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Cosmological Radiative Transfer + Hydro + N-body Simulation of Galaxy Formation and the Intergalactic Medium: The Radiation-Hydro Frontier

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Galaxy and star formation are two of the most important unsolved problems in modern astrophysics. Theoretical models are relying more and more on complex computer simulations, aiming at reproducing the complex properties of non-linear gravitational and gas dynamics. It has been known for a long time that radiation processes are also playing an important role in building stars and shaping galaxies. It is only recently however that radiation hydrodynamics has been introduced in the theory of star and galaxy formation, as a possible way to solve the long-standing issue of stellar feedback, and its effects on regulating star formation in giant galaxies. On larger scale, radiation hydrodynamics has also to be considered to model cosmic re-ionization, the next frontier in observational cosmology. I will describe recent advances in modelling radiation hydrodynamics effects in the context of cosmology and galaxy formation simulations, and outline some of the numerical and algorithmic challenges we have to face to prepare the future.