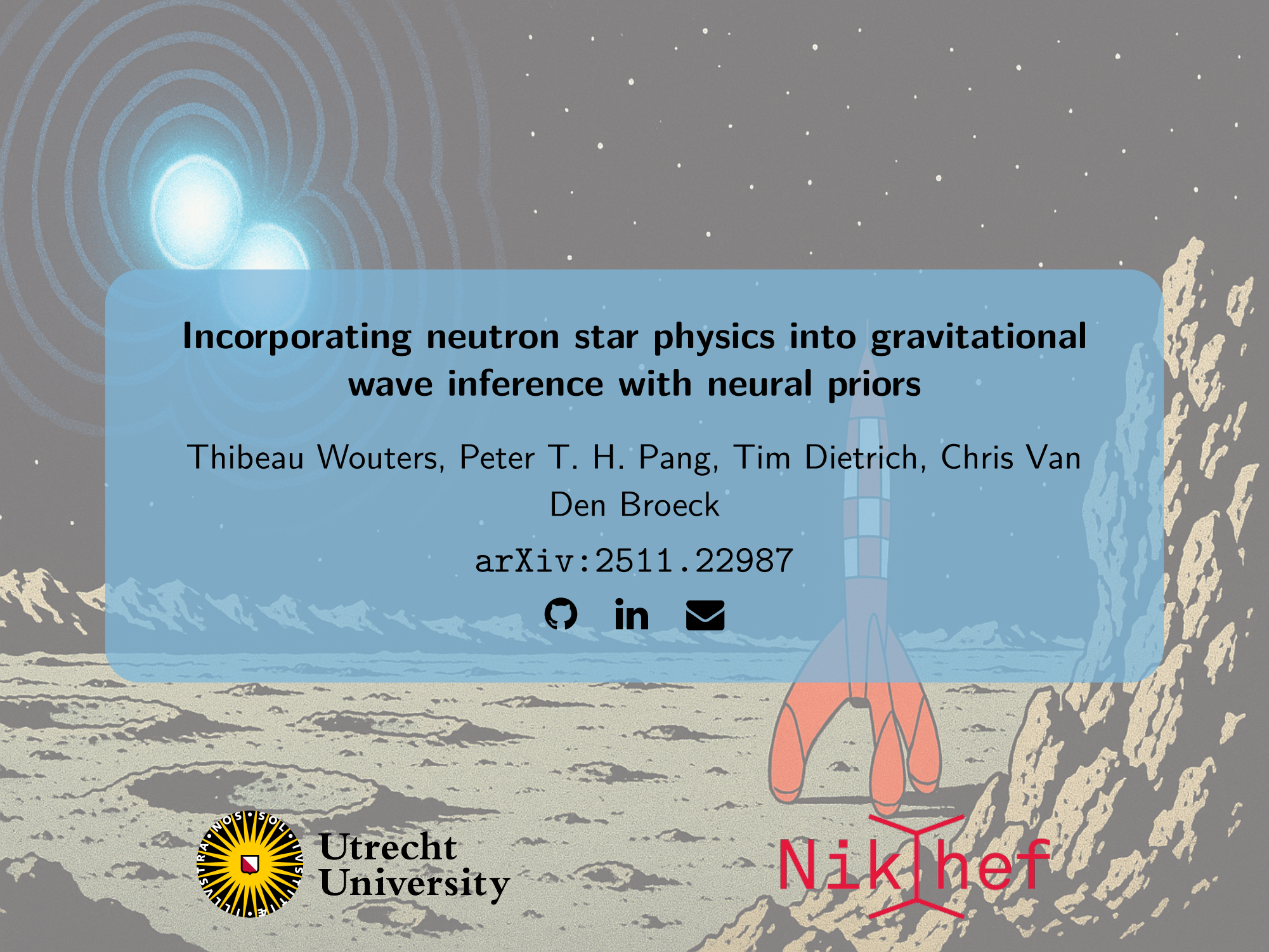

Incorporating neutron star physics into gravitational wave inference with neural priors

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Motivation

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

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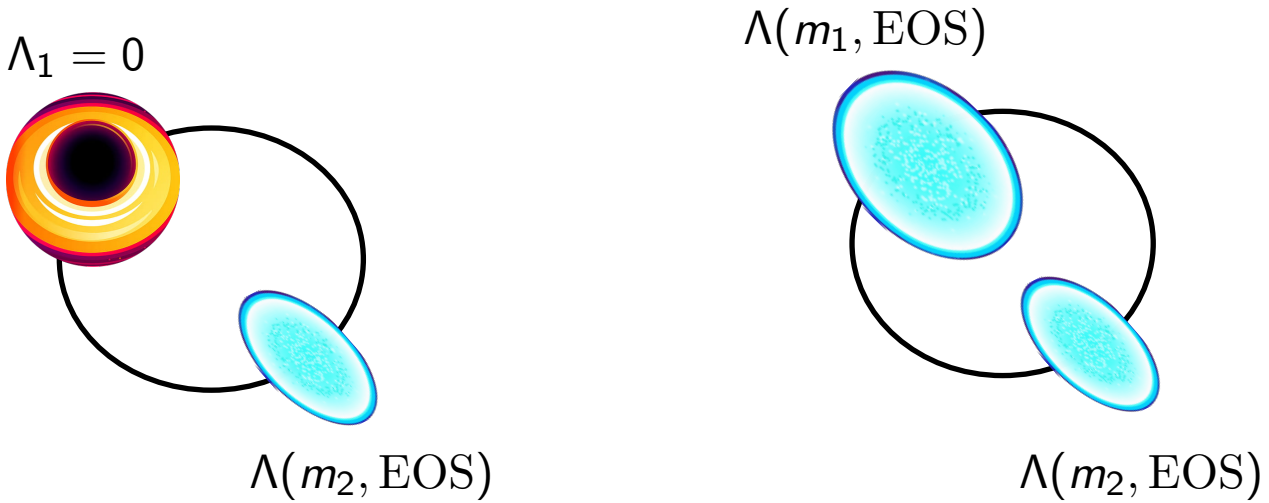
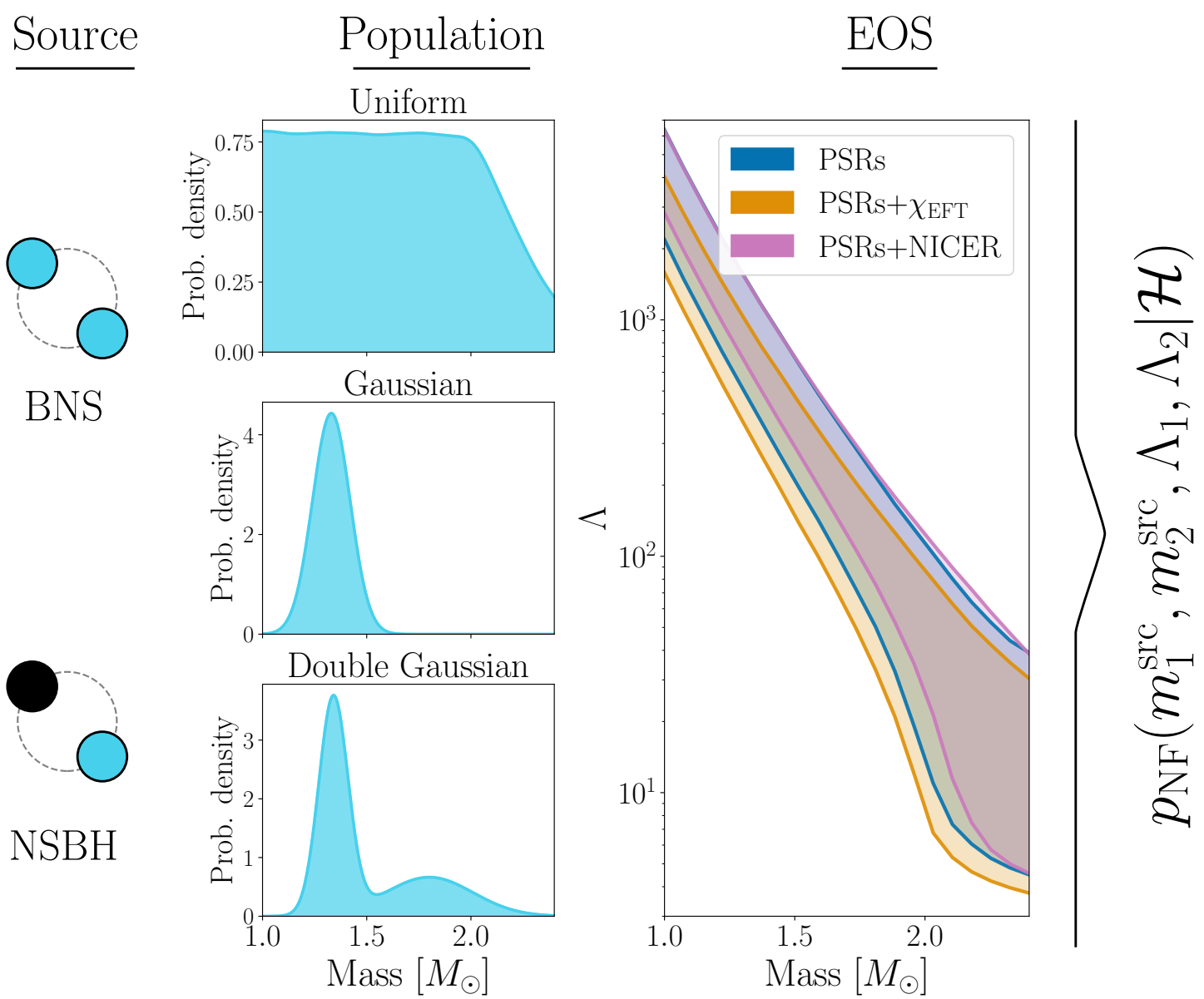
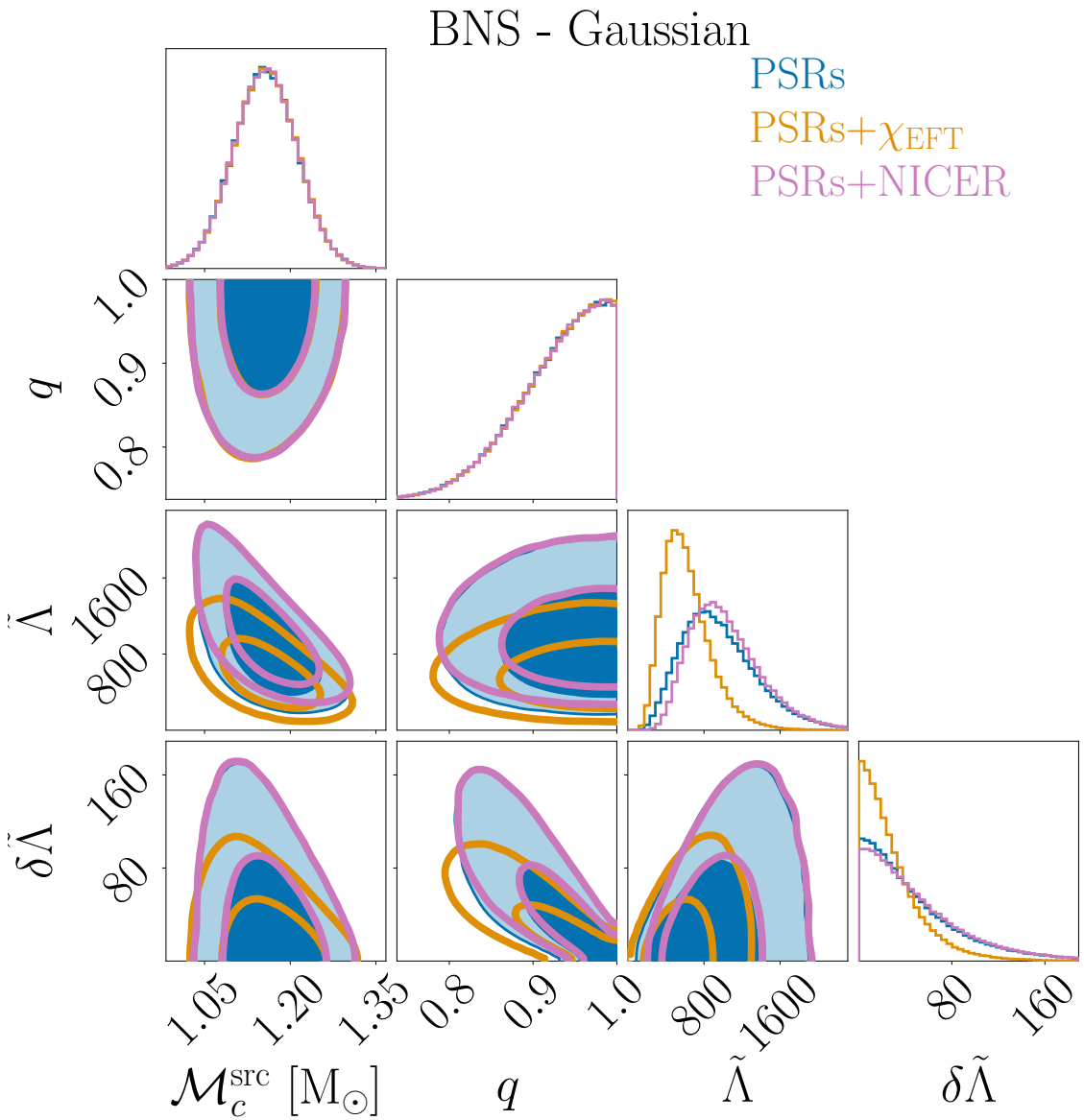
  - Observations outside of GW
- **Neutron stars** – key GW observables?
  - Masses m_1, m_2
  - Tidal deformabilities $\Lambda_1, \Lambda_2 \leftarrow$ equation of state (EOS)



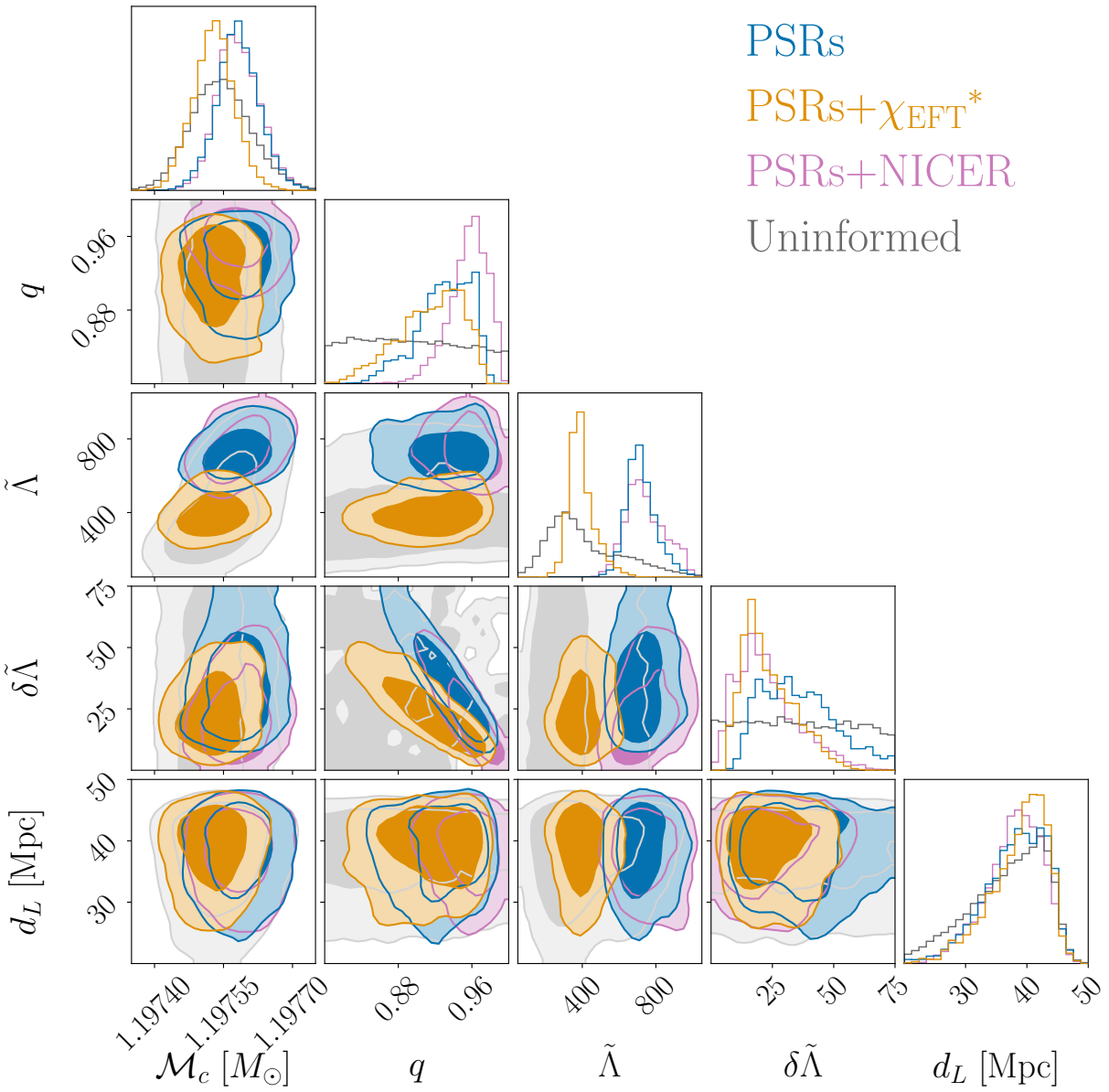
Key idea


Source
Population
EOS
BNS
NSBH
Uniform
Gaussian
Double Gaussian
Prob. density
Mass $[M_\odot]$
PSRs
PSRs+$\chi_{\rm EFT}$
PSRs+NICER
Λ
$p_{\rm NF}\left(m_1^{\rm src}, m_2^{\rm src}, \Lambda_1, \Lambda_2 | \mathcal{H}\right)$

Example prior



GW170817 posteriors with EOS informed priors



Closing thoughts

- **Neural priors**: encode non-trivial prior information (including uncertainties)
- Implemented in BILBY, but works with any stochastic sampler
  - Appealing for GPU-based samplers (FLOWMC, BLACKJAX)
- Bayesian source classification:
  - GW170817: BNS with soft EOS
  - GW230529: NSBH favored over BNS
- ML for 'informed' sampling (cf. Michael Williams's talk)
- Code is open source
  - ThibeauWouters/neural-priors
  - ThibeauWouters/bilby/tree/neural_prior_bilby_pipe


Thanks for listening!