Asociación Argentina de Mecánica Computacional

Mecánica Computacional Vol XXXIII, págs. 705-705 (resumen)
Graciela Bertolino, Mariano Cantero, Mario Storti y Federico Teruel (Eds.)
San Carlos de Bariloche, 23-26 Setiembre 2014

STUDY OF THE REDISTRIBUTION OF ALPHA PARTICLES DUE TO MHD INSTABILITIES USING GPUS

Pablo García Martinez[a,b,c], **Hugo Ferrari**[b,c] **and Ricardo Farengo**[b]

[a]*Universidad Nacional de Río Negro, Argentina*

[b]*Centro Atómico Bariloche, CNEA, Argentina, ferrarih@cab.cnea.gov.ar, farengo@cab.cnea.gov.ar*

[c]*CONICET, Argentina*

Abstract. In modern large tokamaks, like JET (Joint European Torus), the heating produced by the slowing down of alpha particles is of the order of 10% of the total energy applied to sustain the required plasma conditions. However, in the next generation of tokamaks, such as ITER (International Thermonuclear Experimental Reactor), it is expected that the alpha paticles will provide more than the 50% of the total heating power. For this reason, the study of the dynamics of fusion-born energetic alpha particles inside a tokamak configuration is of fundamental importance for self-heated (or "burning") plasmas experiments.

In previous works [1,2] we studied the redistribution of alpha particle populations caused by a large-scale periodic magnetohydrodynamic (MHD) instability known as sawtooth oscillation.

The exact particle trajectories in the total fields, equilibrium plus perturbation, were computed using a Runge-Kutta type algorithm. The original code was implemented using Fortran and run in parallel on multi-CPU. Further efforts are still required to consider different models for the electromagnetic fields (EMF) of the sawtooth instability as well as to study the effect of other instabilities.

The present work describes how the code is converted to NVIDIA's CUDA to take advantage of GPU computing. Speedup factors as high as 50x were obtained for simple cases where the EMF may be computed analytically. However, for the most general case the magnetic equilibrium as well as the perturbed EMF are obtained numerically. In these cases the speed improvement is limited by the access to global memory of each thread. Methods to mitigate this problem are analyzed and performance is compared. Also the accuracy of the GPU implementation is tested and the applicability of single precision computations is discussed.

[1] Farengo et al., 2012 Plasma Phys. Control. Fusion 54 025007
[2] Farengo et al., 2013 Nucl. Fusion 53 043012