

Incorporating neutron star physics into gravitational wave inference with neural priors

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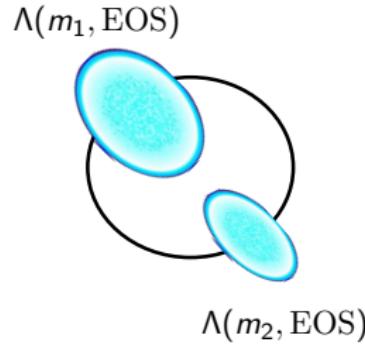
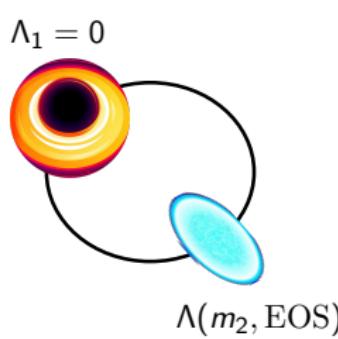
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Motivation

- Posterior \propto likelihood \times prior
- Prior: usually agnostic, but can encode valuable information!
 - Theoretical understanding
 - Observations outside of GW

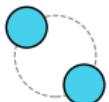
Motivation

- Posterior \propto likelihood \times prior
- Prior: usually agnostic, but can encode valuable information!
 - Theoretical understanding
 - Observations outside of GW
- Neutron stars – key GW observables?
 - Masses m_1, m_2
 - Tidal deformabilities $\Lambda_1, \Lambda_2 \leftarrow$ equation of state (EOS)

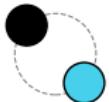


Key idea

Source



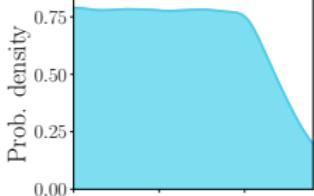
BNS



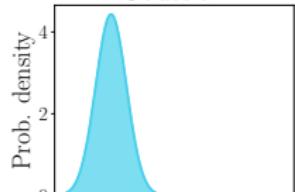
NSBH

Population

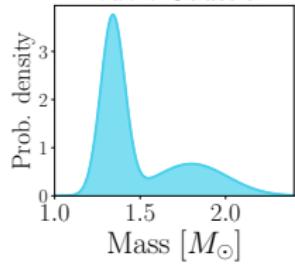
Uniform



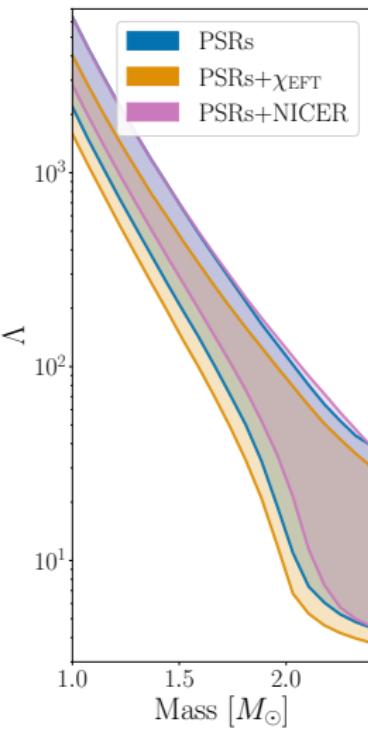
Gaussian



Double Gaussian

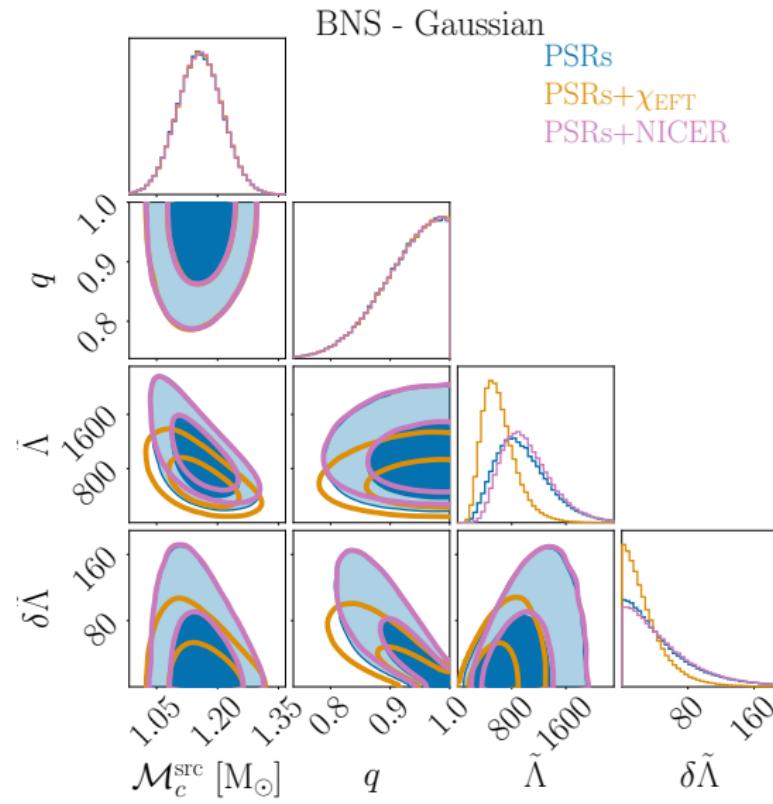


EOS

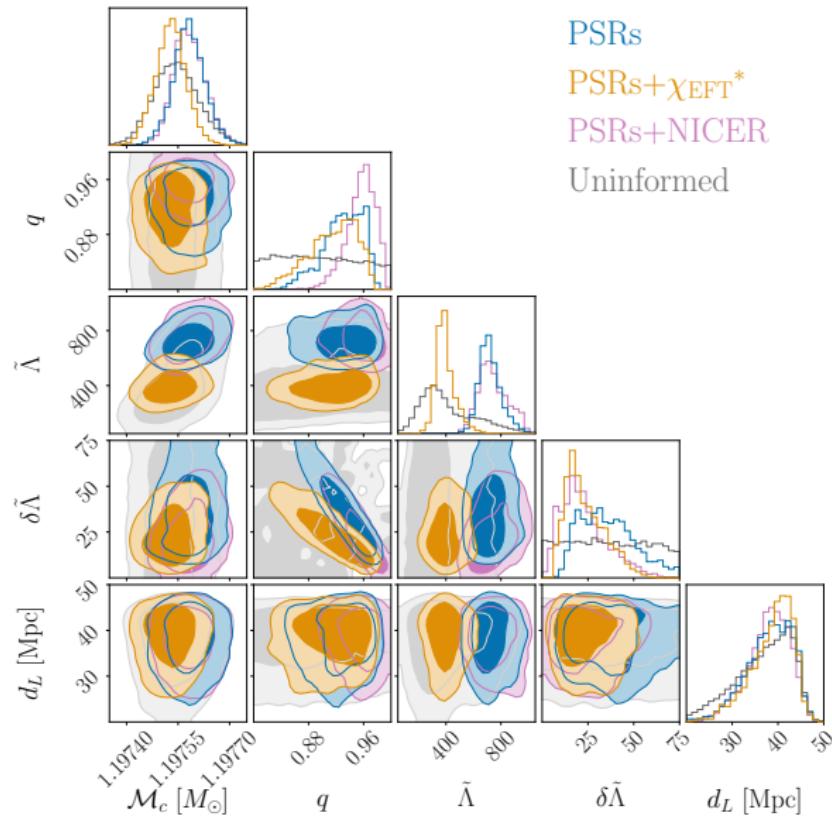


$$p_{\text{NF}}(m_1^{\text{src}}, m_2^{\text{src}}, \Lambda_1, \Lambda_2 | \mathcal{H})$$

Example prior



GW170817 posteriors with EOS informed priors



Closing thoughts

- **Neural priors:** encode non-trivial prior information (including uncertainties) (cf. Matthew's talk)
- Implemented in BILBY, but works with any stochastic sampler
 - Appealing for GPU-based samplers
- Bayesian source classification:
 - GW170817: BNS, soft EOS
 - GW190425: BNS
 - GW230529: NSBH favored over BNS
- Another example of ‘informed’ sampling (cf. Michael’s talk): ML used inside traditional samplers



Thanks for listening!

