

Weekly work summary

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content

- simulation of electromagnetic 5-field landau fluid using spectral method
 - ▶ parallel computation scheme and relevant treatment

Spectral Method(Fourier transform)

$$\begin{aligned} \text{forward : } f(m) &= \frac{1}{N} \sum_{n=0}^{N-1} f(n) e^{-i2\pi mn/N} \\ \text{backward : } f(n) &= \sum_{m=0}^{N-1} f(m) e^{i2\pi mn/N} \end{aligned} \quad (1)$$

$$\begin{aligned} f(k) &= \frac{1}{N} \sum_{n=0}^{N-1} f(x) e^{-i2\pi nx/L_x} \sim \frac{1}{N} \sum_{n=0}^{N-1} f(x) e^{-ik_x x} \\ f(x) &= \sum_{m=0}^{N-1} f(k) e^{i2\pi mx/L_x} \sim \sum_{m=0}^{N-1} f(k) e^{ik_x x} \end{aligned} \quad (2)$$

for linear terms $L(x)$:

$$\mathcal{F}(L(x)) = \quad (3)$$

for nonlinear terms $A(x)B(x)$:

$$\mathcal{F}(A(x)B(x)) = \quad (4)$$

1D Fourier Transform using FFTW3

$$\begin{aligned} f(x) &= 1 + \sin(5x) + 2\sin(10x), x \in [0, 2\pi] \\ \text{i.e. } f(n) &= 1 + \sin\left(5\frac{2\pi n}{N}\right) + 2\sin\left(10\frac{2\pi n}{N}\right), n \in [0, M] \end{aligned} \quad (5)$$

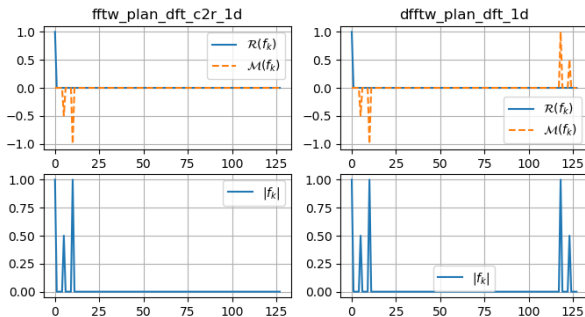


Figure:

1D Fourier Transform using FFTW3

$$m \in [0, 1..N/2 - 1, -N/2, .. - 1]$$

$$k_x \in [0, 1\frac{2\pi}{L_x} \dots - 1\frac{2\pi}{L_x}] \quad (6)$$

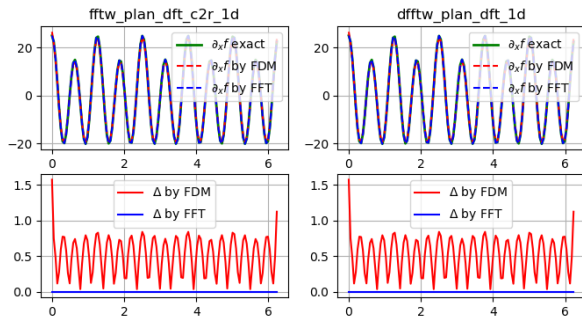


Figure:

2D Parallel Fourier Transform using P3DFFT

2D FFT,

$$f(m, n) = \frac{1}{MN} \sum_{y=0}^{M-1} \sum_{z=0}^{N-1} f(\theta, \phi) e^{-i2\pi nz/N} e^{-i2\pi my/M}$$
$$f(y, z) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} f(m, n) e^{i2\pi nz/N} e^{i2\pi my/M}$$
(7)

in P3DFFT output,

$$m \in [0, 1..M/2 - 1, -M/2, .. - 1]$$
$$n \in [0, 1, 2, ..N/2 - 1]$$
(8)

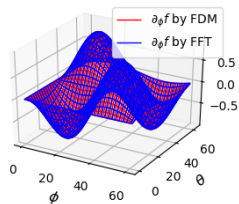
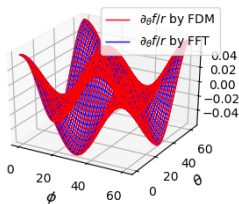
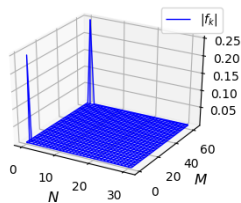
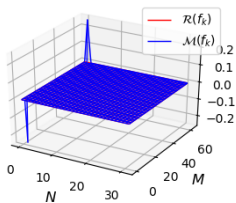


Figure:

1D MPI + OpenMP

sorting

1D MPI + OpenMP

2D decomposition

Result Comparision