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Keywords

Cosmology, particle physics, dark matter, numerical methods

Research topic & background

In the Early Universe particles in the primordial plasma interact with each other leading to various important consequences, e.g. dark matter production or creation of the baryon-antibaryon asymmetry. These interactions occur out of equilibrium and need to be described taking into account all the relevant particle's distributions. This leads to significant computational difficulty, due to a necessity of solving partial integro-differential Boltzmann equations.

A lot has been accomplished in recent years in tackling this problem, including development of a numerical code called DRAKE (drake.hepforge.org) that focuses on evolution of the dark matter's distribution function during its production and evolution in the Early Universe. The proposed project aims at contribution to its development by improving on one of its parts.

Scope of the project

After the prospective contributor would be introduced to the basics of the topic and the existing code, he/she would focus on improving the implementation of the differential equation solver, by adopting one or more of the following: tune up existing numerical integration routines, introduce parallelization, add a non-uniform and/or dynamical grid in the method of lines, or add routines for error estimates.

The level of involvement and thus the scope would depend on the prospective contributor's time, experience and interest: ranging from a very limited involvement (few lines of code to be written and tested) to a more extensive one if someone develops interest in the project.

Impact of the project

Improvement on efficiency and error estimate of the DRAKE code - a tool that is envisioned to become one of the standard programs used in the state-of-the-art theoretical research of dark matter.

Who is it for?

Someone with interest in numerical methods. No experience is strictly speaking needed, but some exposure (e.g. introductory courses) would be useful. No physics knowledge beyond high school is required.

Perks include

- Acknowledgment in paper, website & source code
- Visit to NCBJ [funding for the stay is envisioned, may include also travel costs]
- Reference letter
- For students: passing of a practicum (if needed)