Cosmic Dawn III: the latest and largest radiation-hydrodynamical simulation of the Epoch of Reionization

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Abstract

Cosmic Dawn III (CoDa III) is a new, fully-coupled radiation-hydrodynamics simulation of cosmic reionization and galaxy formation and their mutual impact, to redshift z < 5. CoDaIII was completed in January 2021 on Summit (Oak Ridge Leadership Computing Facility), and features an improved resolution in mass, 8 times higher compared to our previous iteration CoDa II. With 8192ˆ3 particles and cells in a (94 Mpc)ˆ3 box, it is large enough to model global reionization and its feedback on galaxy formation while resolving all haloes above 2.10ˆ7 Msun. To accomplish this massive numerical enterprise, CoDa III uses the hybrid CPU-GPU code RAMSES-CUDATON (Ocvirk et al. 2016, 2020), deployed on 24576 GPUs and 131072 CPUS, making it the largest simulation of the Epoch of Reionization ever performed, with about 20 PetaBytes of data produced, as well as the most massively parallel setup ever achieved with RAMSES. CoDa III modified and re-calibrated the subgrid star-formation algorithm with respect to our previous simulation CoDa II, making reionization end slightly later, at z _˜ 5.5, dramatically improving the agreement with the observations of intergalactic Lyman-alpha forest in quasar spectra, in both opacity and ionizing rate evolution, while conserving the good match already obtained with electron-scattering optical depth from cosmic microwave background fluctuations. I will show how this improved agreement came to be by examining the respective properties of the intergalactic medium and the galaxy population in the simulation. I will try to reserve a significant part of the talk to present the issues and pitfalls we've had to navigate/solve due to the enormous size of the simulation in number of particles and cells as well as proc number.

*Speaker