Detectability of a phase transition in neutron star matter with third-generation gravitational wave interferometers

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(Caen-Meudon group)

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GdR Ondes Gravitationnelle
Marseille
October 15, 2024

Hadron-Quark phase transition (PT)

In the context of Neutron Star

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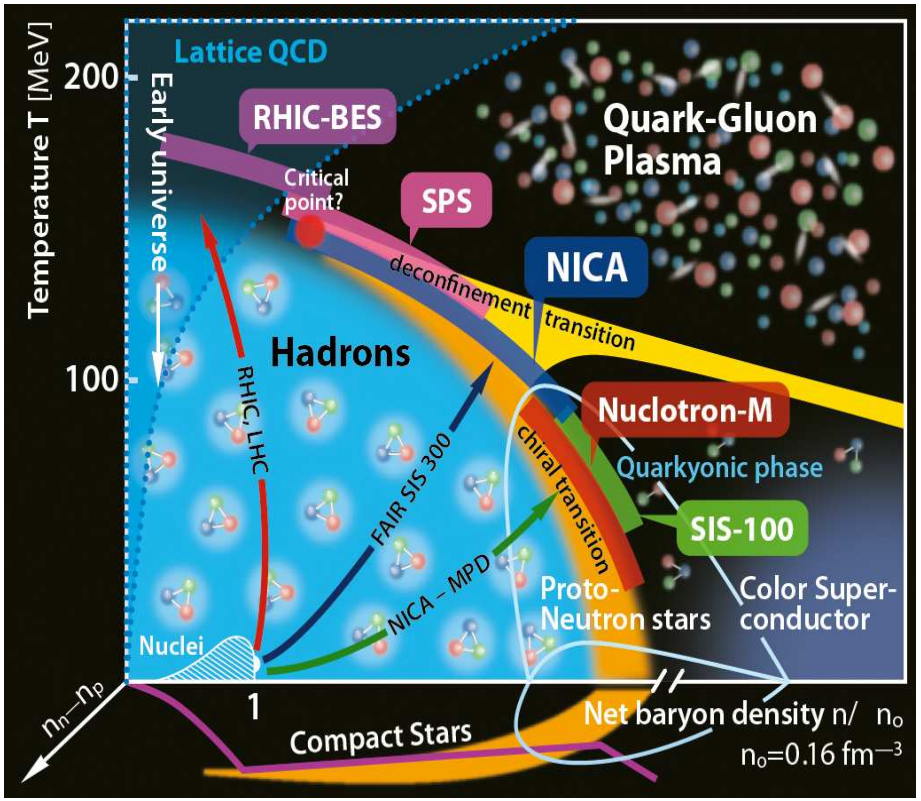

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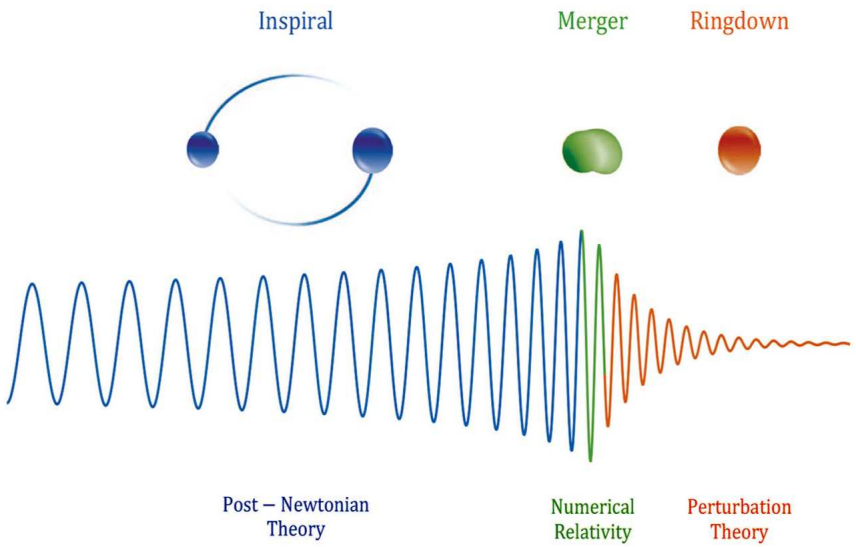

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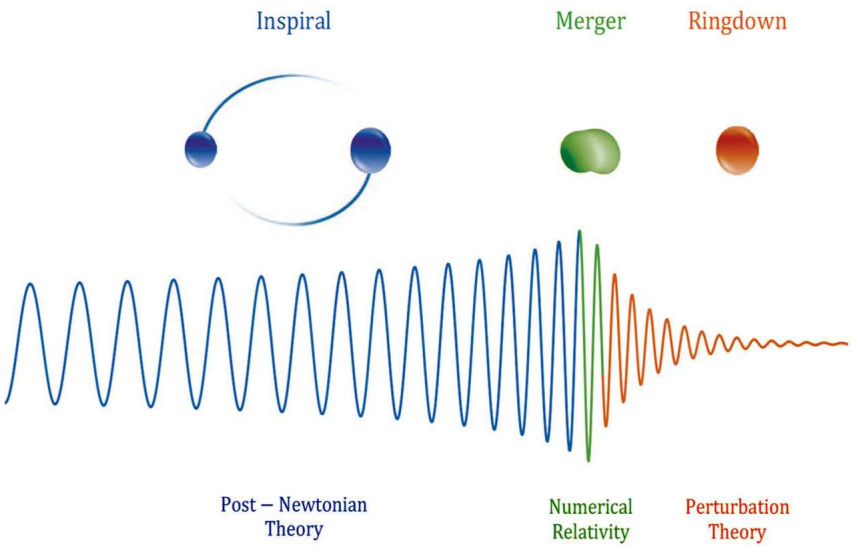

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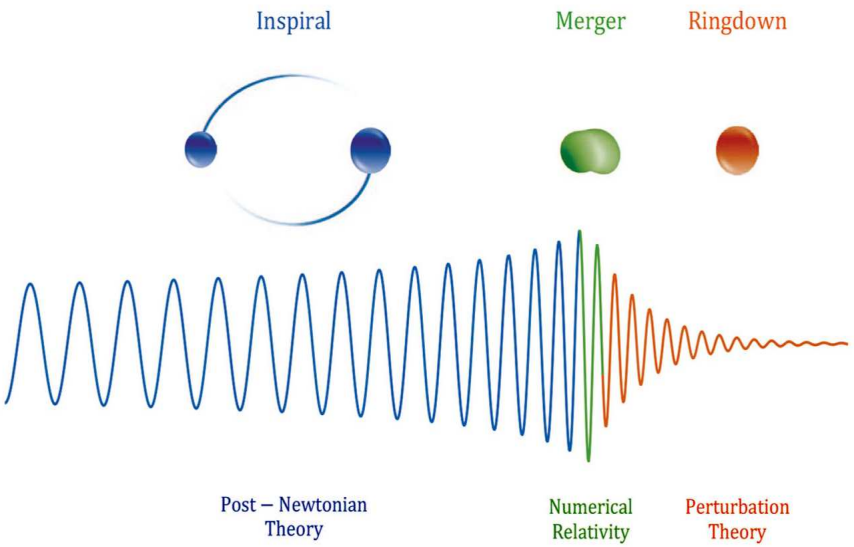

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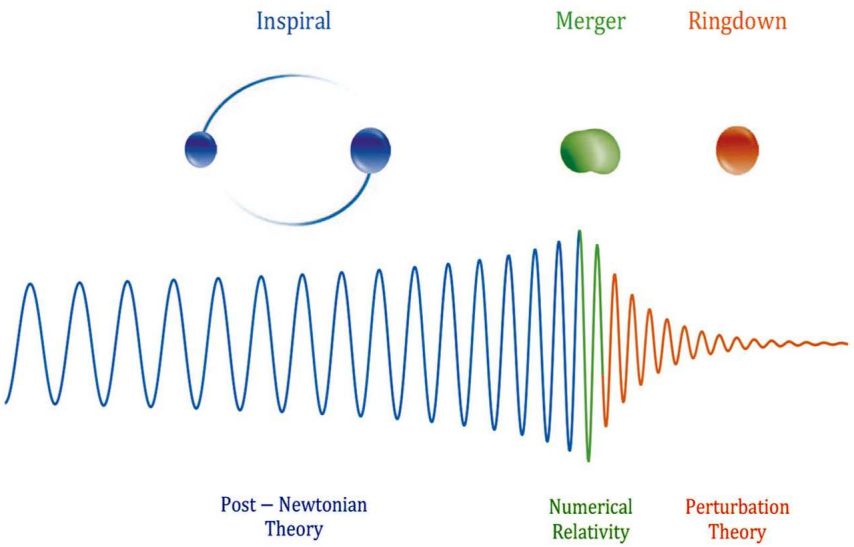

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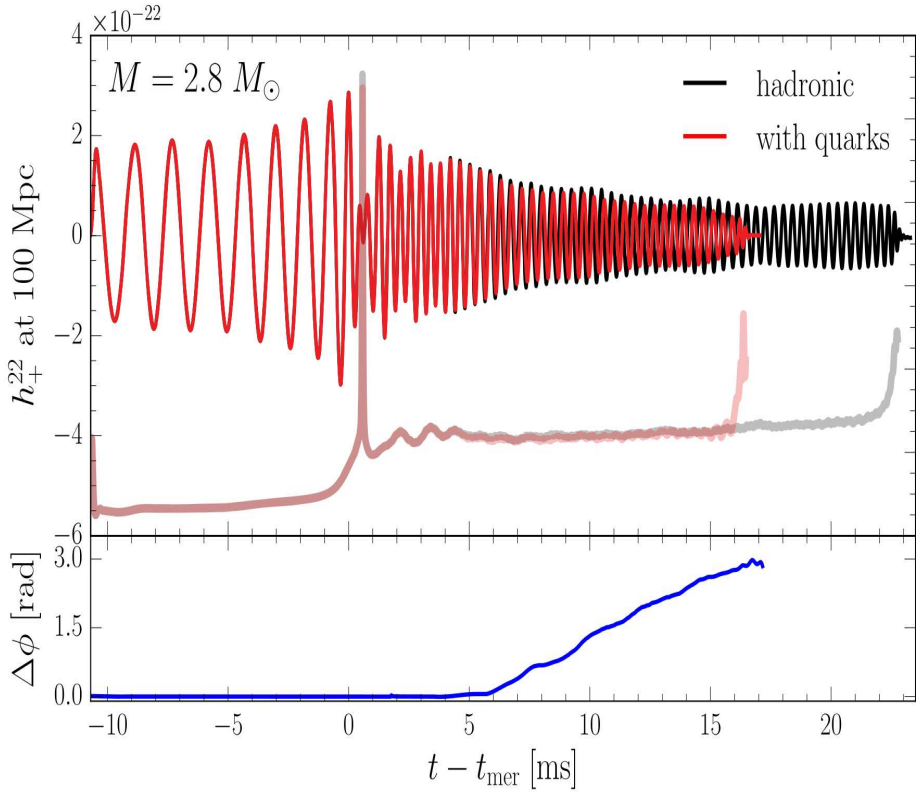

Most *et. al.*, PRL 122, 061101 (2019)

Questions one can ask:

- Can PT be detected through a GW signal?
- In which conditions it can be detected? Early/Late??
- What are the signatures in the signal?
  For overview see e.g.
  Blacker *et. al.*
  PRD 102, 123023 (2020).

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Uncertainties in information

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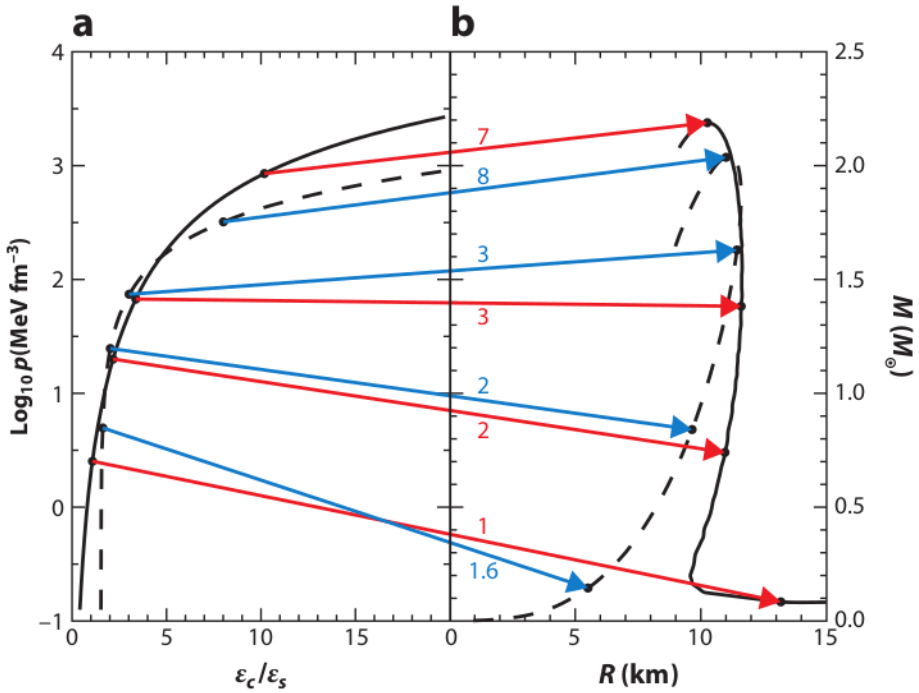

J. Lattimer, ARNPS 62, 485–515 (2012)

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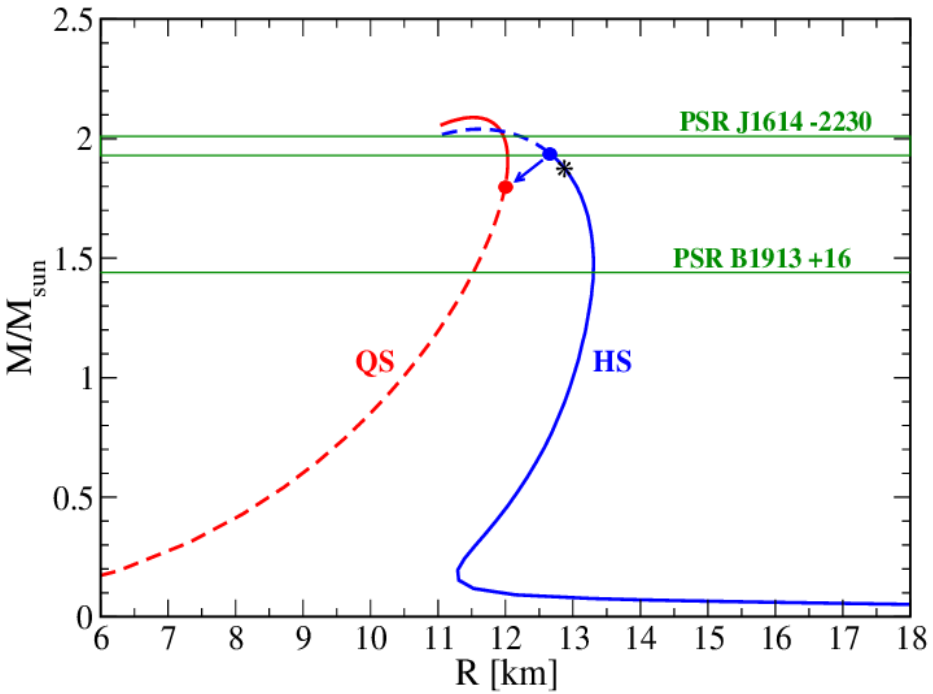

I. Bombaci, conference paper

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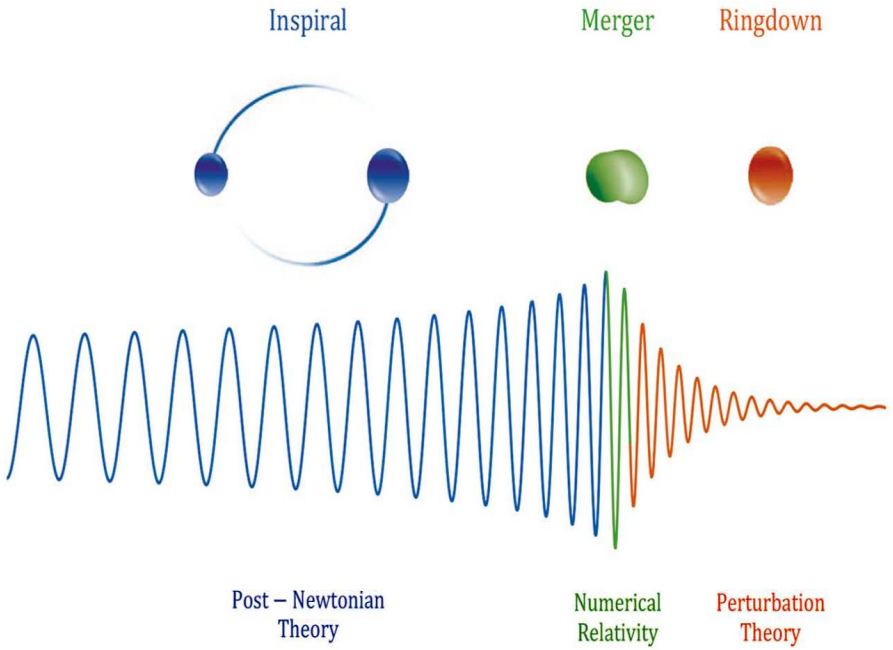

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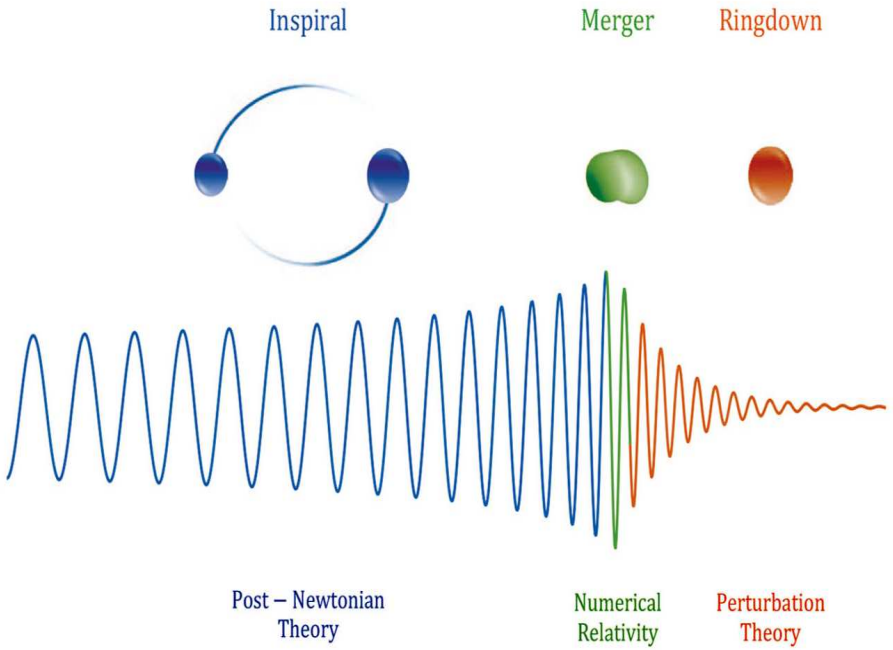

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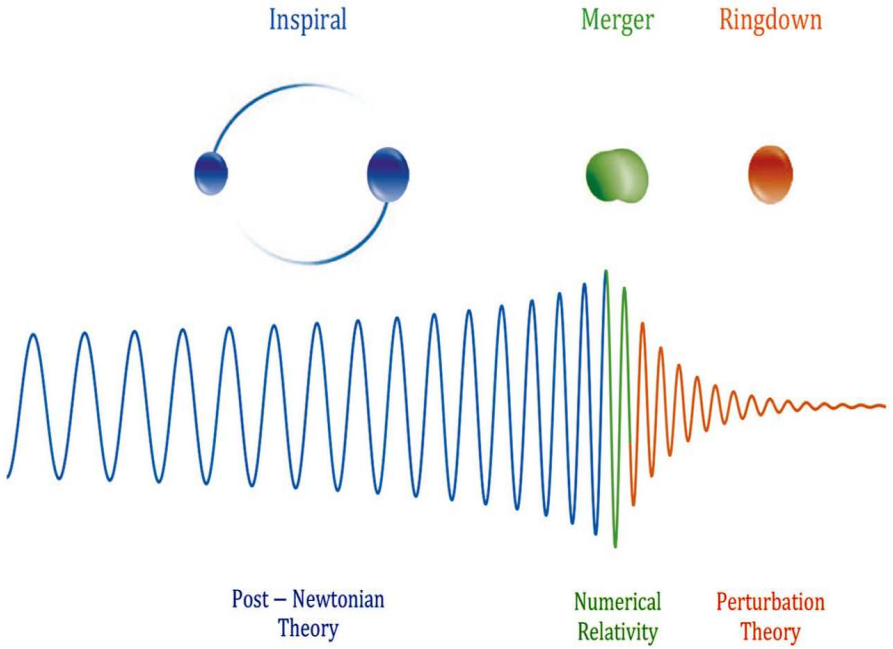

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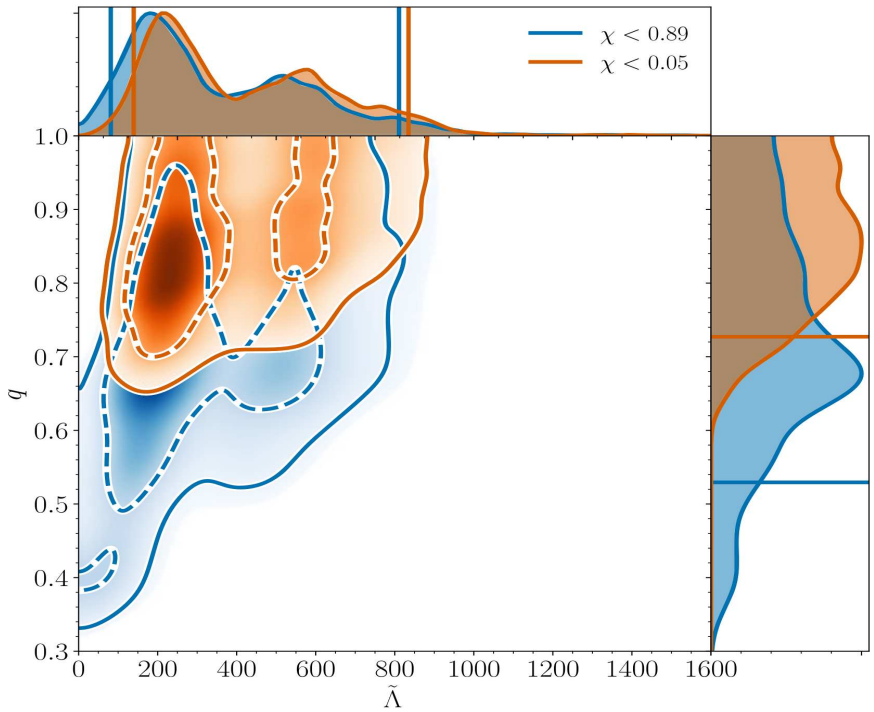

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LVC, PRX 9, 011001 (2019)

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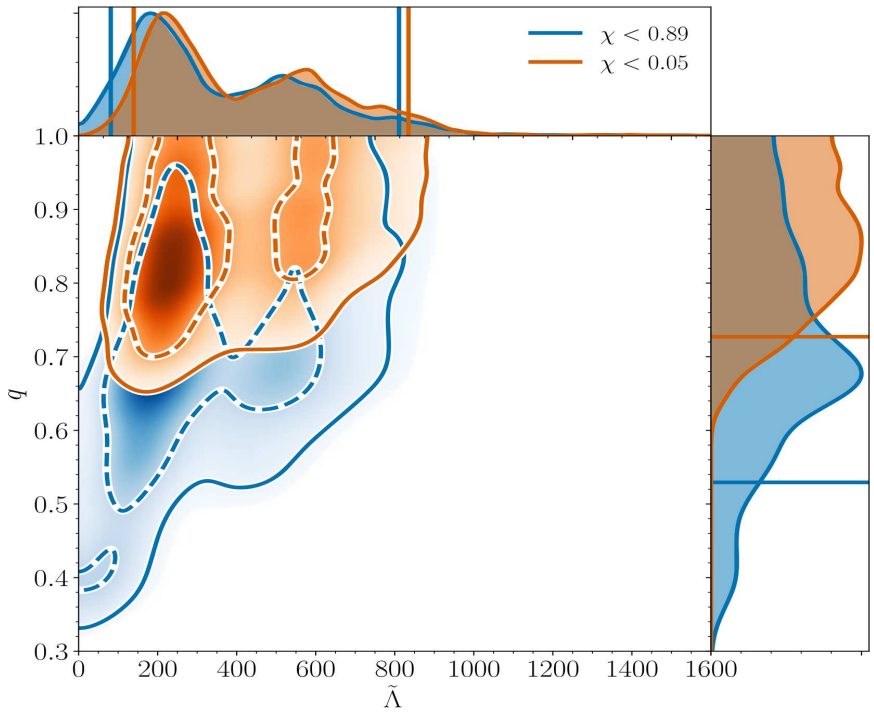

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- Prospect of many NS-NS in ET with 3G detectors

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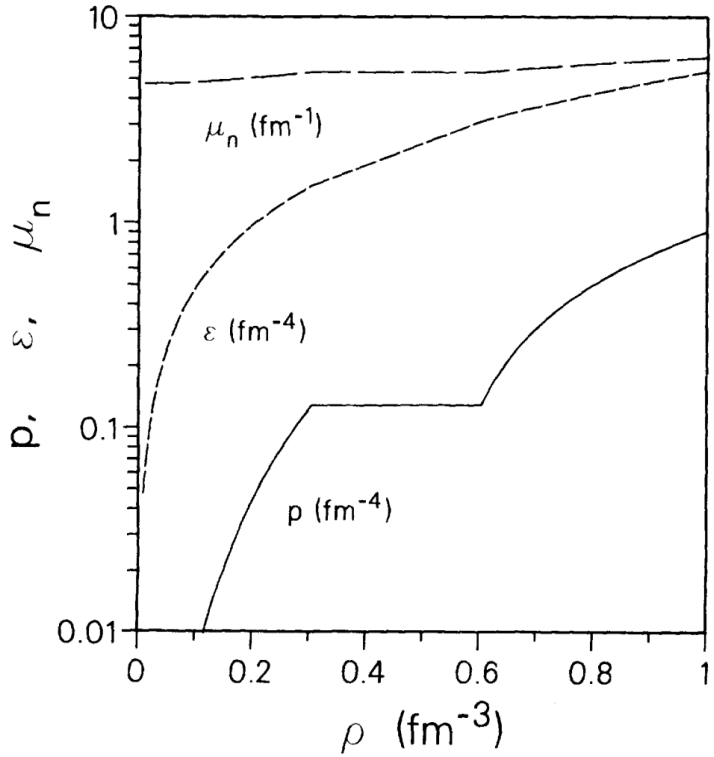

Glendenning PRD 46, 1274 (1992)

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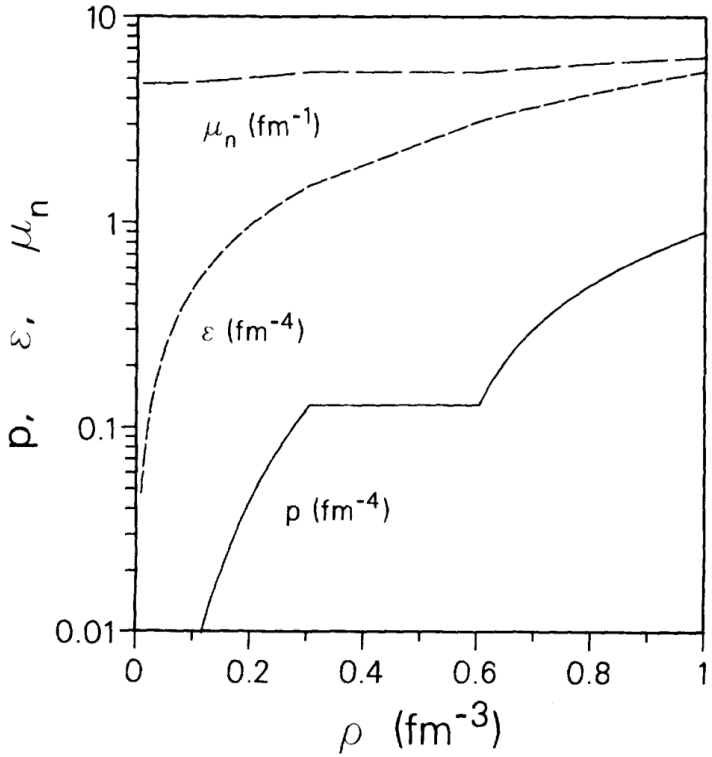

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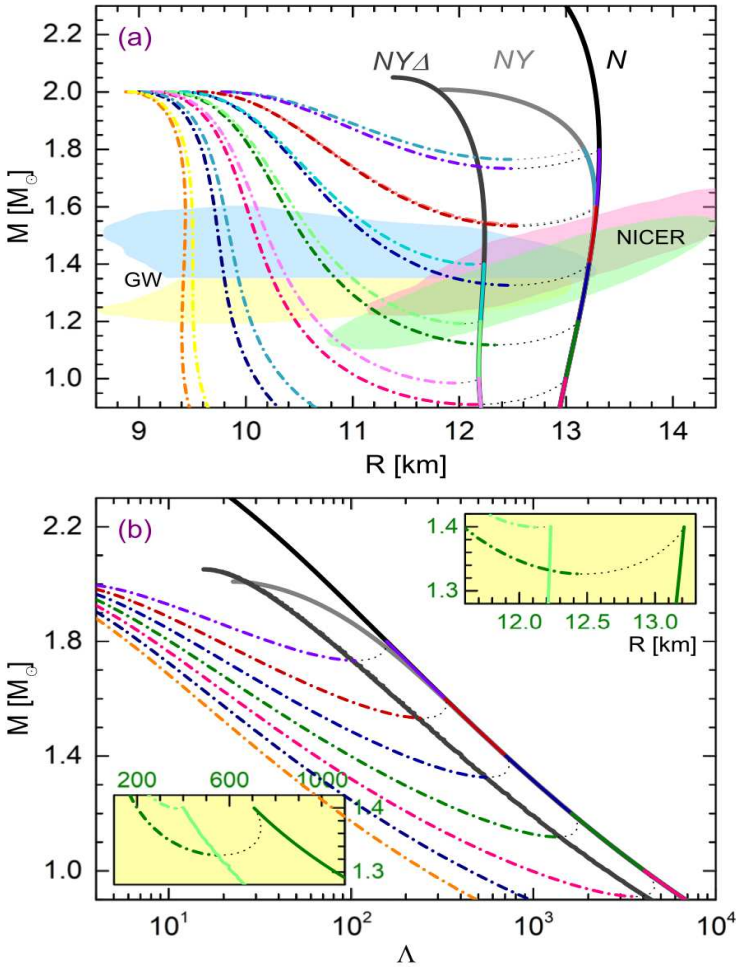

Li, Sedrakian and Alford, PRD 101, 063022 (2020)

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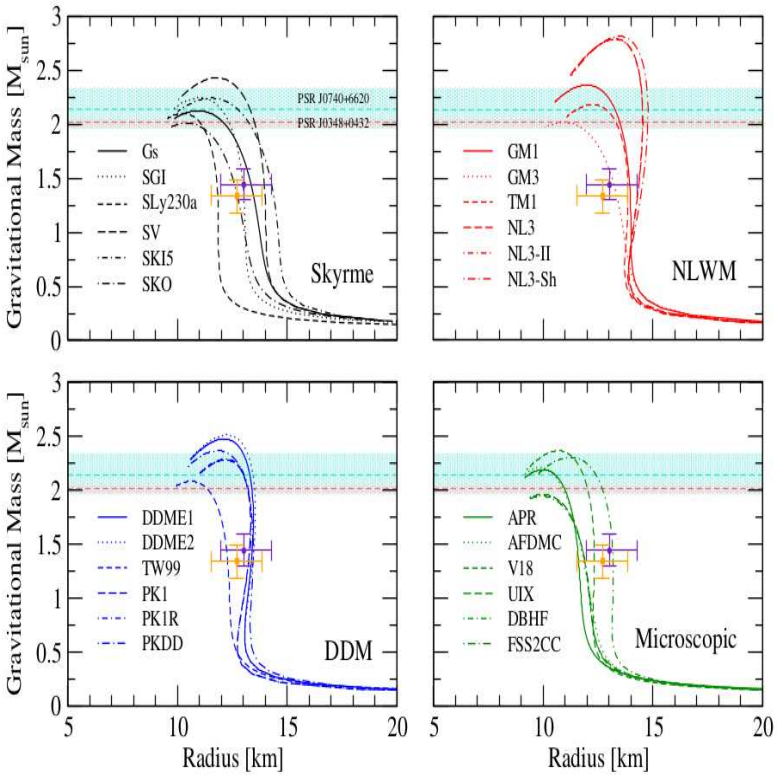
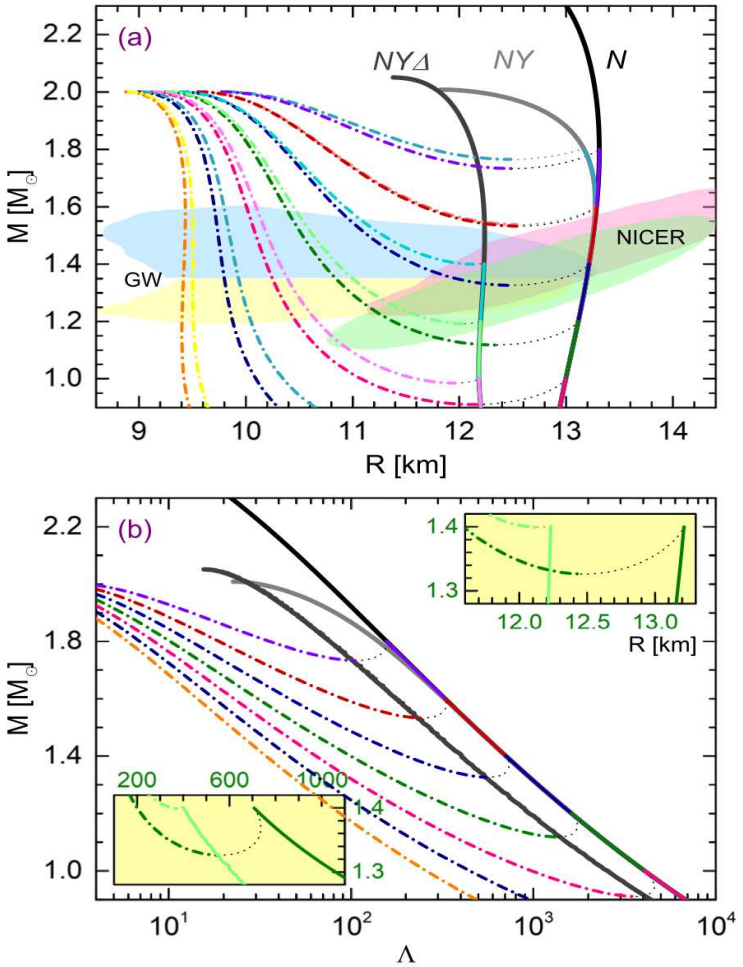


G. Burgio & I. Vidaña, Universe 6, 119 (2020)



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Founding aspects [PRC 97, 025805 (2018)]

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e_{meta}(n_n, n_p) &= KE(n_n, n_p) + \sum_{\alpha \geq 0} \frac{1}{\alpha!} \left(v_\alpha^{is} + v_\alpha^{iv} \delta^2 \right) x^\alpha. \\
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Constraints in Bayesian studies:

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Dinh-Thi *et. al.* 2021, CM *et.al* 2022, 2023.

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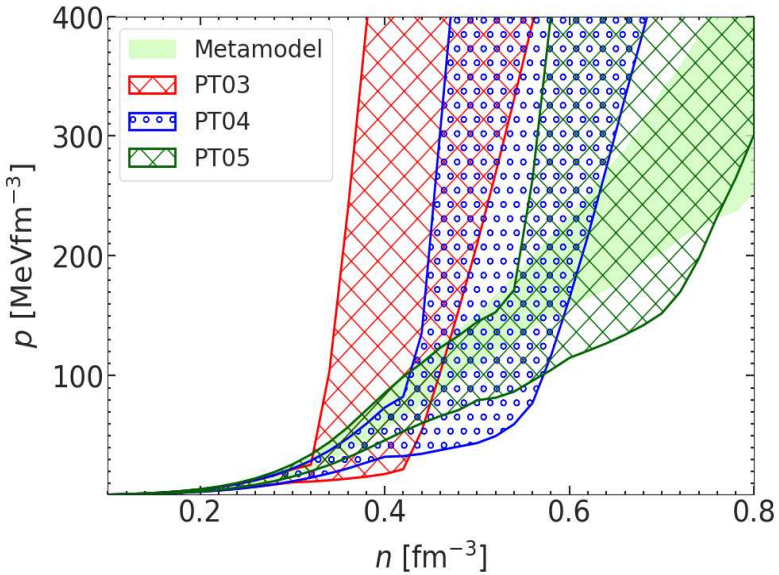

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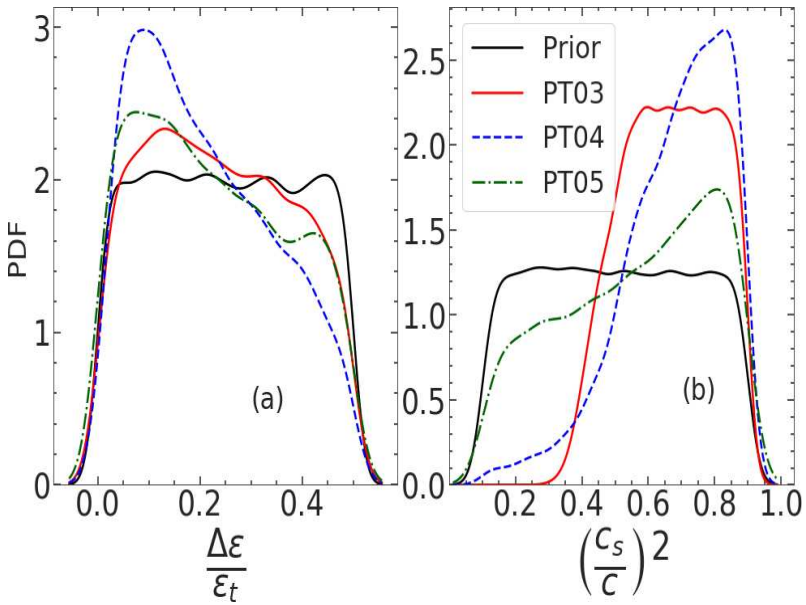

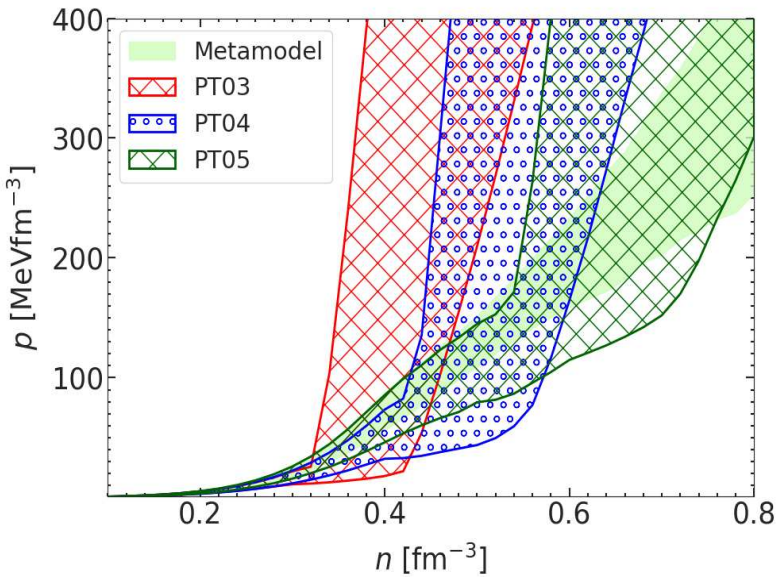

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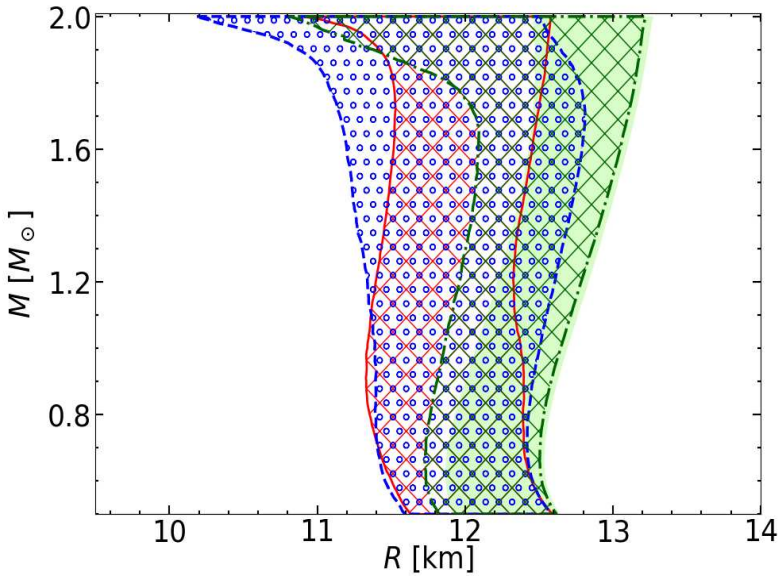

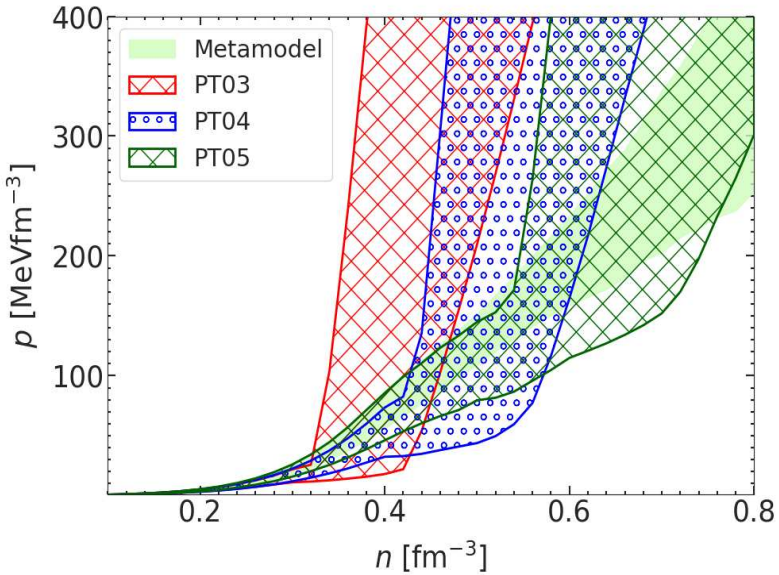

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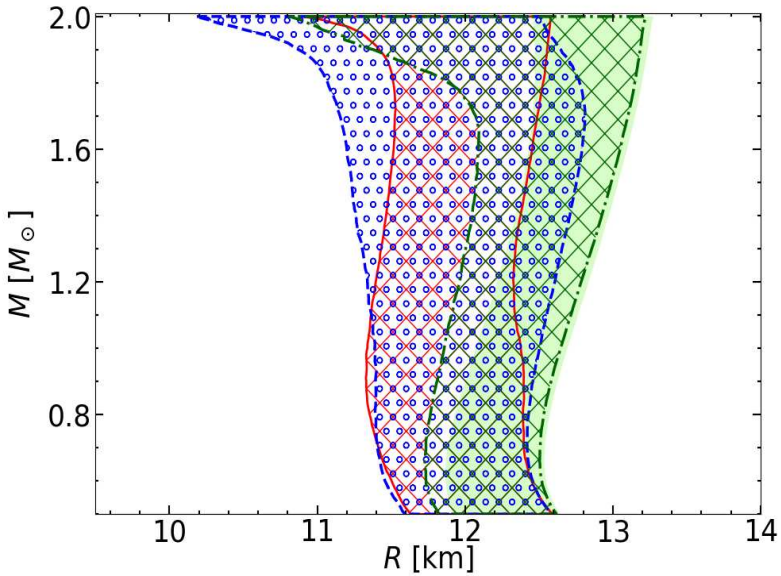

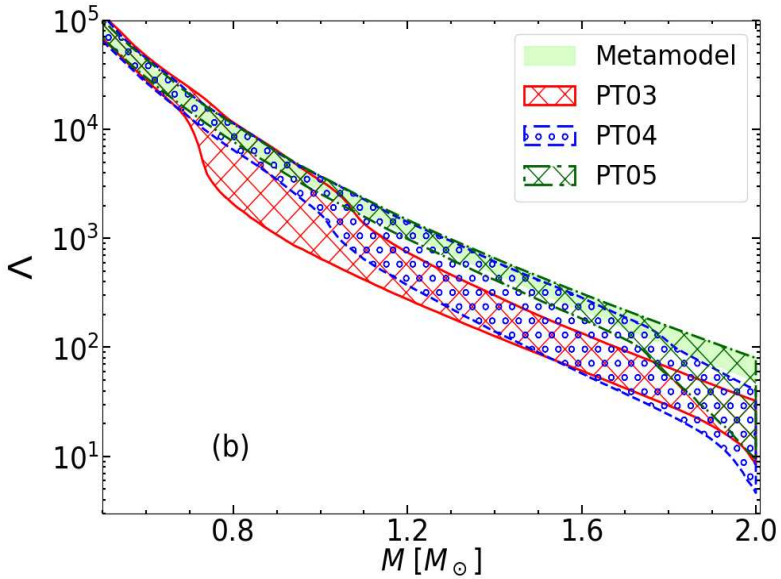

Simulated observations with GWBench

Observable with uncertainties

Different choices for $\mathrm{q}, \mathcal{M}_\mathrm{c}, \mathcal{D}_\mathrm{L}$ and PT injection models.

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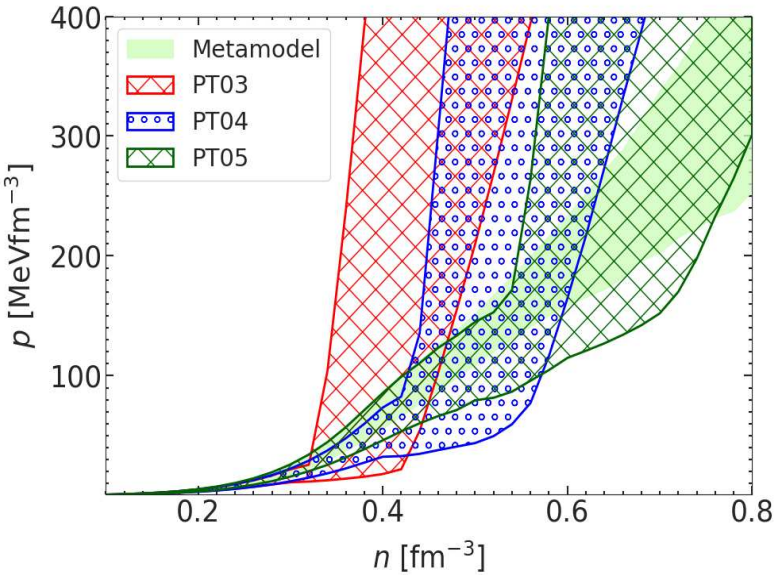

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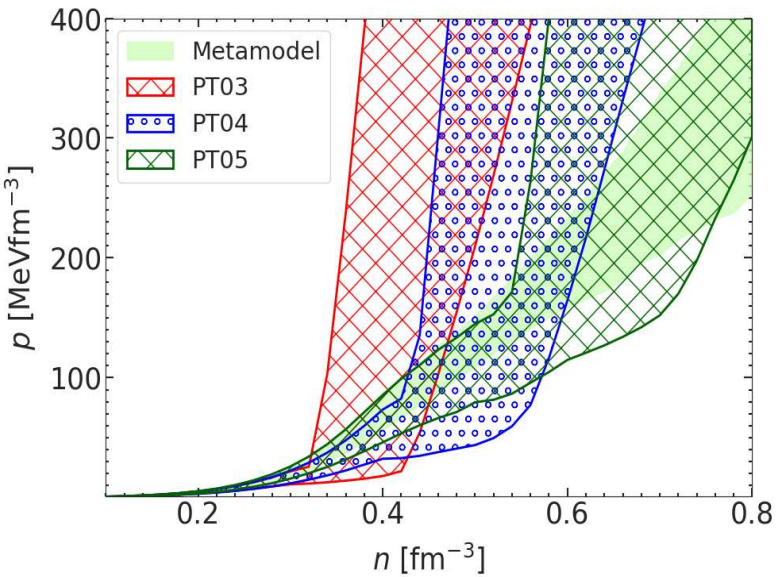

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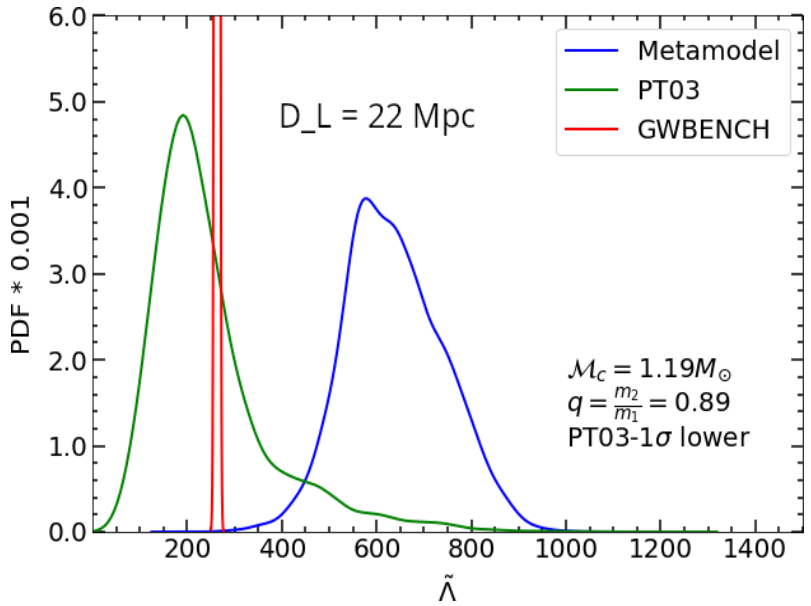

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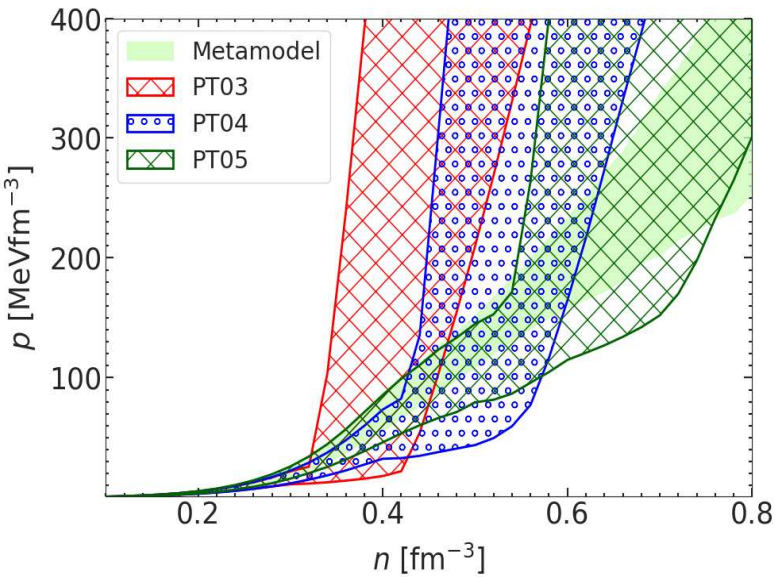

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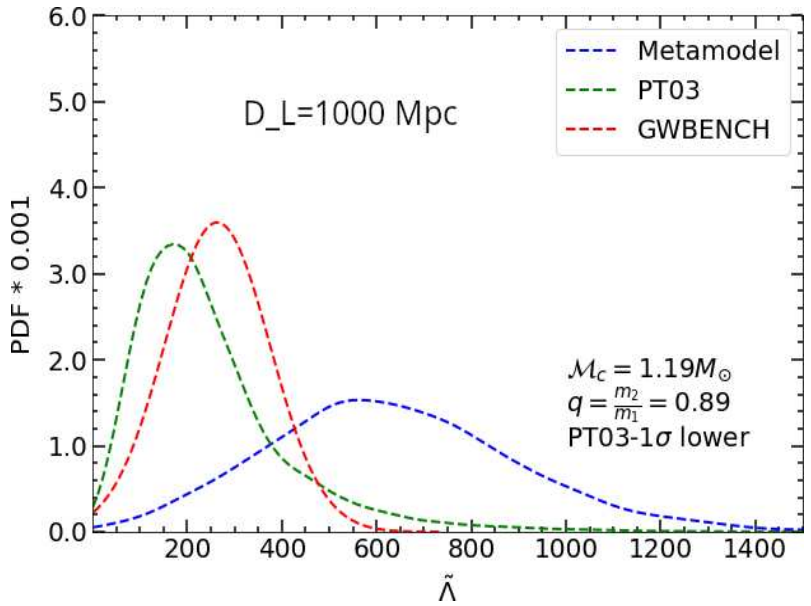

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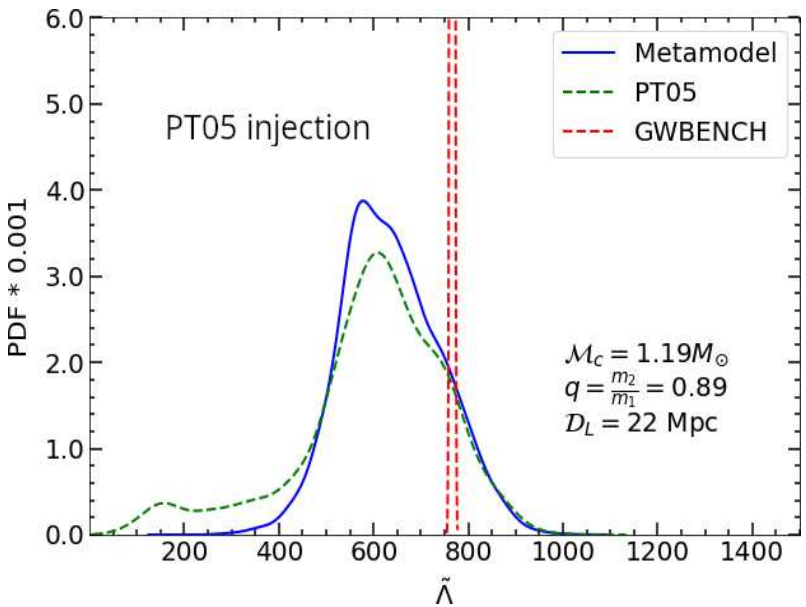

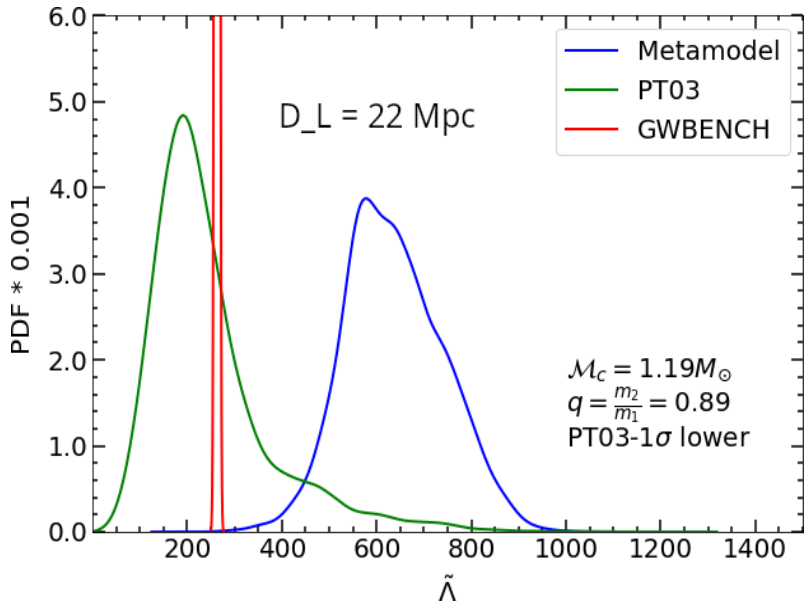

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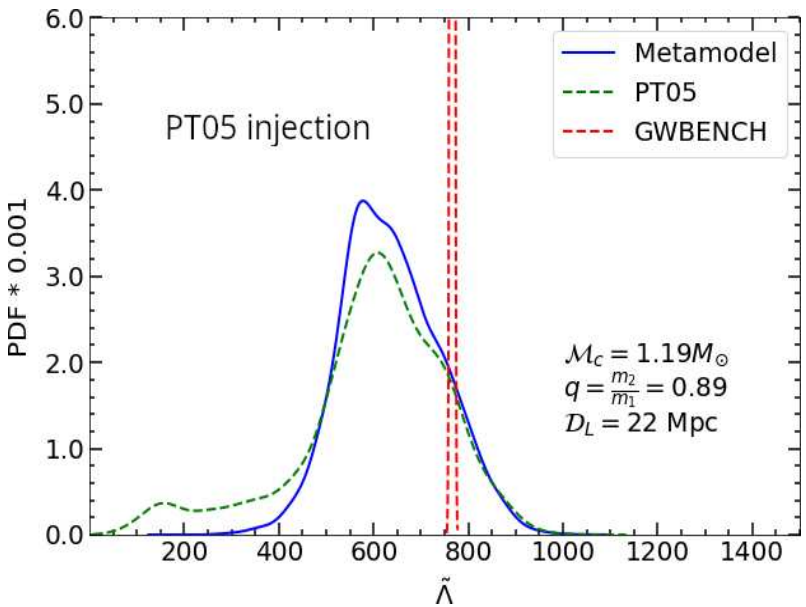

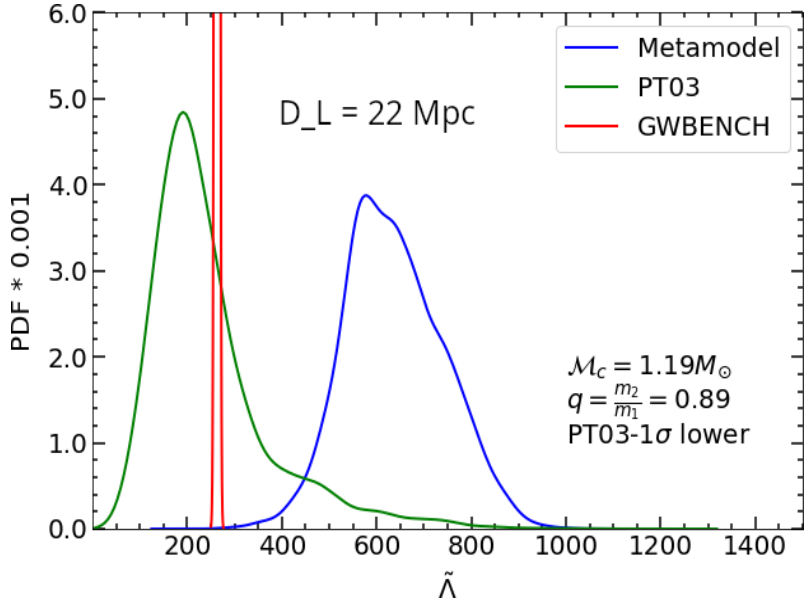

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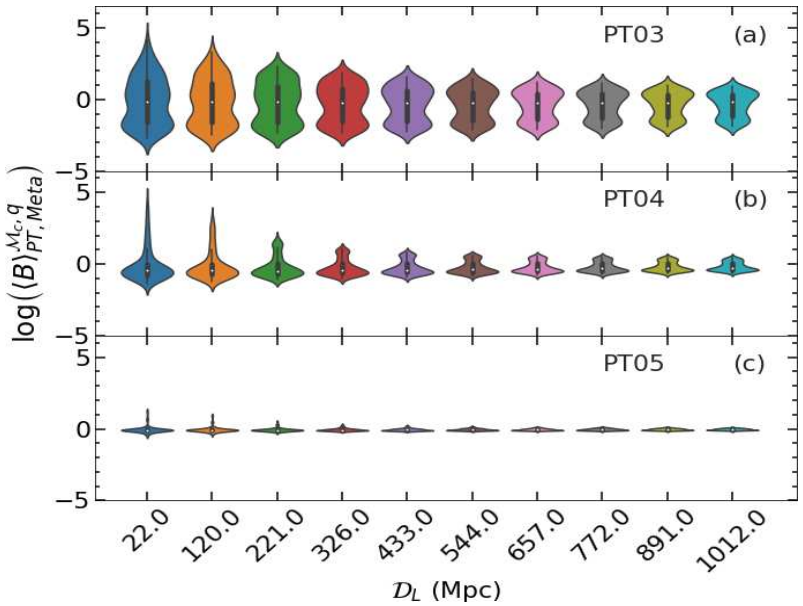

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Summary and outlook

- A possible mechanism to detect the signature of 1st order phase transition was proposed.
- Hybrid metamodelling is used in the Bayesian framework.
- We assess the detectability of PT from a single loud event from the inspiral signal.
- We infer the presence of a PT at low densities with B $\approx$ 100, upto distance 300 Mpc.
- Analysis based on many events are on the way.