INVESTIGATION OF THE ENTROPY OF A SYSTEM OF MANY PARTICLES WITH DIFFERENT POTENTIALS

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This paper is devoted to the study of entropy of a system of many particles. The study of entropy behavior is based on the Vlasov kinetic equation, using numerical solution. In [1] it was shown that the well-known approximation of the Vlasov equation for the distribution function

$$\frac{\partial f}{\partial t} + (\vec{v}, \nabla_r f) + \left(\frac{\vec{F}}{m}, \nabla_v f\right) = 0$$

is not always true.

In General, for example for systems with dissipation, we should use equation without approximation

$$\frac{\partial f}{\partial t} + (\vec{v}, \nabla_r f) + \left(\langle\dot{\vec{v}}\rangle, \nabla_v f\right) + f \mathrm{div}_v \langle\dot{\vec{v}}\rangle = 0.$$

As a consequence, the following expression is satisfied

$$-\frac{1}{N}\frac{d}{dt}\iint f(\vec{r}, \vec{v}, t) \ln f(\vec{r}, \vec{v}, t)\, d^3r\, d^3v = \langle\langle \mathrm{div}_v \langle\dot{\vec{v}}\rangle\rangle\rangle.$$

To verify this relationship numerical simulation was performed. A good agreement of numerical simulation with a given equation is obtained. In view of the special laboriousness of the computation, parallel algorithms using CUDA technology are implemented in this paper. A parallel algorithm for solving the Vlasov equation by the particle method is presented. Acceleration of calculations in 10^2 times is received. Research was supported in part through computational resources provided by the Shared Facility Center “Data Center of FEB RAS” (Khabarovsk) [3].

References

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