

Embedding Neural Networks in ODEs to Learn Linear Cosmological Physics

CCA/IAP Debate 2

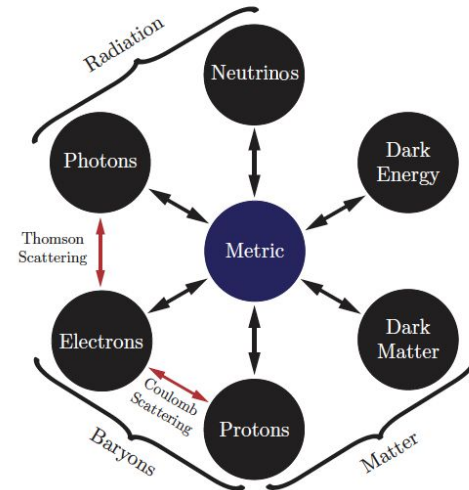
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E-B Solver - the Cornerstone of Cosmology

LSS and the CMB models evolve perturbations described by GR and the Boltzmann eqn. (Einstein-Boltzmann system)

Accurate modeling requires solving this (stiff) ODE system

How can we “discover” the presence of new linear physics?



A new workflow for linear cosmology?

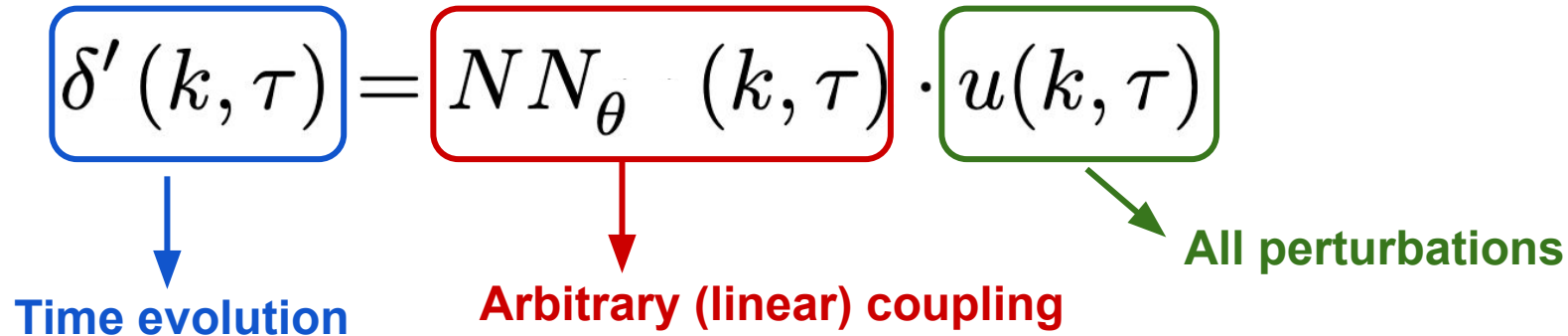
Unknown physics parameterized by NN!

Background has been explored, but now perturbations!

Embed NN *inside* ODE function:

$$\delta'(k, \tau) = NN_{\theta}(k, \tau) \cdot u(k, \tau)$$

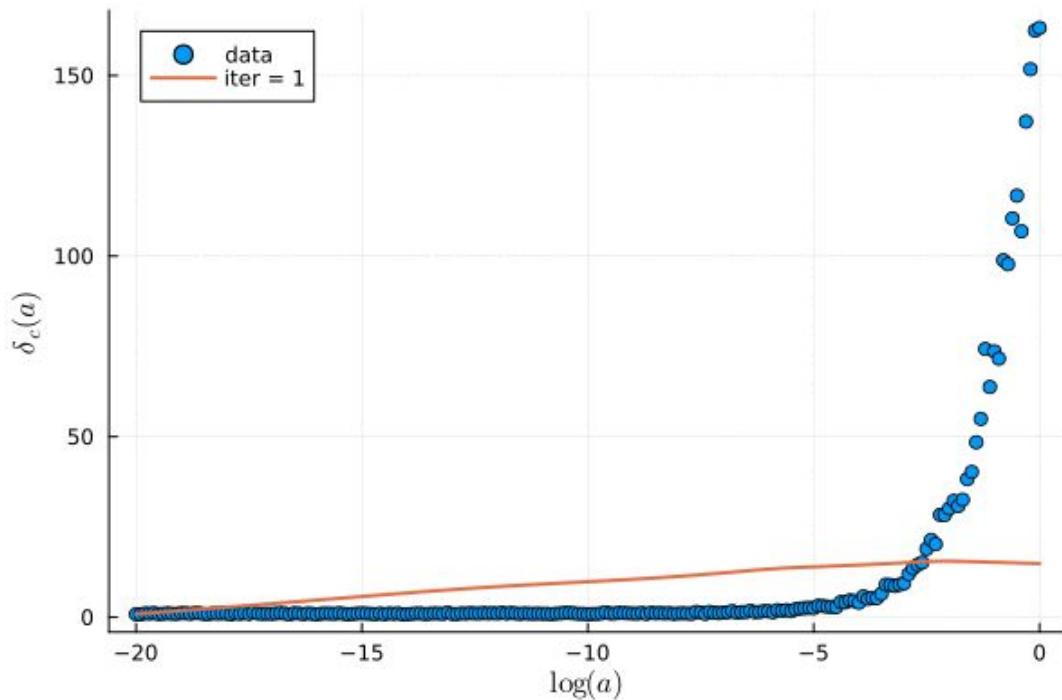
Time evolution **Arbitrary (linear) coupling** **All perturbations**



As flexible as you desire, but with rigid guardrails!

A new workflow for linear cosmology?

Pretend we “forgot” CDM linear theory - can it be learned?



Yes!*

Current work - NN Uncertainty!

Do not know **where** to focus model-building efforts

Workflow goal is to guide **human** model building

With **NN uncertainty**, can do this for specific dataset!