Conference Poster

Revised primordial chemistry of the early universe

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Revised Primordial Chemistry of the early Universe
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During the dark age (the period between the recombination epoch, \( z \approx 1000 \), and the formation of the first stars at \( z \approx 6 \approx 50 \)), molecules form from neutral and charged atomic species, and open new channels of radiative exchange. Matter cooling and heating in the collapsing first structures is directly dependent on the quantity and nature of these first molecules, in particular \( \text{H}_2 \). We calculate with the best available data the chemical reactions taking place around the dark age, in the average expanding matter as well as in linear density fluctuations [1].

Revised Primordial Chemistry

The standard Big Bang nucleosynthesis model for the Universe produces mainly hydrogen, helium and lithium and their isotopes. Once these primordial nuclei combine in order to form the corresponding atoms, the standard Big Bang chemistry (SBBc) may start. It is the first chemistry of the elements hydrogen, helium, lithium and their respective isotopic forms. We use the thermochemical network developed by [2], [3], [4], and [5], with an extensive improvement in drawing numerical integration errors, and paying attention to the sensitivity of results on the initial conditions. Indeed the coupled chemical and thermal system contains stiff differential equations [1].

Molecular Evolution in Different Cosmological Models

SBBc is relative to a flat Universe with \( \Omega_M = 0.7 \), \( \Omega_{\Lambda} = 0.0444 \) and \( H_0 = 71 \text{ km s}^{-1} \text{ Mpc}^{-1} \) with a initial helium mass fraction \( X_H = 0.2848 \). \( \text{H}_2 \) and \( \text{HD} \) abundances are relatively insensitive to cosmological parameters (i.e. \( \Omega_M, H_0 \)) making it a poor diagnostic of cosmological models at \( z > 10 \).

Differential Chemistry in fluctuations

Structure formation initiates from the growth of small positive density fluctuations, void formation from small negative density fluctuations. We are currently analyzing in the linear regime the revised differential chemistry for models with different initial density fluctuations \( \delta_i \) and different comoving wavenumber \( k \), allowing us to quantify the differential growth of molecular abundances as function of initial perturbation amplitudes and modes [6]. Overall the sensitivity of abundances is high on density fluctuations already in the linear regime.

References


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