Phase-field model for spinodal decomposition

Cahn-Hilliard equation:

$$\frac{\partial c}{\partial t} = \nabla^2 M \left[\frac{\delta f}{\delta c} - \kappa \nabla^2 c \right]$$

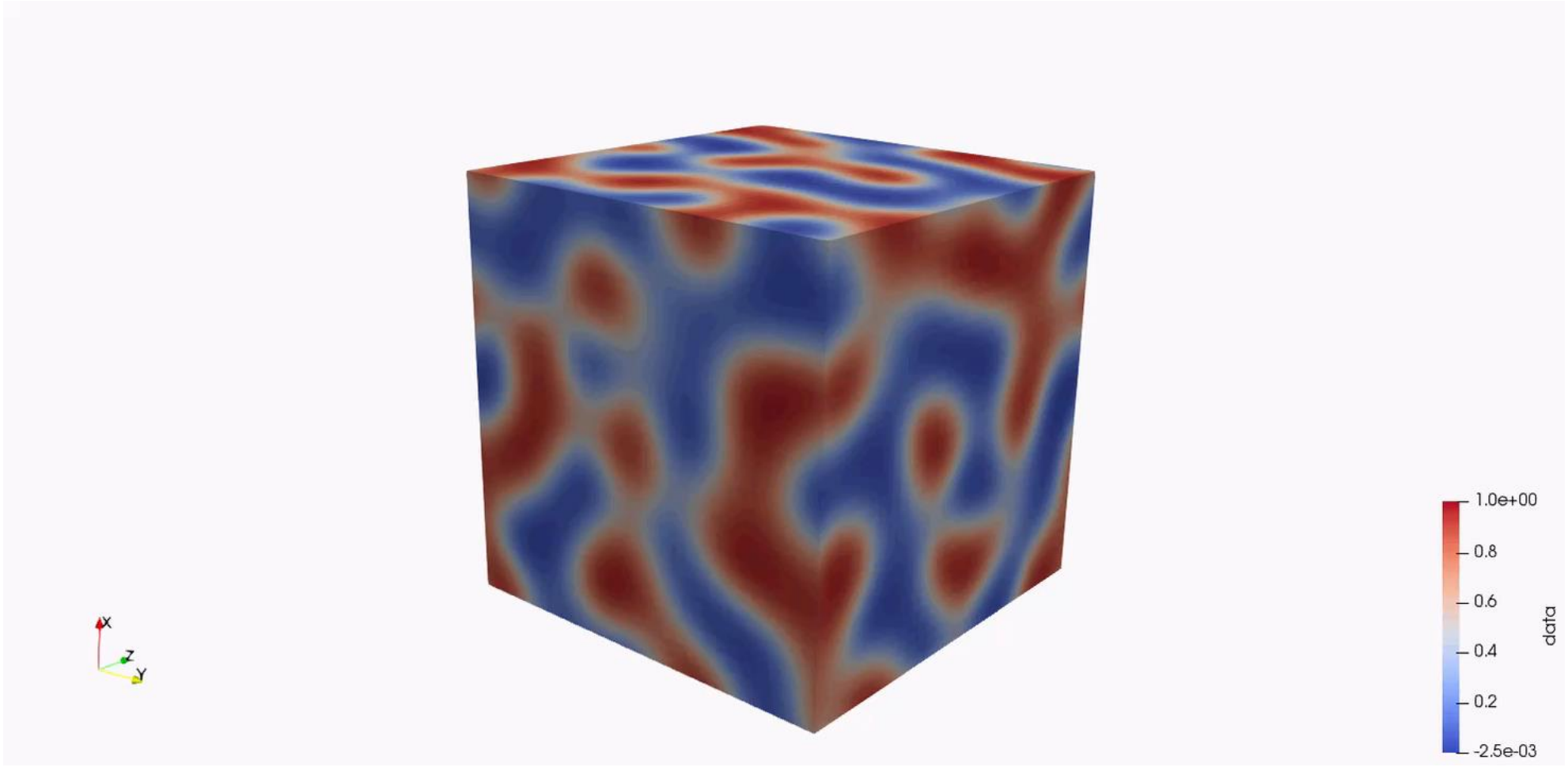
Semi-implicit Fourier spectral numerical solution [1]:

$$\{c\}_k^{n+1} = \frac{\{c\}_k^n - \Delta t k^2 M \left\{ \frac{\partial f}{\partial c} \right\}_k^n}{1 + \Delta t k^4 M \kappa}$$

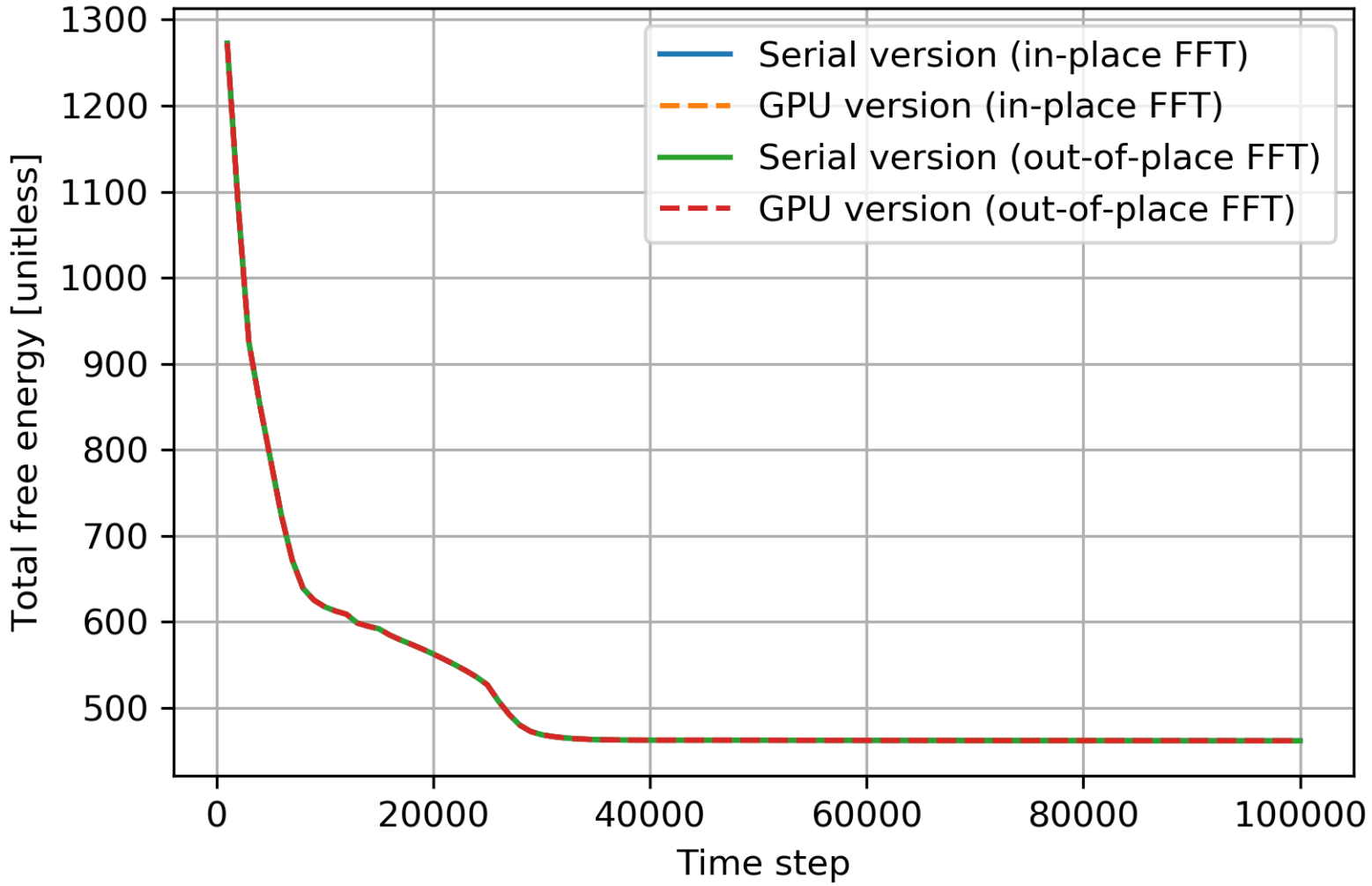
where:
c is concentration
t is time
M is Mobility
$f(c)$ is chemical energy
κ is gradient energy
$\{x\}_k$ is Fourier transform of x
k is vector in Fourier space

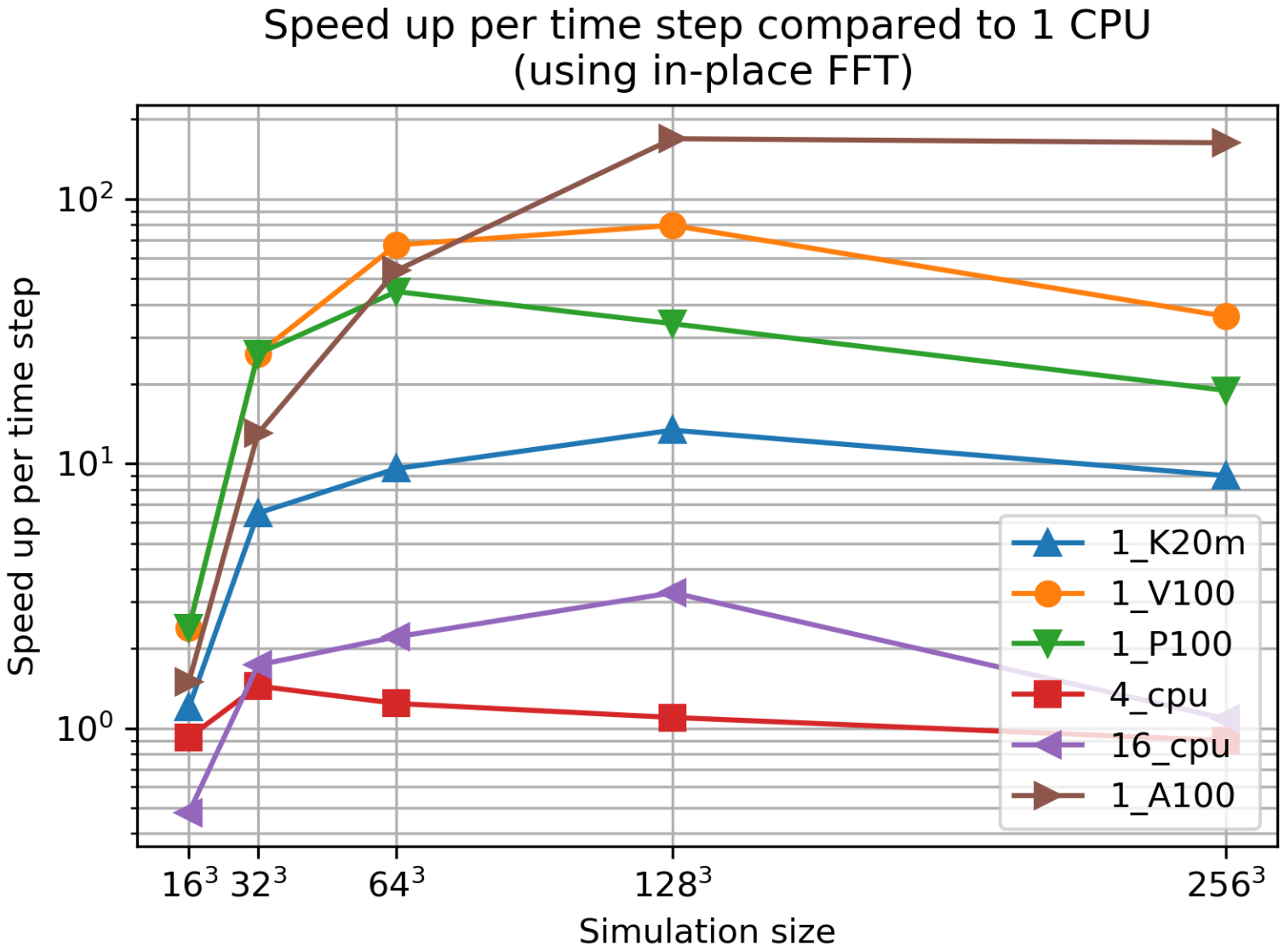
[1] Zhu, J., Chen, L.Q., Shen, J. and Tikare, V., 1999. Coarsening kinetics from a variable-mobility Cahn-Hilliard equation: Application of a semi-implicit Fourier spectral method. *Physical Review E*, *60*(4), p.3564.

Phase-field simulation results



Serial and GPU code results





CPU: Intel(R) Xeon(R) CPU E5-2698 v3 @ 2.30GHz
GPU: K20m, V100, P100, A100
Compilers: gcc/9.4.0, cuda/11.0
Libraries: fftw/3.3.4