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A GPU-accelerated and Python-wrapped update of the C2Ray radiative transfer code for Cosmic Reionization Simulations

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The cosmic epoch of reionization (EoR) is studied using Radiative Transfer (RT) codes that simulate the radiative feedback from primordial galaxies and stars in the early Universe. This includes the simulation of the evolution of the neutral hydrogen fraction and thermal properties of the intergalactic medium (IGM) due to the computed ionizing and heating radiation. These simulations constitute the ground-basis experiment for the upcoming Square Kilometre Array (SKA) radio telescope. Ideally, they require huge volumes (~ 1 Gpc size) and a large number of sources to reproduce the relevant cosmological scale. Therefore, RT and heating simulations require considerable computational power.

We propose to upgrade the C^2Ray code, widely used for EoR simulations. This code was written in Fortran90 in the late 90s (then updated over the years) and is CPU-parallelized using OpenMP and MPI. It uses short-characteristics raytracing to compute the propagation of UV radiation from primordial sources into the IGM and solves the differential equations that keep track of the neutral hydrogen fraction and thermal properties of the gas. The first part of the update consists in building a python interface to C^2Ray by wrapping its core subroutines as a fast compiled module. This could make its usage more flexible and allow some of its components to be used individually in other projects. The second part consists in upgrading the raytracing algorithm (which represents the dominant computational cost of the code) to make it GPU-parallelizable. The end goal is to achieve a significant reduction of the computation time required for EoR simulations.

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