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Optimization of the computation of the multidimensional integrals for estimation of the meson lifetime

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For the analysis and prediction of experimental results in the heavy ion collision experiments the theoretical models describing the behavior of hadrons in hot and dense matter are required. Modern theoretical calculations often require the creation of a serious computer support at the level of creating new algorithms, calculation methods and software packages for solving of large systems of integro-differential equations and multidimensional integrals. In this paper we calculated the lifetime of mesons in hot and dense nuclear matter depending on the temperature, which requires calculation of the 5-dimensional integral with complicated integrand function. For this task was chosen algorithm based on Monte Carlo method of calculating integrals. The code for calculating the integral was written using the Tina's Random Number Generator, the analysis of the dependence of the accuracy of the method on the number of selected points (convergence) was made. Due to the complexity of the integral, the number of generated events exceeded $2*10^7$, which led to the need to parallelize computations. For optimization of computation the algorithm of parallel calculations was implemented in C++ programming language using OpenMP and NVIDIA CUDA technology. Calculations were performed on nodes with multicore CPUs and Intel Xeon Phi coprocessors and NVIDIA Tesla K40 accelerator installed within the heterogeneous cluster of the Laboratory of Information Technologies, Joint Institute for Nuclear Research, Dubna. Using the code, the lifetime of meson was calculated using all possible pion-pion scattering reactions.

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