Topology of the Epoch of Reionisation within numerical simulations

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Résumé

During the Epoch of Reionisation (EoR), the large scale structures of the Universe emerge while ionising the intergalactic gas. It creates bubbles of ionised gas around the first galaxies. These bubbles percolate near the end of the EoR, at a redshift of approximately 6. In the next decades, the EoR will be directly observed for the first time with radio-telescopes, like the Square Kilometer Array. Thanks to the 21 cm emission of the neutral hydrogen gas, we will have access to 2D images of the distribution of neutral gas during the whole reionisation process.
In the meantime, I will present an approach that allows me to study the evolution of the EoR within reionisation time maps from models of numerical simulations (Thélie et al. 2022, Thélie et al. submitted, arXiv:2209.11608). I use EMMA cosmological simulations (Aubert+15) and 21cmFAST semi- analytical ones (Mesinger+11) of the EoR with a 1 Mpc/h resolution. Thanks to topological measurements on the reionisation times, I can extract information about the evolving process of reionisation: reionisation history with its filling factor, ionisation front velocity with its gradients, ionised/neutral bubbles size evolution with its isocontours length, reionisation seeds count with the critical points probability distribution function, and fronts percolation with the skeleton length.
In Thélie et al. 2022, I studied the spatial configuration of reionisation patches and show that reionisation fronts predominantly propagate along the density filaments in our simulations. In Thelie et al. submitted (arXiv:2209.11608), the reionisation time field is proven to be rather close to a gaussian random field when its resolution is closed to that of the upcoming 21 cm images of the SKA radio-telescope. I will present a summary of these first results and discuss future applications for this new framework to study reionisation.

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