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Experimental simulation of primordial nucleosynthesis nuclear processes by applying high-powered lasers.

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Recently the research pace in the field of laboratory astrophysics is rather high. Powerful lasers became an important class of experimental setups for laboratory astrophysics. Currently, it became possible to increase the laser pulse energy up to hundreds of joules while reducing the duration to hundreds of femtoseconds, which corresponds to reaching the petawatt power level. By this means the peak intensity at the target surface reaches $10^{22}\ W/cm^2$. When the matter is exposed by multiterawatt laser radiation, plasma occurs with unique parameters –ions energy on the $MeV(10^6 eV)$ level, magnetic field up to gigagauss $(10^9 G)$ and a pressure exceeding a billion of atmospheres. As such lasers were developed physics got a unique tool to study various astrophysical processes through their laboratory simulation.

For the experimental simulation of primordial nucleosynthesis nuclear processes by applying powerful lasers it is necessary to obtained the laser plasma temperature T $(0.4–0.9)\times10^9 K$ and the average energy of the particles $_{particles} = \frac{3}{2}kT$ $(50–110keV)$ and of the photons $_{\gamma}$ $2.7kT$ $(90–210keV)$, that are common for primordial nucleosynthesis conditions.

The results of experimental studies of our laboratory show that in laser-produced plasma with laser intensity of $2\times10^{18} W/cm^2$ it is possible to obtain such characteristics of the plasma. The results on the initiation of nuclear fusion reactions of primordial nucleosynthesis, including $D(d,n)^3He$, $^3He(d,p)^4He$, $^7Li(p,\alpha)^4He$, $^6Li(d,\alpha)^4He$, $^{11}B(p,3\alpha)$ nuclear reactions in laser-produced plasma were obtained.

In our opinion, the study of nuclear reactions in laser plasma which parameters are similar to parameters of primordial nucleosynthesis plasma is the most promising way to study the problems of primordial nucleosynthesis, including the lithium problem.

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