Z107a Differentiable cosmological parameter estimation in the era of Stage-IV cosmological surveys

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Modern cosmology is entering a new stage as data-driven science. Since a plethora of data is produced by Stage-IV cosmological surveys, the data analysis to process the raw data into statistics and extract physical information from them becomes more challenging. Therefore, computational efficiency while keeping high accuracy is crucial for analysing deep and wide observational data. Moreover, in Markov chain Monte-Carlo (MCMC) analysis for cosmological parameter estimation, a wide variety of theoretical templates are adopted to estimate possible systematic effects due to the model selection. As a result, MCMC analysis must be iterated with tens of models.

In light of this situation, differentiable programming emerges as a powerful tool to accelerate the entire data analysis pipeline. In this talk, I will provide an overview of the differentiable approach used in cosmological parameter estimation analysis with large-scale structure measurements, e.g., weak lensing. To illustrate the power of a differentiable pipeline, I focus on the differentiable analysis for the joint analysis of weak lensing and cosmic microwave background. The pipeline benefits from `jax` library with automatic differentiation and just-in-time compilation to make use of Hamiltonian Monte-Carlo sampling, which explores the parameter space more efficiently with the help of gradient information. In addition, the emulator approach with automatic differentiation is also utilised to interpolate cosmological statistics from precomputed data accurately.