CLASS + SONG Workshop, CCA, New York, 15-16.07.2019

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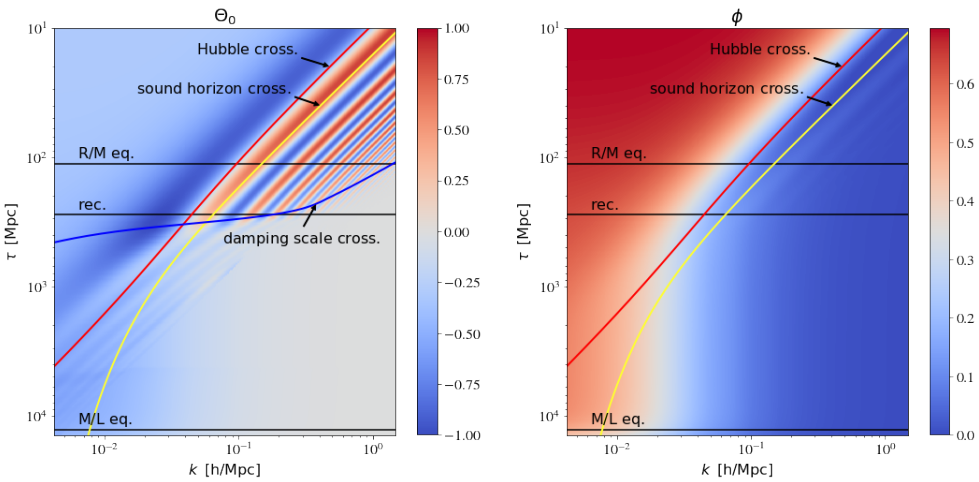
Purposes

For the communities working on theoretical and observational cosmology, especially on the CMB and Large Scale Structures, Einstein-Bolztmann solvers are essential tools. However due to their complexity, they can be slightly intimidating – especially when it comes to the most interesting tasks of modifying them, implementing new physics, adding new observables, or including effects at second order in perturbation theory.

CLASS [1] (by J. Lesgourgues & T. Tram) is one of the best known public Einstein-Bolztmann solvers used worldwide. It is meant to be friendly and flexible enough for serving as a starting point to any kind of extension and modification. It is written in plain C, and wrapped with C++ and python. It has been thoroughly tested since its release in 2011, and it is still undergoing significant developments in the directions of new physics, more modern algorithms and new applications. The public code SONG[2] (by Fidler & Pettinari) is the extension of CLASS to the (considerably richer) level of second-order perturbation theory. Despite of existing on-line material (courses, documentation, exercises), reaching the level of advanced user or developer for these codes remains a significant investment of time. The goal of this workshop is to provide a solid introduction that will speed up the mastering of the codes by the participants.



[1] `class-code.net`
[2] `github.com/coccoinomane/song`

Content

We will propose two theory lectures, seven applied lectures and three exercise sessions, each of one hour (see the detailed schedule on the next page).

On the theory side, even if the theory of linear cosmological perturbations is well-known, some non-trivial aspects are required in order to become confident with the implementation of new physics in CLASS. Second-order effects beyond the famous CMB lensing contribution are much less known and will be introduced at the end of the first day.

On the applied side, we will describe the input and output of CLASS, and show how to manipulate them from the terminal, or even better, directly from a python script or a jupyter notebook. We will provide the most crucial information on the style, structure and syntax of the code without which CLASS cannot be easily understood and modified. We will comment on the latest CLASS developments (to be released slightly before and/or after the course), related to the implementation of advanced thermal histories, interacting DM, spectral distortions, and methods beyond line-of-sight integrals. Finally, a concise presentation of SONG will show how to compute second-order effects in the CMB spectrum and bispectrum on a powerful computer.

We will tutor three exercise sessions to train the participants not just for the basic use of the two codes, but also for modifying CLASS. Not all of the proposed exercises will be doable within three hours, but we will provide help and support even after the workshop for finishing the exercises. We will be ready to send the full solutions on request.

Prerequisites

The workshop is open to any cosmologists, from the master level to the senior researcher level. The only prerequisites to the course are a basic knowledge of the standard cosmological model and of the C and python programming languages. We are aware that participants may have very different levels in cosmology and coding, and we will take this into account in the lectures and during the tutoring. For a fruitful and efficient workshop we aim at gathering motivated and interactive participants, who will install the codes on their laptops or remote desktops before the first day of the workshop, ask questions, and do their best to solve the exercises during the dedicated sessions. Detailed instructions on the code installation are available online, but we will also circulate instructions to the participants before the workshop. It is expected that each participant brings their own laptop to follow the lectures and do the exercises.

Venue

This workshop is sponsored by the Simons Foundation and hosted by the Center for Computational Astrophysics (CCA), 162 5th Ave., New York. There are no registration fees. CCA will offer breakfast, lunch, dinner on Monday and coffee breaks to all registered participants.

The workshop has been planned together with Yacine Ali-Haïmoud (NYU) and David Spergel (CCA). The local host will be Francisco Villaescusa (CCA).

Registration

If you are interested, register by filling this RSVP **before Friday 24.05 midnight**. For those who cannot come, CCA will set up a live stream and recording of the event.

Schedule

Monday 15^{th} July

Breakfast for workshop participants at 8:30

9:00 - 10:00	**CLASS Basics:**
	Coding spirit and general rules
	short break with coffee
10:15 - 11:15	**CLASS Usage I:**
	From interactive runs to python notebooks
	short break
11:30 - 12:30	**CLASS Theory:**
	Less trivial aspects of the implemented linear perturbation theory
	Lunch at CCA
14:00-15:00	**CLASS Usage II:**
	Exploring the code's possibilities through python notebooks
	short break with coffee
15:15-16:15	**CLASS Exercises I:**
	Extracting and plotting various quantities
	short break
16:30-17:30	**SONG Theory:**
	Second order perturbation theory and its signatures in the CMB

Workshop dinner at CCA

Tuesday 16^{th} July

Breakfast for workshop participants at 8:30

9:00 - 10:00	**CLASS Coding I:**
	Essential rules and conventions specific to the code
	short break with coffee
10:15 - 11:15	**CLASS Coding II:**
	How to implement new physics and new ingredients
	short break
11:30 - 12:30	**CLASS Exercises II:**
	Modifying the code
	Lunch at CCA
14:00-15:00	**SONG Usage:**
	Concept and structure of SONG
	short break with coffee
15:15-16:15	**SONG Exercises:**
	Calculating second-order perturbations
	short break
16:30-17:30	**CLASS News:**
	Most recent and on-going developments (advanced thermal histories, interacting DM, spectral distortions, beyond line-of-sight integrals...)