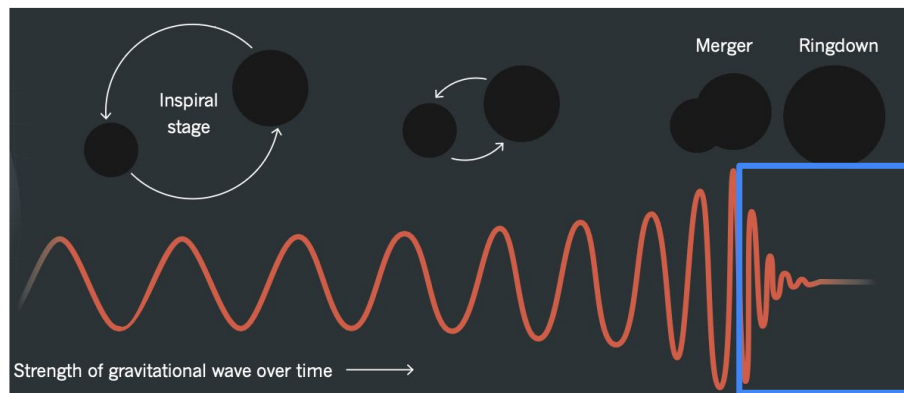# Ringdown analysis with SBI and secondary mode marginalization

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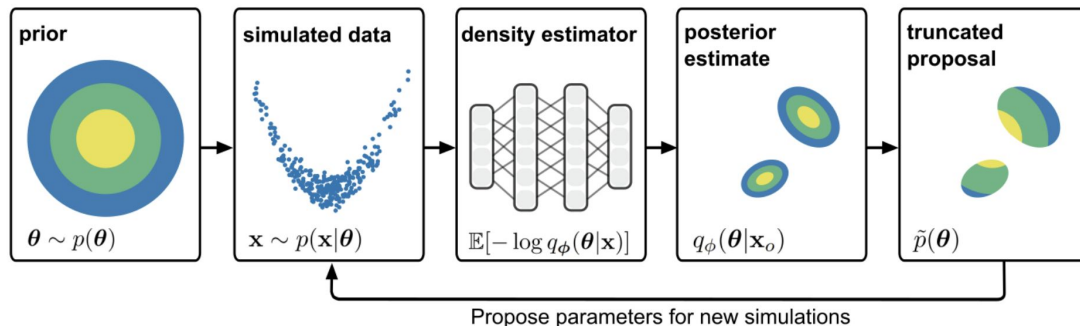
Motivation

Strength of gravitational wave over time →

Ringdown: superposition of damped sinusoids: quasi-normal modes (ℓ, m, n)

Subdominant modes often neglected assuming Gaussian noise

- **Simulation-Based Inference** → fast, flexible framework for analysis

- Our approach: Truncated Sequential NPE

prior	simulated data	density estimator	posterior estimate	truncated proposal
$\theta \sim p(\theta)$	$\mathbf{x} \sim p(\mathbf{x}|\theta)$	$\mathbb{E}[-\log q_\phi(\theta|\mathbf{x})]$	$q_\phi(\theta|\mathbf{x}_o)$	$\tilde{p}(\theta)$

Propose parameters for new simulations

Setup

- Injected data
    - **Real**: ringdown of GW150914
    - **Simulated**: GW150914-like, SNR = 15

- Inferred parameters: $\{M_f, \chi_f, \mathcal{A}_{\ell mn}, \phi_{\ell mn}\}$

- *Marginalization* at simulation time
  Inclusion of <u>unrecovered</u> subdominant modes during training

  # total parameters = # inferred + # marginalized

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