Extreme Matter in Extreme Stars 2024: Contributions from Utrecht University

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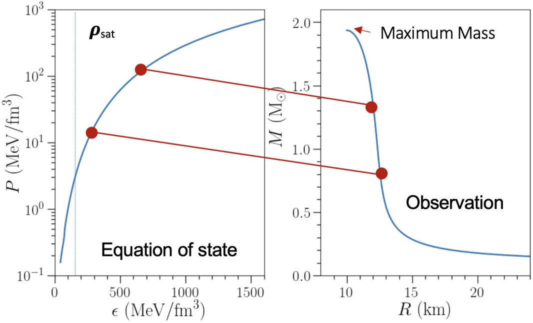
23 – 27 September 2024

Gravitational waves from binary neutron star

The EOS predicts the relation between mass M and radius R or tidal deformability Λ of neutron stars.

We can infer the tidal deformability of neutron stars from gravitational wave signals emitted by binary neutron star mergers.

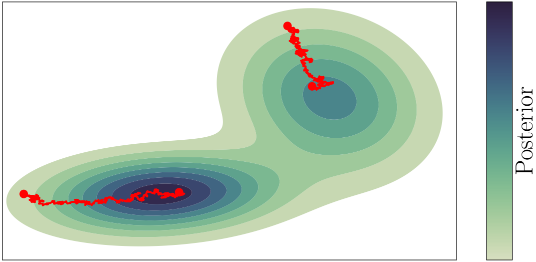


Parameter estimation of neutron star properties

Bayesian inference: get posterior of GW parameters θ (13 to 17 parameters) from gravitational wave data d:

$$p(\theta|d) = \frac{p(d|\theta)p(\theta)}{p(d)} = \frac{\text{likelihood} \times \text{prior}}{\text{evidence}}$$

Problem: Computationally expensive: $\sim 1-2$ months on a single CPU core for binary neutron star signal



Accelerating Bayesian inference with machine learning

- Accelerate the Bayesian inference with (i) JAX and (ii) normalizing flows (machine learning)
- Result: $\sim$ 30 minutes on a single GPU
- Enable large-scale simulations on EOS constraints from gravitational waves
- Ongoing effort: extend to next-generation gravitational wave detectors