New study helps to understand cosmological lithium problem

November 18 2021, by Zhang Nannan

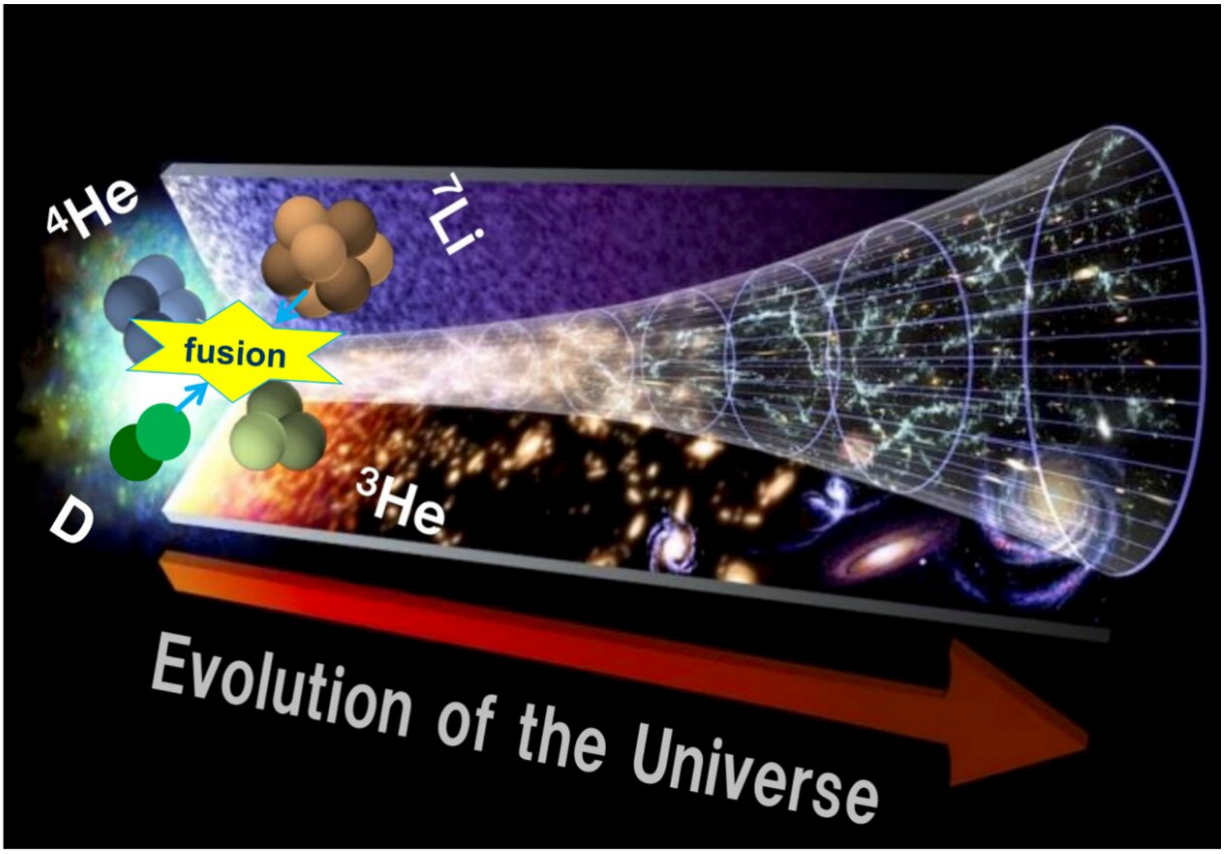

Fig. 1: Artist's representation of the evolution of the universe, with time flowing to the right in the direction of the red arrow.
The ^{7}Li(d,n)2^{4}
He reaction takes place in the process of primordial nucleosynthesis at the very beginning. Credit: Hou Suqing

An international research team has recently updated the $^{7}Li(d,n)2^{4}He$ reaction rate based on latest experimental data, which removes the significant ambiguity in the cosmological lithium (Li) problem from the perspective of nuclear physics.

The big bang is regarded as the most successful model to describe the origination and evolution of the universe currently. However, its success has been limited by the so-called lithium problem, which refers to the fact that primordial lithium-7 abundance is overpredicted by a factor of three in comparison to the value from observation, while predictions match the observed primordial deuterium and helium abundances.

From the perspective of nuclear physics, the accurate reaction rates of lithium destruction reactions are crucial for accurate prediction of the primordial lithium-7 abundance and further understanding of the lithium problem. Nevertheless, as an important lithium-7 destruction reaction, the $^{7}Li(d,n)2^{4}He$ reaction has not been well studied before 2018.

In the latest study published in *The Astrophysical Journal*, the researchers updated the $^{7}Li(d,n)2^{4}He$ reaction rate based on the recent experimental measurements on the three near-threshold beryllium-9 excited states. This work was conducted by an international team led by Hou Suqing at the Institute of Modern Physics of the Chinese Academy of Sciences (CAS).

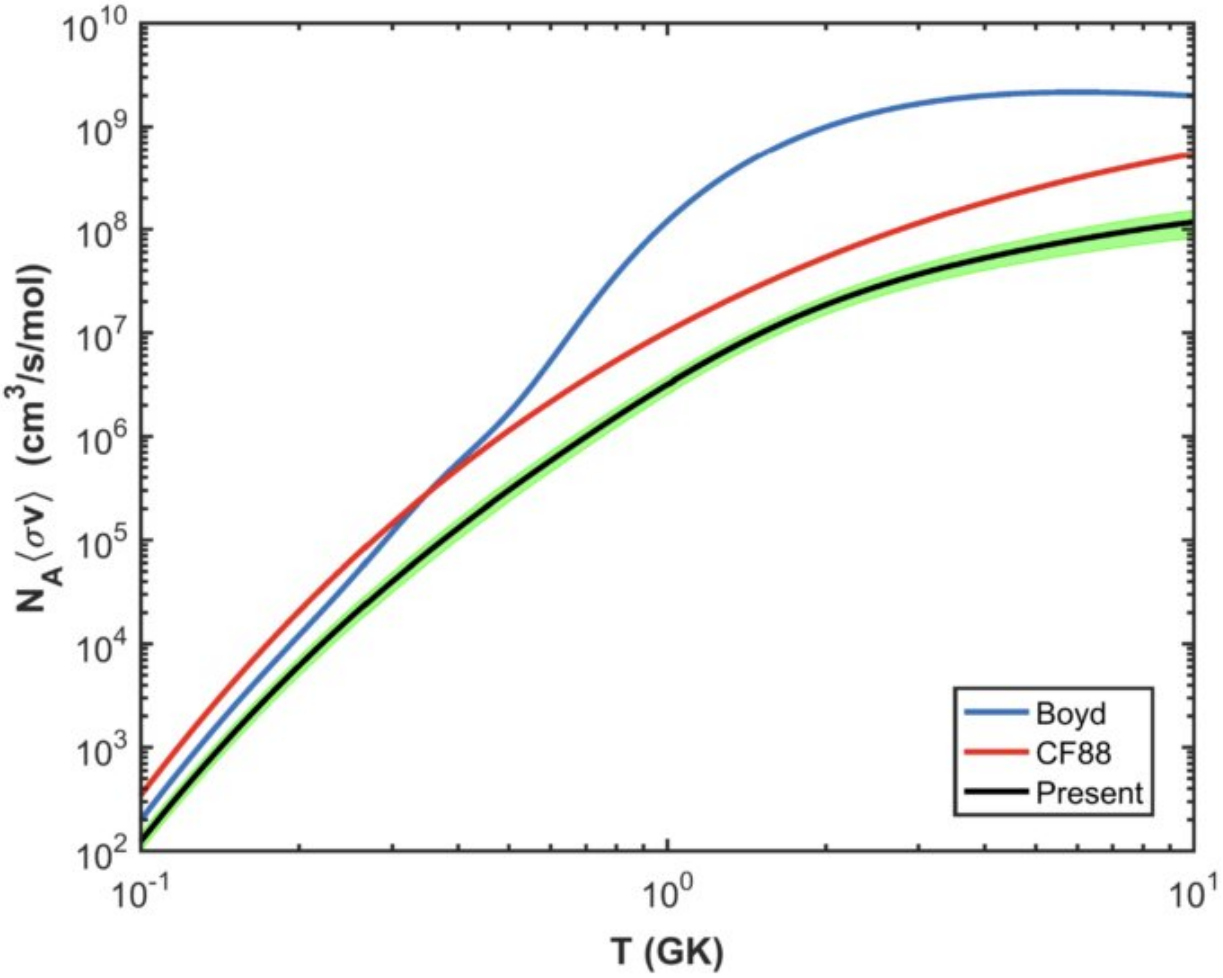

Fig. 2: Total reaction rate of ^{7}Li(d,n)2^{4}He as a function of temperature in units of giga Kelvin where the green shaded band is its associated uncertainties. For comparison, researchers also plot the previous results from CF88 and BM93. Credit: Hou Suqing

In this study, the researchers found that the new ^{7}Li(d,n)2^{4}He rate is overall smaller than the previous estimation by about a factor of 60 at the typical temperature of the onset of primordial nucleosynthesis.

In addition, they presented uncertainties of the ^{7}Li(d,n)2^{4}He reaction rate that are directly constrained by experiments for the first time.

According to the researchers, the new results remove the significant ambiguity in the calculated lithium-7 abundance due to this reaction, which will be useful to understand the primordial lithium problem and probe exotic physics beyond the standard model.

More information: S. Q. Hou et al, New Thermonuclear Rate of 7Li(d,n)24He Relevant to the Cosmological Lithium Problem, *The Astrophysical Journal* (2021). DOI: 10.3847/1538-4357/ac1a11

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