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Visualization of Astrophysical Simulations on Programmable Graphics Hardware"

In numerical astrophysics and cosmology typically many length scales must be considered to accurately model the physical phenomena. For instance star formation, where the regions of proto-galaxies as well as the local environment of the stellar objects need to be resolved at the same time. A specific adaptive numerical technique that allows to cover a large range of spatial and temporal scales is called AMR (Adaptive Mesh Refinement). The basic idea is to recursively overlay regions of a coarse initial structured grid with patches of increasing resolution, making optimal use of the computational resources. Therefore this technique is often used in astrophysical simulations. We will present our interactive visualization pipeline for rendering large, three-dimensional time-dependent astrophysical AMR data sets with interactive frame-rates on standard desktop computers. The approach exploits modern graphics hardware to process hundreds of screen pixels in parallel via programmable pixels shaders. It supports to integrate unstructured point datasets, like stars and/or galaxy splats into the rendering of gaseous interstellar, respectively intergalactic material. The approach further supports a combined color-mapping for several input data fields and allows for a very flexible adaption to the special requirements of different types of simulations. Its interactivity makes it an useful tool for data analysis as well as for fast generation of high-quality animations from astrophysical datasets.
We will show various resulting 3D HD-animations ranging from large scale structure formation in the early universe, to the evolution of the first stellar objects and the cosmological reionization era.