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Before real data: pressing graph neural networks to do field-level simulation-based inference with galaxies

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Field level likelihood-free inference is one of the brand new methods to extract cosmological information, over passing inferences of the usual and time-demanding traditional methods. In this work we train different machine learning models, without any cut on scale, considering a sequence of distinct selections on galaxy catalogs from the CAMELS suite in order to recover the main challenges of real data observations. We consider mask effects, peculiar velocity uncertainties, and galaxy selection effects. Also, we are able to show that we obtain a robust model across different sub-grid physical models such as Astrid, SIMBA, IllustrisTNG, Magneticum, and SWIFT-EAGLE using only galaxy phase-space information (3D positions and 1D velocity). Moreover, we are able to show that the model can still track the matter content of the simulations keeping only the 2D positions and 1D velocity. The main purpose is to provide a proof of concept that graph neural networks, together with moment neural networks, can be used as a useful and powerful machinery to constrain cosmology for the next generation of surveys.

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