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Null Stream Based Glitch Mitigation for Gravitational Wave Parameter Estimation

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Gravitational wave (GW) detectors routinely encounter transient noise bursts, known as glitches, which are caused by either instrumental or environmental factors. Due to their high occurrence rate, glitches can overlap with GW signals, as in the notable case of GW170817, the first detection of a binary neutron star merger. Accurate reconstruction and subtraction of these glitches is a challenging problem that must be addressed to ensure that scientific conclusions drawn from the data are reliable. This problem will exacerbate with third-generation detectors like Einstein Telescope (ET) due to their higher detection rates of GWs and the longer duration of signals within the sensitivity band of the detectors. Robust glitch mitigation algorithms are, therefore, crucial for maximizing the scientific output of next-generation GW detectors. For the first time, we demonstrate how the null stream inherent in ET's unique triangular configuration can be leveraged by state-of-the-art glitch mitigation methodology to essentially undo the effect of glitches for the purpose of estimating the parameters of the source. The null stream based approach enables mitigation and subtraction of glitches that occur arbitrarily close to the peak of the signal without any significant effect on the quality of parameter measurements, and achieves an order of magnitude computational speed-up compared to when the null stream is not available. By contrast, without the null stream, significant biases can occur in the glitch reconstruction, which deteriorate the quality of subsequent measurements of the source parameters. This demonstrates a clear edge which the null stream can offer for precision GW science in the ET era.

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