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Inexpensive Inference of Missing Physics in Gravitational Wave Sources

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The upcoming LISA observatory will measure parameters of sources like EMRIs with exquisite precision, providing a unique avenue to test General Relativity (GR) and the matter-rich environment in galactic centers. Such "beyond-vacuum-GR" effects modify the inspiral, and if neglected from the analysis, can significantly bias ($\geq 10\sigma$) parameter recovery as shown by previous studies. Yet, the rich landscape of proposed beyond-vacuum-GR effects modifying the "null" vacuum-GR hypothesis makes inference through conventional methods like Markov Chain Monte Carlo (MCMC) practically infeasible. We propose bias-corrected importance sampling, a generic inference framework for nested hypotheses, making it particularly suitable for the inference and test of beyond-vacuum-GR effects in GW signals. I will discuss the effectiveness of the technique for EMRIs and compare it against MCMC. Finally, in the context of the proposed LISA global-fit pipeline, I will motivate why such methods may be necessary for feasible and systematic inference of beyond-vacuum-GR effects.

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