Reionization, small-scale structures and radiative feedback

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Abstract

Simulations of the early structure formation and the Epoch of Reionization have now reached sufficient volume, dynamic range and resolution to make reliable predictions of the fundamental features and observable signatures of these epochs at the full range of relevant scales. I will summarise important recent progress we have made in this area, including performing a series of simulations of early structure formation on all scales from the tiny cosmological minihaloes hosting the very first stars up to very large volumes of hundreds of Mpc, with up $6912^3 = 330$ billion particles, largest by far simulations of this epoch. We have derived a precise high-z halo mass function and scale-dependent halo clustering, directly useful for modelling the LOFAR and SKA sky. These structure formation simulations were used as basis for performing state-of-the-art radiative transfer simulations in volumes of up to $(714Mpc)^3$, comparable to the full volume of the LOFAR EoR experiment, but including all atomically-cooling ionizing sources. I will discuss the best observational signatures, from point of view of the simulations, for using EoR radio observations to understand the nature of the ionizing sources. I will also present the first results from a suite of extremely high resolution, massively parallel radiative hydrodynamics simulations of the reionization with grids up to 4096^3, which were ran on up to 132,000 computing cores and 8,192 GPUs. Our simulations resolve and follow in detail the feedback effects of all star forming objects from the minihaloes hosting the first stars onwards. This allows us to address questions like what was the nature of the first sources, what is the post-reionization abundance and spatial distribution of satellite galaxies and globular clusters, how much such objects contributed to reionization and how radiative feedback influenced later galaxy formation and the intergalactic medium.