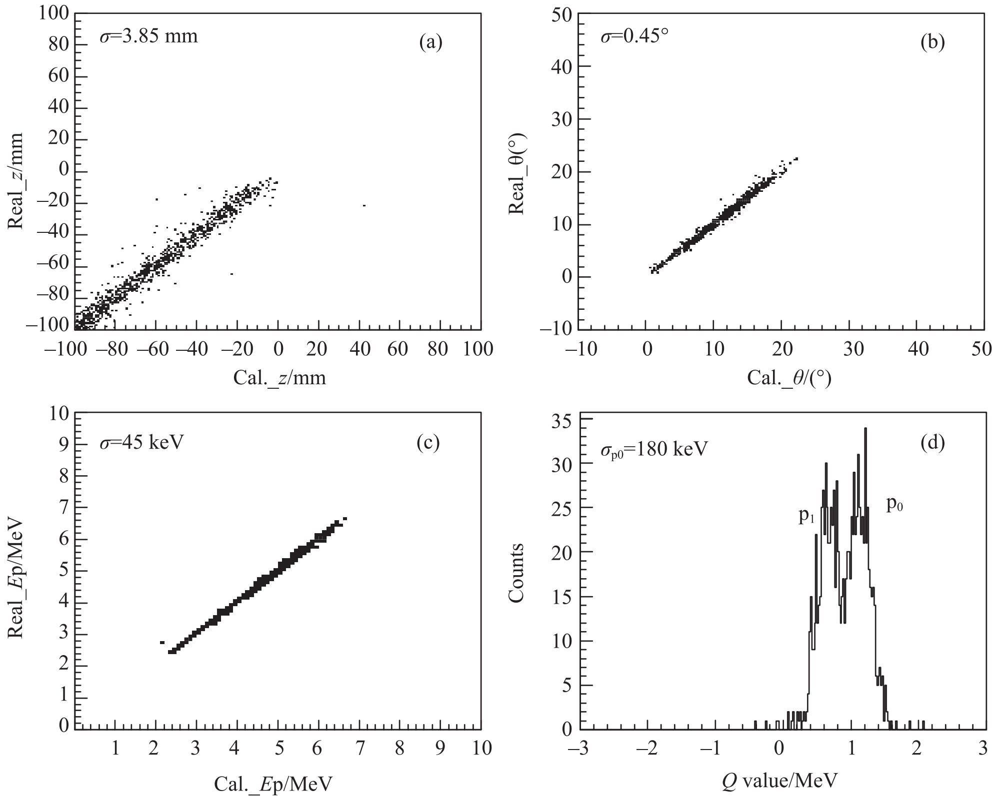

Fig. 1 Geant4 simulation results of the ^{14}O(α,p)^{17}F reaction. The "Real_" represents the values given by Geant4 and the "Cal._" indicates the reconstructed values. (a) reaction position resolution, (b) angular resolution, (c) proton energy resolution, (d) Q value spectrum. The sigma values are indicated in the figures respectively. The p_0 and p_1 peaks in (d) are the protons deexciting to the ground and 1^{st} excited state of ^{17}F.

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2 - 13 New Solution to Cosmological Lithium Problem

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In the Big Bang theory, primordial nucleosynthesis was finished during first half hour of the universe's existence. This process yielded the main light elements including hydrogen, deuterium, helium and lithium. The theoretical predictions match very well the observed deuterium and helium abundance, but the ^{7}Li abundance is overpredicted by a factor a three[1]. This inconsistency is called "cosmological lithium problem". In the past decade, many attempts to solve this problem using conventional astrophysics and nuclear physics failed. Recently, we proposed a new solution to lithium problem by introducing non-extensive statistics into Big Bang nucleosynthesis[2].

It is well known that astrophysical reaction rate is derived by the convolution between the energy dependent reaction cross section and the Maxwell-Boltzmann distribution of the interacting particles[3]. Motivated by non-extensive statistics has been applied in a host of different fields, including physics, astronomy, biology and economics[4]. Here, we use non-extensive distribution to describe particle's velocity distribution in primordial plasma instead of classical Maxwell-Boltzmann distribution. This new distribution is characterized by a parameter q, and reduces to Maxwell-Boltzmann distribution for q=1.

For a typical 1+2→3+4 reaction, tThe formula of reaction rate in non-extensive distribution can be depicted as below[2]:

$$\langle\sigma\nu\rangle_{12}=B_q\sqrt{\frac{8}{\pi\mu_{12}}}\times\frac{1}{(kT)^{3/2}}\times\int_0^{E_{\max}}\sigma_{12}(E)E\left[1-(q-1)\frac{E}{kT}\right]^{\frac{1}{q-1}}\mathrm{d}E.$$

We also derived the non-extensive reverse reaction rate as shown in (2016) Ref. [2]. With these no-extensive rates, we performed nucleosynthesis simulation with a reaction network involving 34 reactions. Here, the thermonuclear (forward and reverse) rates for those 17 principal reactions have been determined in the present work using non-extensive statistics, with 11 reactions of primary importance and 6 of secondary importance[5] in the primordial light-element nucleosynthesis. The calculation results show that lithium problem can be solved while maintaining concordance with D and ^{4}He for parameter q constrained to lie in the range $1.069\leq q\leq 1.082$[2]. (seen in Fig. 1).

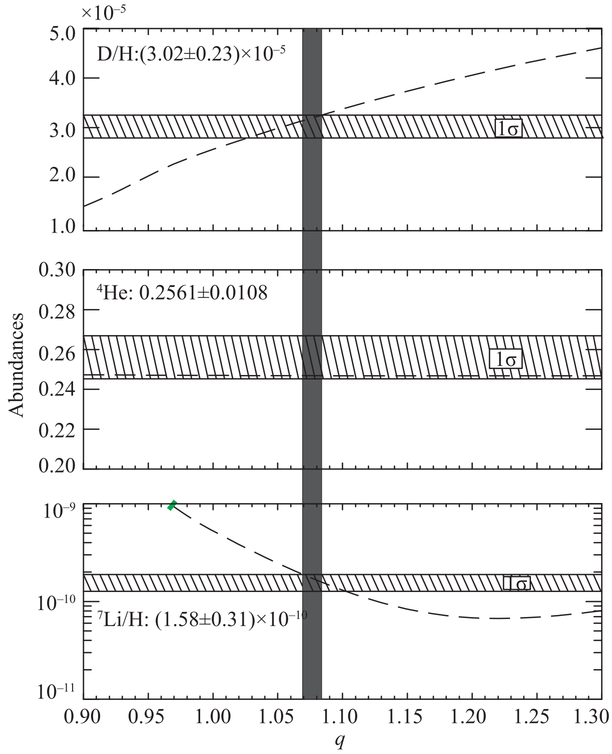

Fig. 1 Predicted primordial abundances as a function of parameter q (in dashed lines). The observed primordial abundances with 1σ uncertainty for D, ^{4}He, and ^{7}Li are indicated as hatched horizontal bands. The vertical band constrains the range of the parameter q to $1.069\leq q\leq 1.082$. Note that the “abundance” of ^{4}He exactly refers to its mass fraction.

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