

Z115r Differentiable modeling of the Universe in the age of machine learning

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Rapid advances in machine learning have brought not only myriad powerful neural network models, but also breakthroughs that can potentially benefit established scientific research. For optimal inference of physical information from cosmological surveys, we need fast and differentiable forward model of the Universe. Using the adjoint method, we've developed a memory and computation efficient differentiable simulation framework on GPUs, upon which we are adding various cosmological probes. One most important probe is gravitational lensing, for which we have developed a novel Hamiltonian, post-Born, three-dimensional, on-the-fly ray tracing algorithm. The end goal is a field-level forward model of all probes of the whole observable Universe, with which we can jointly infer physics of interest and/or the initial conditions of the Universe, while marginalizing over others.