4th Einstein Telescope Annual Meeting

Contribution ID: **4** Type: **talk**

Fast and accurate parameter estimation of high-redshift sources with the Einstein Telescope

Wednesday 12 November 2025 14:17 (17 minutes)

The Einstein Telescope (ET), along with other next-generation gravitational wave (GW) detectors, will be a key instrument for detecting GWs in the coming decades. However, analyzing the data and estimating source parameters will be challenging, especially given the large number of expected detections –of order 10^5 per year –which makes current methods based on stochastic sampling impractical. In this work, we use Dingo-IS to perform Neural Posterior Estimation (NPE) of high-redshift events detectable with ET. NPE is a likelihood-free inference technique that leverages normalizing flows to approximate posterior distributions. After training, inference is fast, requiring only a few minutes per source, and accurate, as corrected through importance sampling and validated against standard Bayesian inference methods. To confirm previous findings on the ability to estimate parameters for high-redshift sources with ET, we compare NPE results with predictions from the Fisher information matrix (FIM) approximation. We find that NPE correctly recovers the eight degenerate sky modes induced by the triangular detector geometry, which are missed by the FIM analysis, resulting in an underestimation of sky localization uncertainties for most sources. FIM also overestimates the uncertainty in luminosity distance by a factor of ~ 3 on average when the injected luminosity distance is $d_{\mathrm{L}}^{\mathrm{inj}} > 10^5$ Mpc, further confirming that ET will be particularly well suited for studying the early Universe.

Author: SANTOLIQUIDO, Filippo

Co-authors: TISSINO, Jacopo; HARMS, Jan; ARCA SEDDA, Manuel; BRANCHESI, Marica; GREEN, Stephen; DUPLETSA, Ulyana (GSSI)

Presenter: SANTOLIQUIDO, Filippo

Session Classification: Observational Science (OSB)

Track Classification: OSB: Div10