CLASS

Cosmological Linear Anisotropy Solving System

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Visit `https://lesgourg.github.io/class_public/class.html` for more info!

What to expect in this first lecture:

•	Basics:	Why use class?
•	Usage:	Installation
•	Usage:	Python Interface
•	Usage:	Samplers
•	Basics:	Existing Species
•	Basics:	Module Overview

We will learn how to use class and which models can be run with it.

What is an Einstein-Boltzmann solver?

Often just called a *Boltzmann code* for brevity, a typical Boltzmann code will:

- Solve coupled Einstein and Boltzmann equations.
- Generally work at linear level in perturbation theory.
- Compute global (Background+Themodynamic) quantities *and* perturbations.

$$\underbrace{G_{\mu\nu} = 8\pi T_{\mu\nu}}_{\text{Einstein-equation}} \qquad \underbrace{\frac{\mathrm{d}f}{\mathrm{d}\lambda} = C[f]}_{\text{Boltzmann-equation}} \tag{1}$$

Why use a Boltzmann code?

Modern Boltzmann codes offer:

- History of the universe at the global level ($H(z)$, $\rho_i(z)$, etc.)
- Thermal history of the universe ($T_b(z)$, x_e, τ, etc.)
- Evolution of (linear) perturbations (δ_i, θ_i, ψ, ϕ, etc.)
- Fourier space transfer functions ($T(k)$)
- CMB spectra, both lensed and unlensed (C_ℓ^{TT},C_ℓ^{TE},C_ℓ^{EE},C_ℓ^{BB})
- Linear matter power spectrum, galaxy counts, cosmic shear ($\xi^\pm$,C_ℓ^{dd},$P_{\rm lin}(k)$)
- Emulated non-linear power spectra
- CMB spectral distortions

All computed in a matter of seconds!

Why use a Boltzmann code?

This has several use cases:

- Analysis of CMB experiments
- Analysis of LSS experiments
- Initial conditions for non-linear simulations (N-body, etc.)
- Consistent treatment of background/thermodynamic evolution

All easy to to with `class`!

Fast execution $\Rightarrow$ ideal for use in an MCMC pipeline.