Formation of the -irst stars: chemistry of primordial gas clouds.

Romain Lenoble*[1], Benoit Commerçon*[2], and Rosdahl Joakim*[3]

[1]Centre de Recherche Astrophysique de Lyon – École Normale Supérieure - Lyon, Université Claude Bernard Lyon 1, Université de Lyon, Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique : UMR5574 – France

[2]Centre de Recherche Astrophysique de Lyon (CRAL) – CNRS : UMR5574 – Bureau : site Monod, bâtiment M7, niveau MON$_M 7_R + 1, porte M7124 Tel.$: 04.72.72.89.17Fax : 04.72.72.88.97$Tel.secretariat$: 0472728700, $France$

[3]Centre de Recherche Astrophysique de Lyon (CRAL) – École Normale Supérieure - Lyon, Université Claude Bernard Lyon 1, Institut national des sciences de lÚnivers, Centre National de la Recherche Scientifique : UMR5574, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers

sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers – 9 Avenue Charles André 69561 ST GENIS LAVAL CEDEX, France

Résumé

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 (Pop II) 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 (1). 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 (2).

We take over these pioneering studies, using an updated chemical network for primordial chemistry, based on theoretical chemistry works, needed to accurately estimate the cooling by H2 and hydrogen deuteride HD (3). We use the KROME (4) code to solve the chemical kinetic of the pristine gas with this new network coupled to the 3D radiation-magneto-hydrodynamics (RMHD) code RAMSES (5). First, 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 both for the kinetics of the gas and for its chemical composition to then study the collapse of isolated massive primordial clouds.

Références

(1) Abel et al. 2002
(2) Bovino & Galli et al. 2020
(3) Galli & Palla 2013, Bossion et al. 2018
(4) Grassi et al. 2014(5) Teyssier 2002

*Intervenant