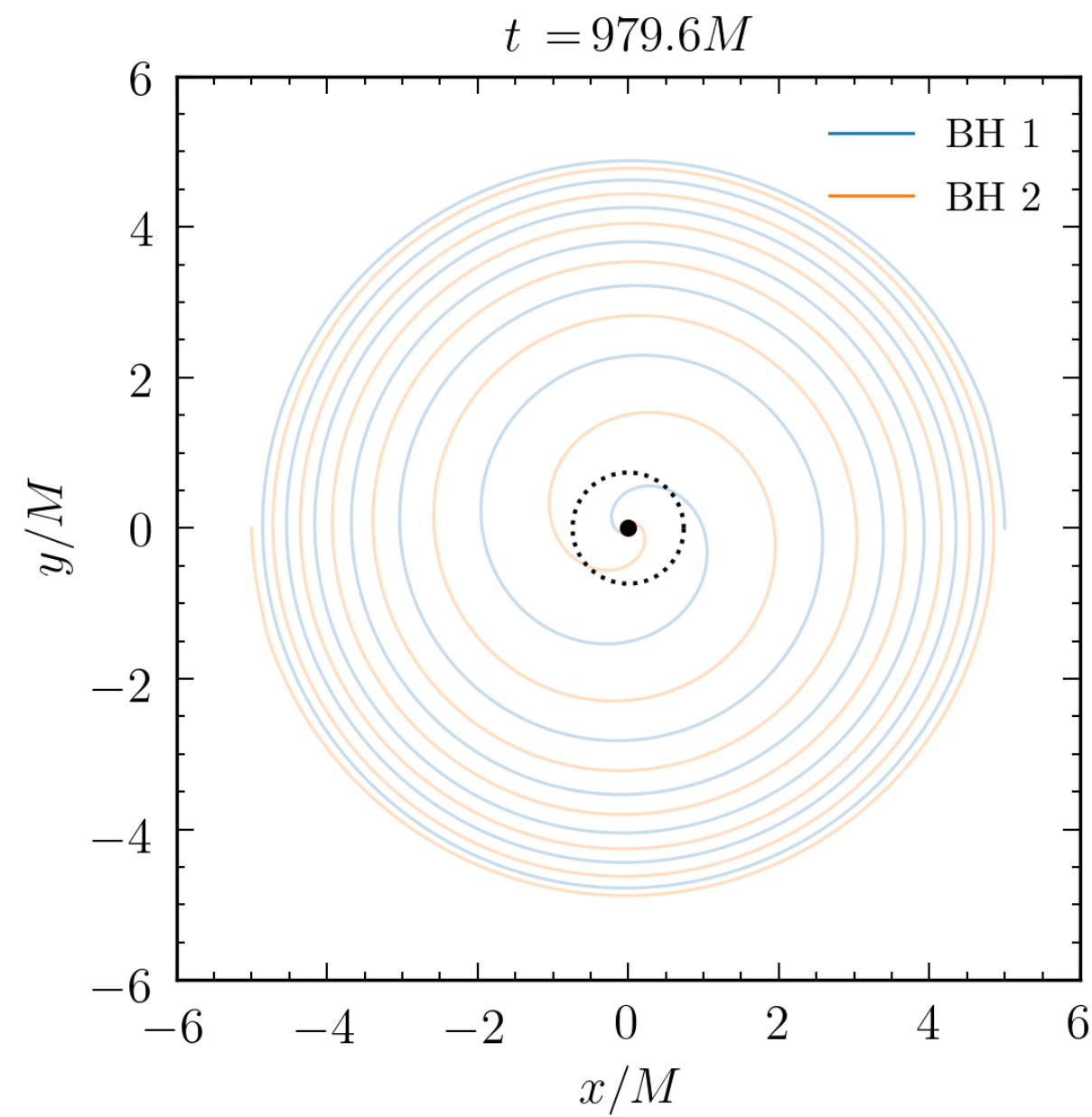
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“Parametrized SEOBNR waveform model”



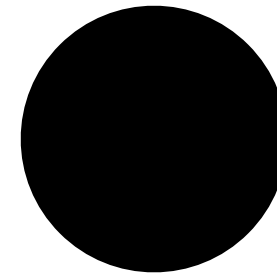
Brief review of the previous talk



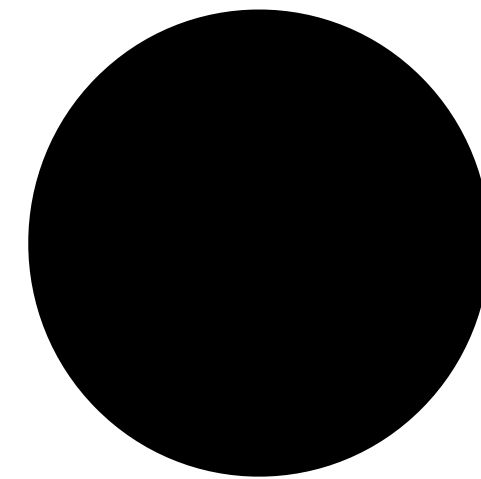
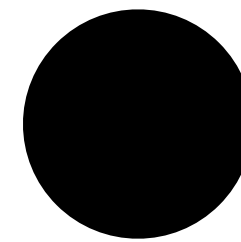
“Parametrized SEOBNR waveform model”

GW150914

$36 M_{\odot}$



$31 M_{\odot}$

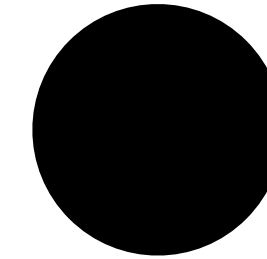


$63 M_{\odot}$

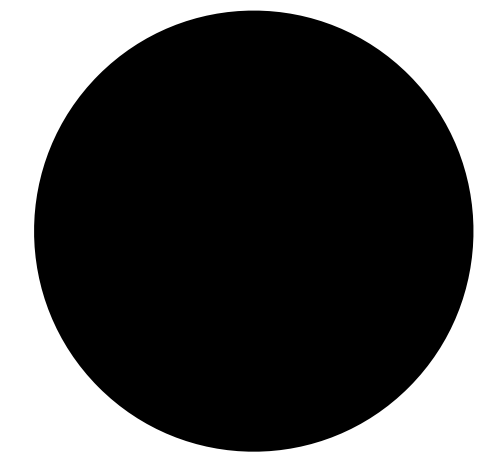
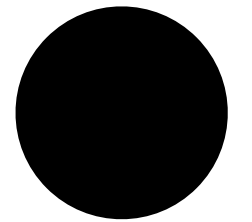
SNR = 24

GW200129

$34 M_{\odot}$



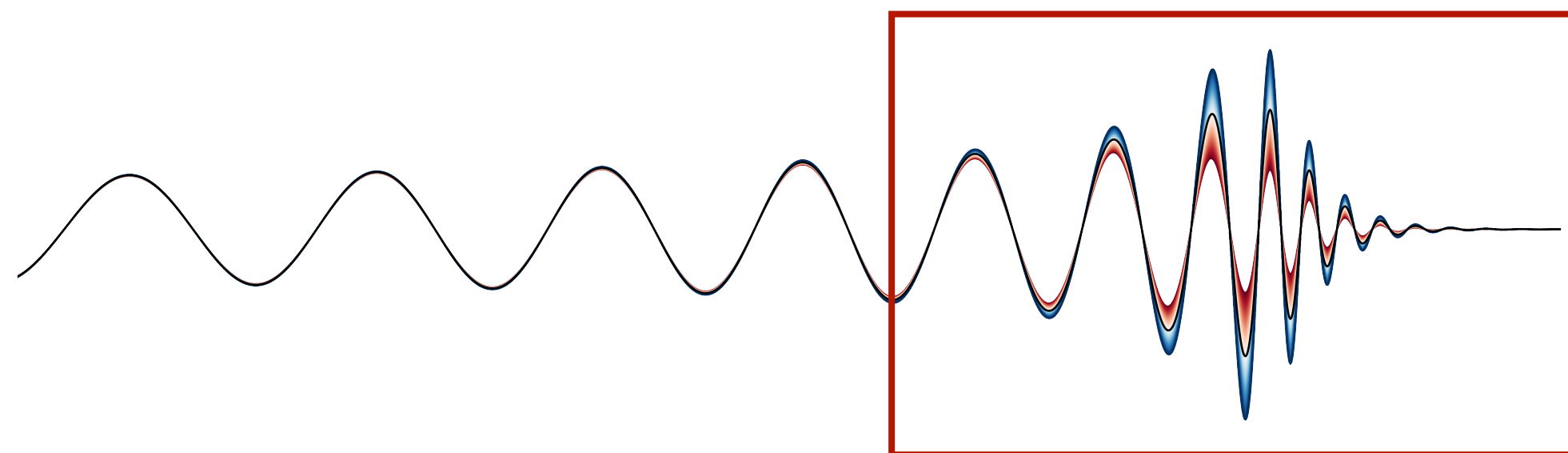
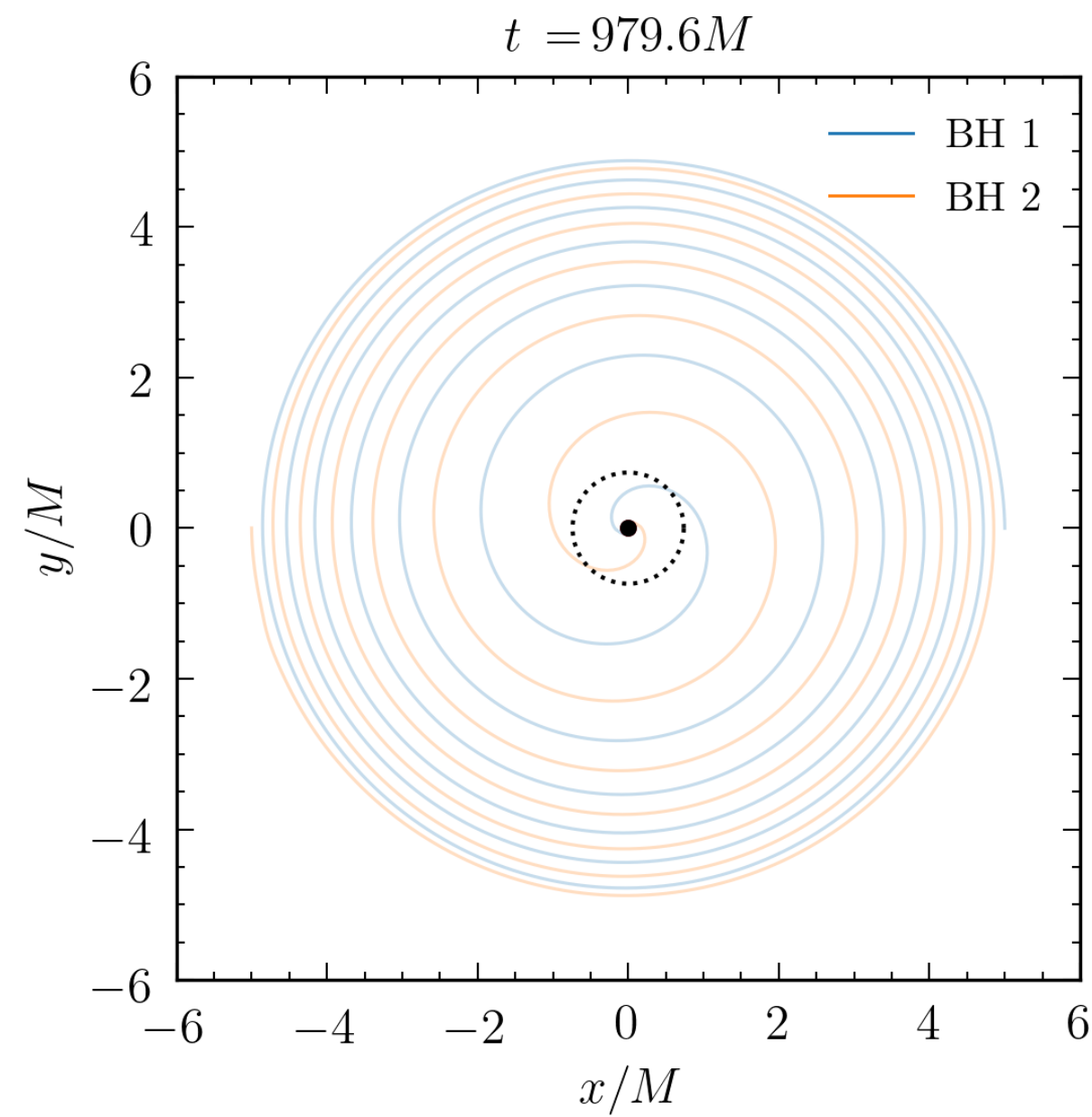
$29 M_{\odot}$



$60 M_{\odot}$

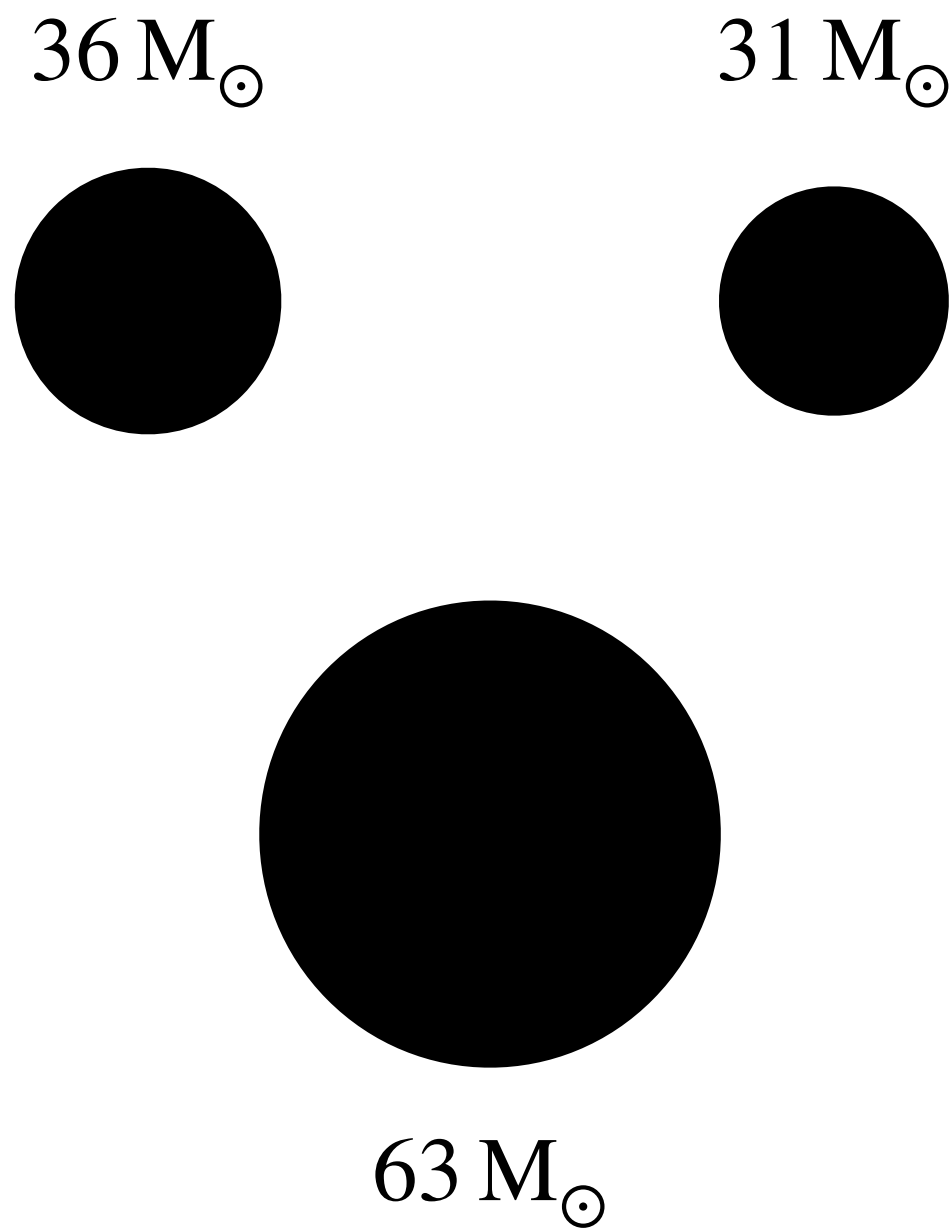
SNR = 27

Brief review of the previous talk



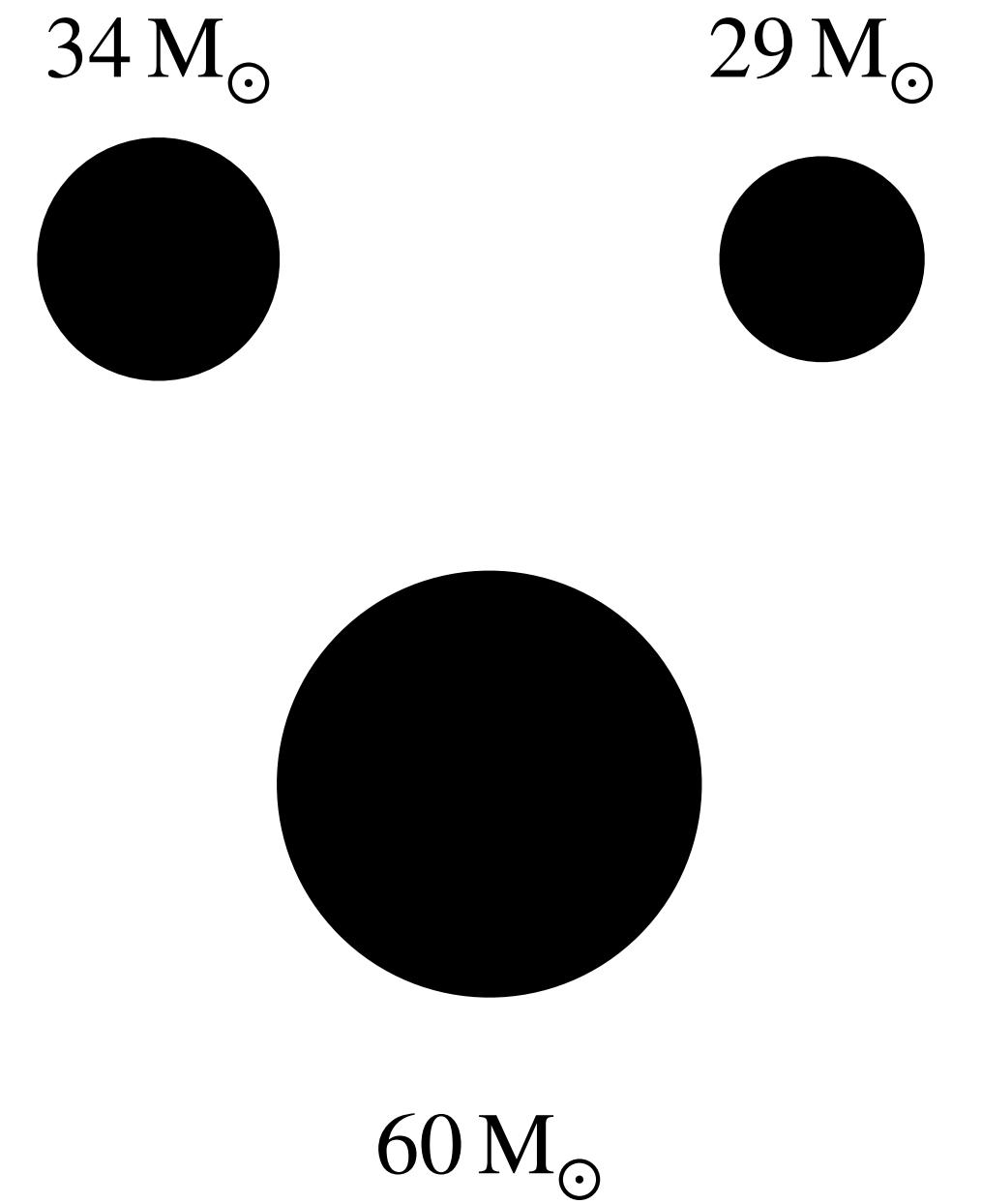
“Parametrized SEOBNR waveform model”

GW150914



SNR = 24

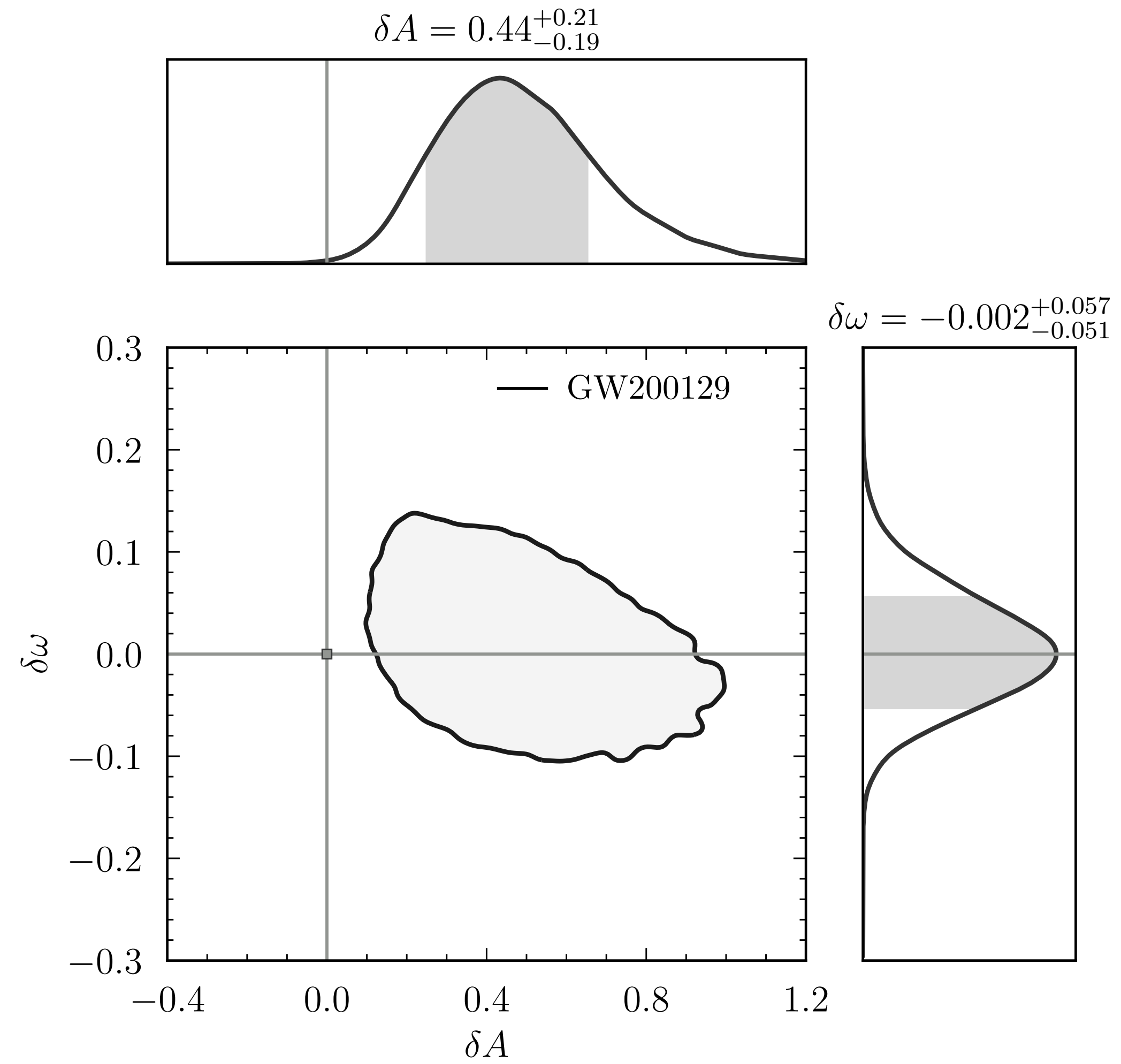
GW200129



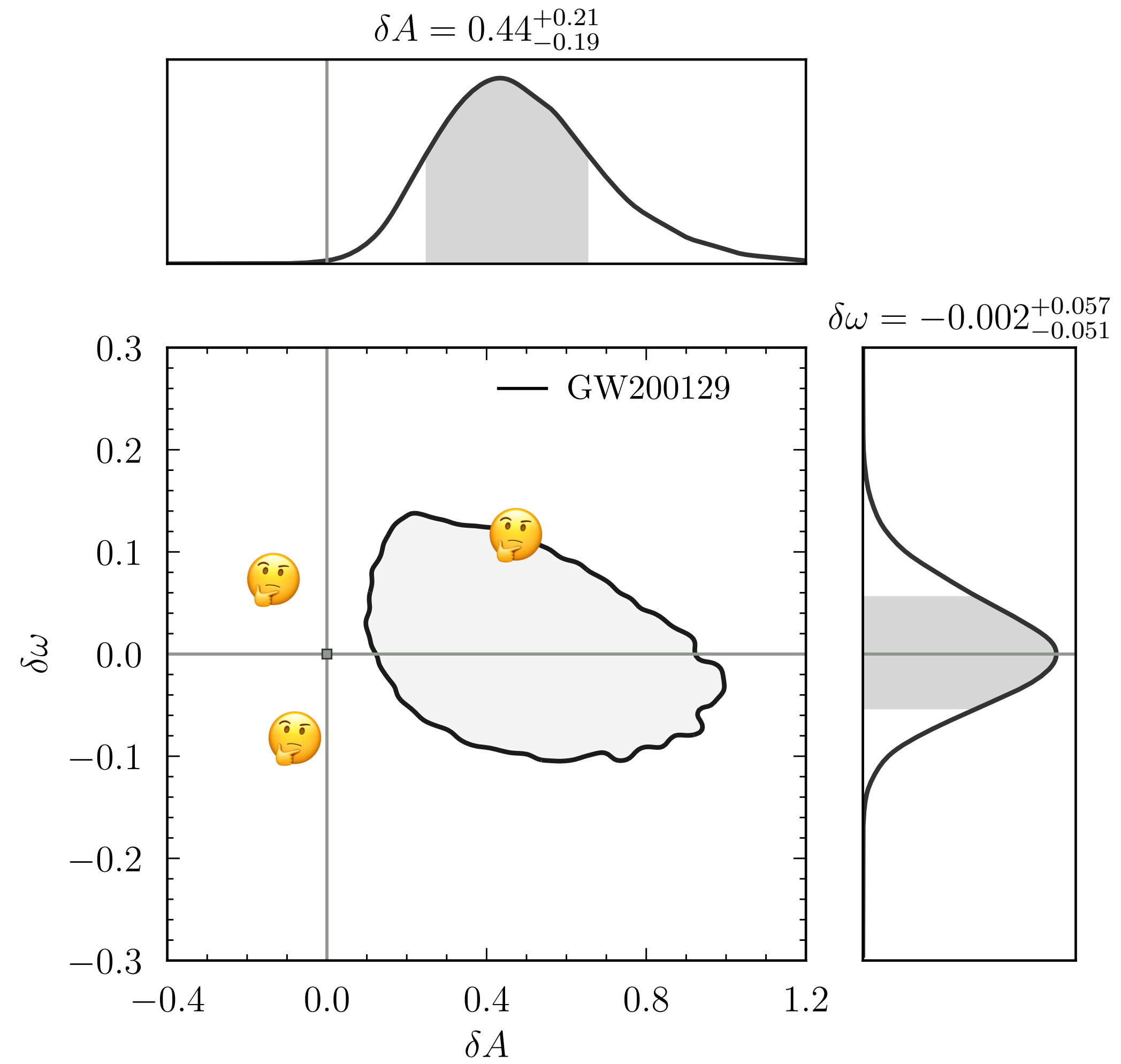
SNR = 27

GW200129: the “curious” event

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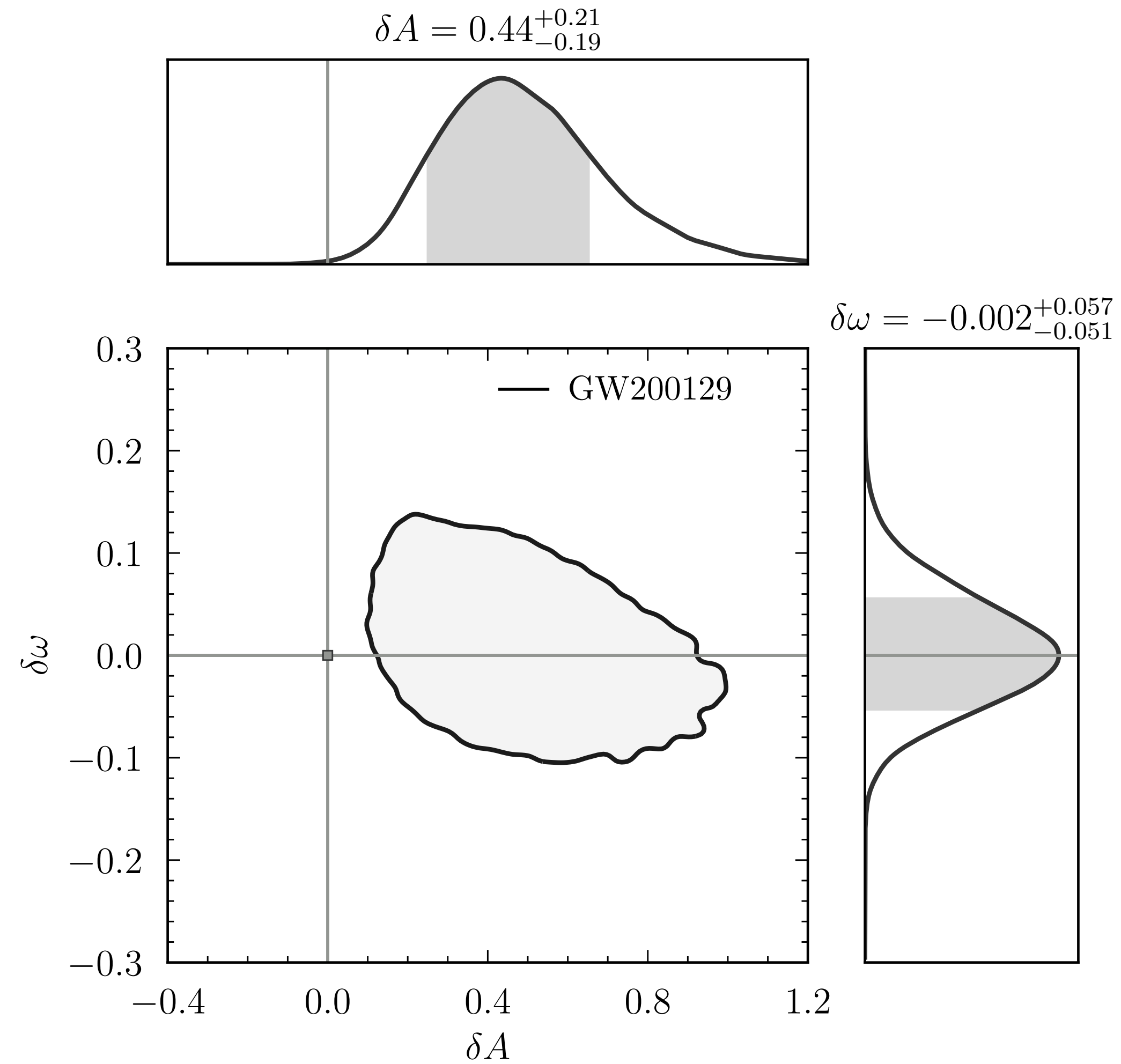


GW200129: the “curious” event



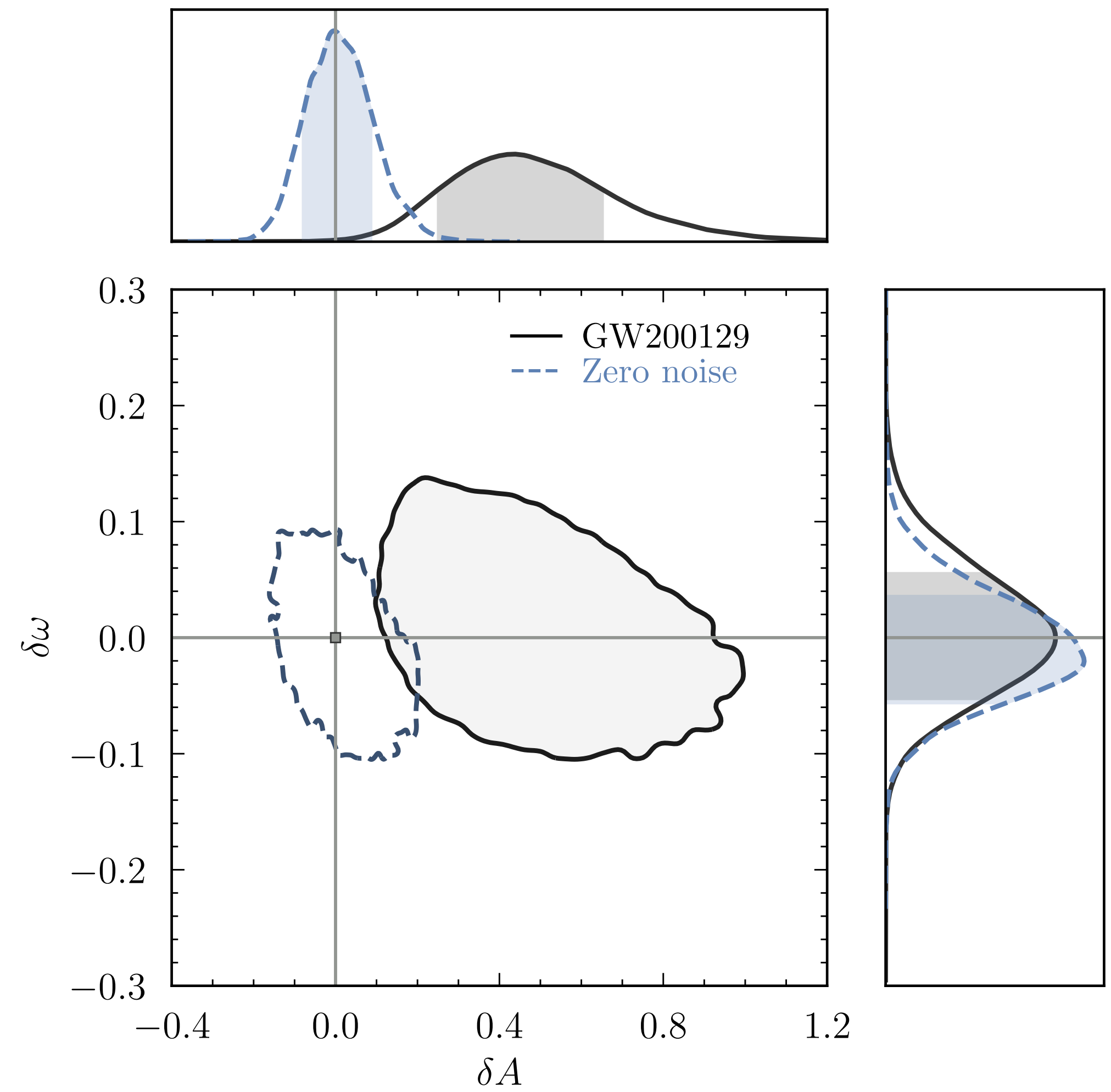
GW200129: the “curious” event

Have we shown general relativity is **wrong**?



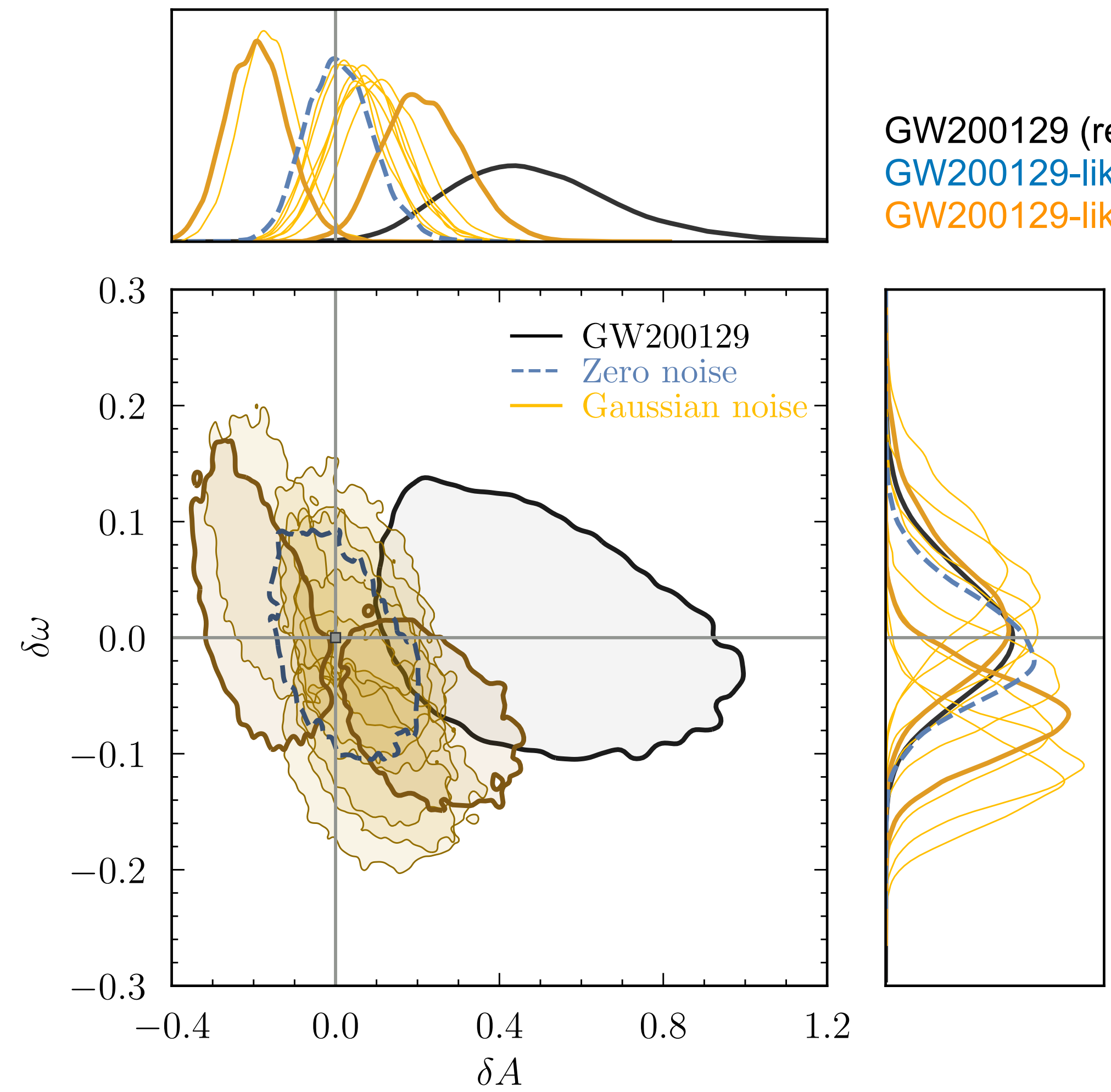
GW200129: the “curious” event

Have we shown general relativity is **wrong**?



GW200129: the “curious” event

Have we shown general relativity is **wrong**?



GW200129 (real data)
GW200129-like (SEOBNRHM, zero noise)
GW200129-like (SEOBNRHM, Gaussian noise)

GW200129: what could be happening?

GW200129: what could be happening?

Systematical error due to
spin precession?

Hannam et al. (2022)

GW200129: what could be happening?

Systematical error due to
spin precession?

Hannam et al. (2022)

Article

General-relativistic precession in a black-hole binary

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 Check for updates

Mark Hannam^{1,17}, Charlie Hoy^{1,17}, Jonathan E. Thompson^{1,17}, Stephen Fairhurst¹, Vivien Raymond¹, Marta Colleoni², Derek Davis³, Héctor Estellés², Carl-Johan Haster⁴, Adrian Helmling-Cornell⁵, Sascha Husa², David Keitel², T. J. Massinger⁴, Alexis Menéndez-Vázquez⁶, Kentaro Mogushi⁷, Serguei Ossokine⁸, Ethan Payne³, Geraint Pratten⁹, Isobel Romero-Shaw^{10,11,12}, Jam Sadiq¹³, Patricia Schmidt⁹, Rodrigo Tenorio², Richard Udall³, John Veitch¹⁴, Daniel Williams¹⁴, Anjali Balasaheb Yelikar¹⁵ & Aaron Zimmerman¹⁶

GW200129: what could be happening?

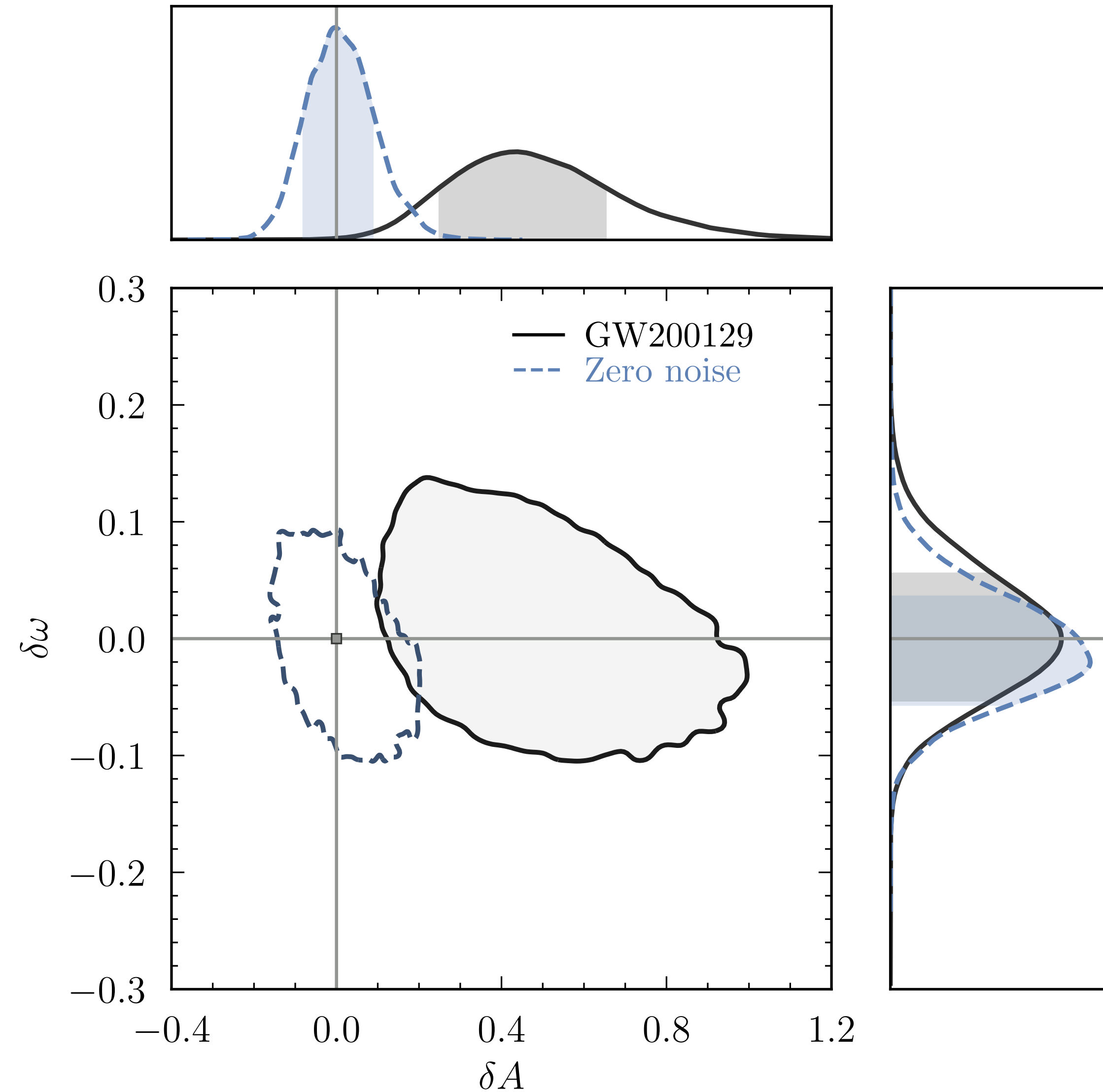
Systematical error due to
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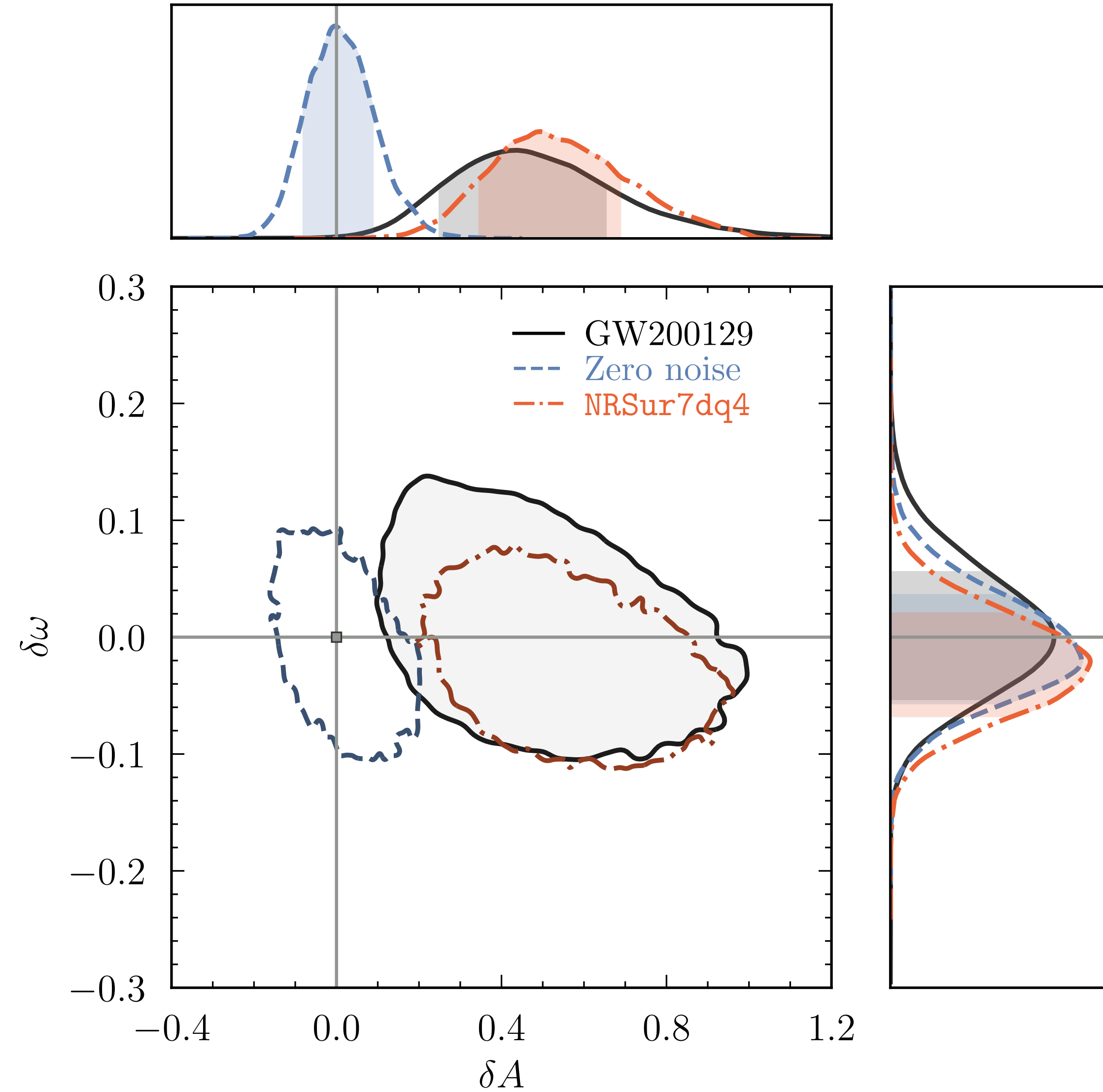
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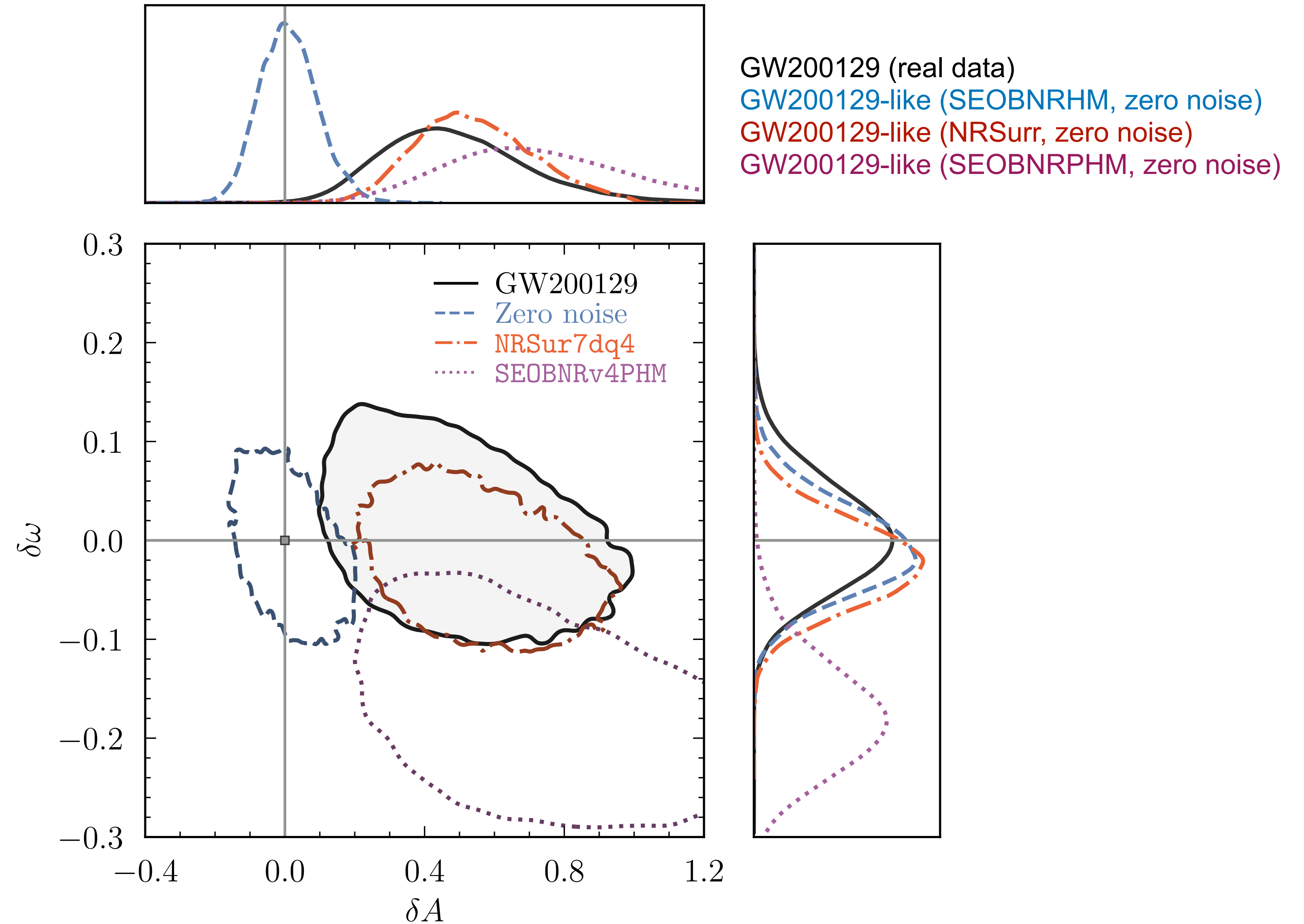
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GW200129: what could be happening?

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GW200129: what could be happening?

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Key message: waveform systematics (in our example, spin precession mismodelling) can bias us to find **false-violations** of general relativity with **present day gravitational wave** events.

GW200129: what could be happening?

Key message: waveform systematics (in our example, spin precession mismodelling) can bias us to find **false-violations** of general relativity with **present day gravitational wave** events.

Key message: parametrized waveform models develop to test general relativity, are also useful to study waveform systematics in general relativity.

GW200129: is this the **full** story?

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Glitches in the detectors?

Payne et al. (2022)

GW200129: is this the **full** story?

Glitches in the detectors?

Payne et al. (2022)

PHYSICAL REVIEW D **106**, 104017 (2022)

Curious case of GW200129: Interplay between spin-precession inference and data-quality issues

Ethan Payne^{}, Sophie Hourihane^{}, Jacob Golomb^{}, Rhiannon Udall^{}, Derek Davis^{}, and Katerina Chatziioannou^{}

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LIGO Laboratory, California Institute of Technology, Pasadena, California 91125, USA*



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GW200129: is this the **full** story?

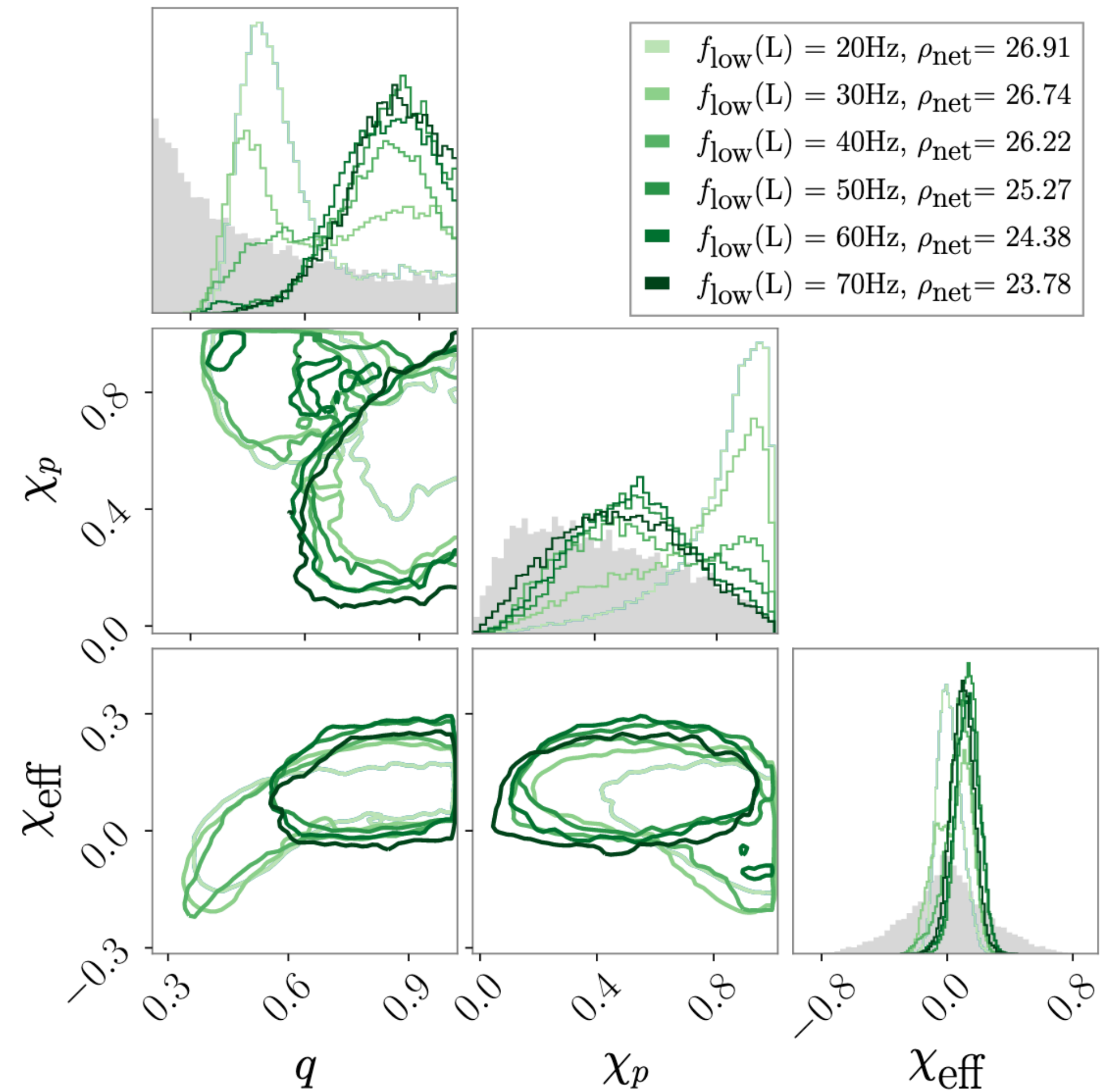
Glitches in the detectors?

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GW200129: is this the **full** story?

Glitches in the detectors?

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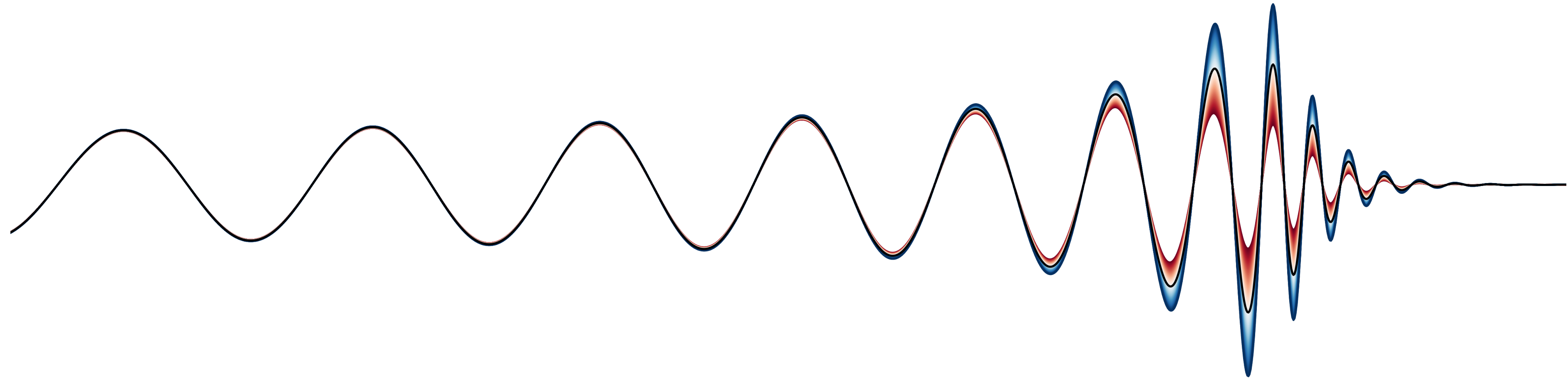
GW200129: is that the full story?

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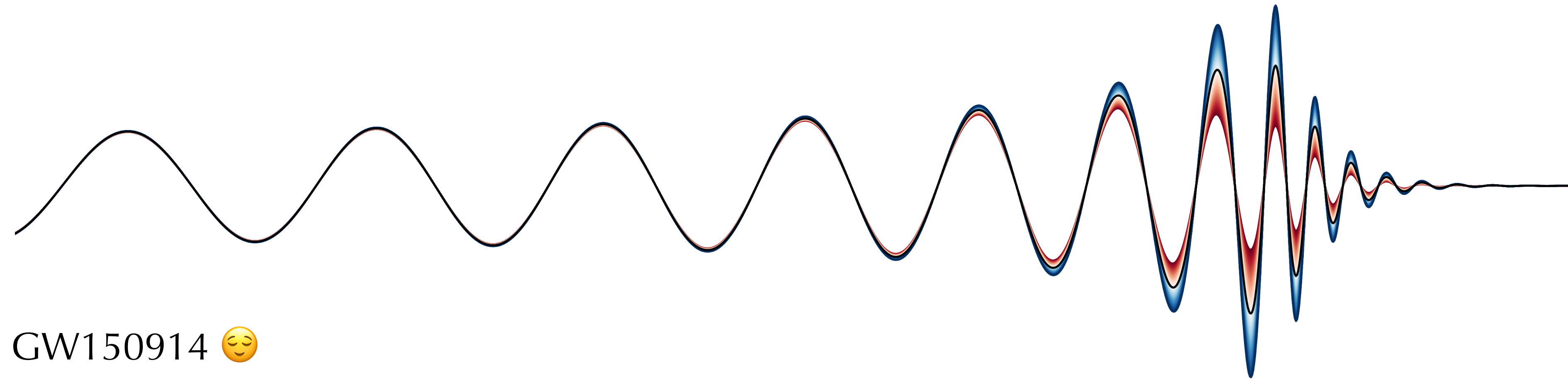
(Updated) key message: waveform systematics and data-quality issues can bias us to find **false-violations** of general relativity with **present day gravitational wave** events.

Take-away messages and *uma provocação*

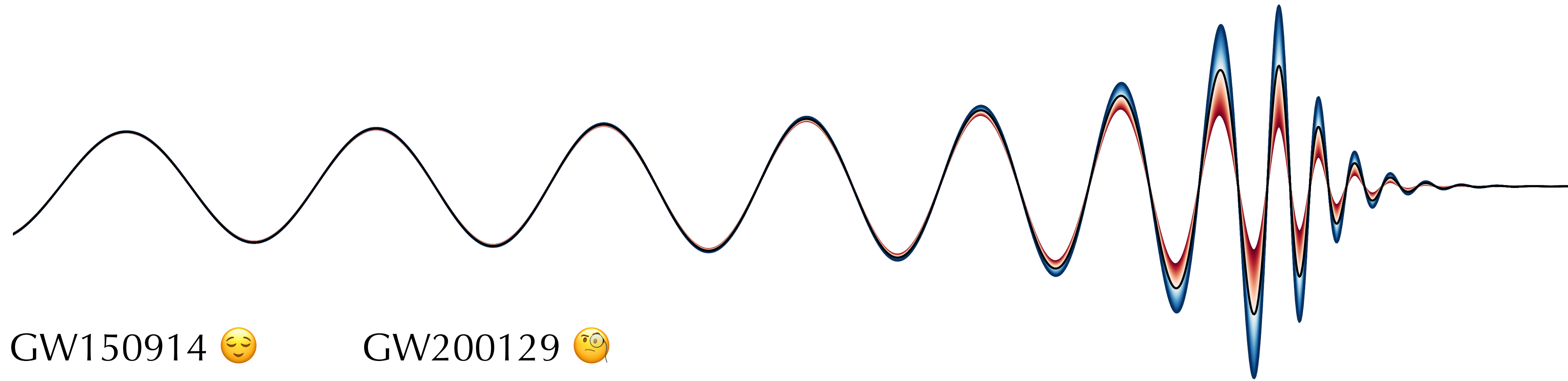
Take-away messages and *uma provocação*



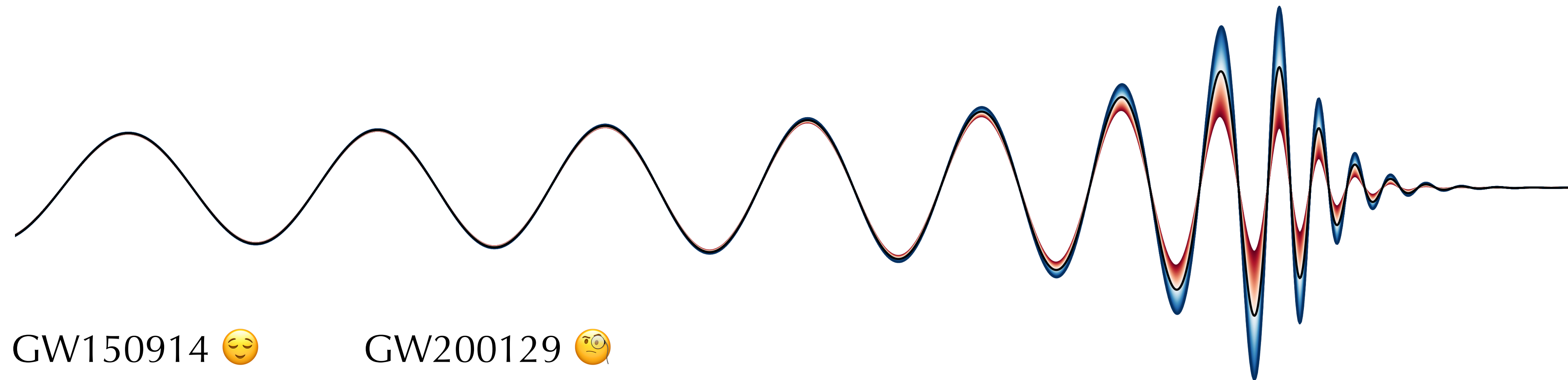
Take-away messages and *uma provocação*



Take-away messages and *uma provocação*



Take-away messages and *uma provocação*



Will we ever overcome waveform **systematics in general relativity** to be able to confidently **claim detection of beyond-general-relativity physics** (if there is **any** to be found)? This question will become even more **important** for **next-generation gravitational-wave** detectors: many more events and much higher detector sensitivities.