Simulations of early structure formation: the properties of halos hosting primordial star formation

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ABSTRACT:

Pop III stars are the first stars that form in the Universe, out of gas of pristine composition. Their intense radiation ionises their environments, and their explosions releases the first heavy elements in the Universe. This sets the initial conditions for the formation of the next generations of stars and the first galaxies. While the properties of the present day stars are well-established by observations and increasingly understood by theory, little is known about the Pop III stars since their observation remains hypothetical. In particular, the mass distribution of the first stars is currently highly debated. In the early 2000s, with the apparition of the first 3D simulations, it was thought that the Pop III stars were all massive and short-lived. It has been recently shown that both accurate primordial cooling modelling greatly impact the fragmentation of primordial gas clouds and possibly allows low-mass Pop III to form which could be still observable today.

We take over these pioneering studies, using an updated chemical network for primordial chemistry. We merge RAMSES with the code KROME to solve the chemical kinetic of the pristine gas coupled to the hydrodynamics. We run cosmological simulations starting at high redshift with a sub-pc resolution to identified cold and dense gas clouds that will be the birth sites of the first stars. We study how the chemical abundances of a given halo influences the existence of a clump within it. We thus obtain realistic initial conditions to then study the collapse of isolated massive primordial clouds.