Ĩ f G f ☆

@ fG f , f
G
F @ f G f 3 G @
F f -
@ @
A f @ f G f f @ - -
f , f 4 @ f f G -

N @ f @ U FF f

A A W (A) A 8) A A 1)

$$\delta ,$$ (4)

F f

$$\hat{\ } \sigma \quad 2\pi \sigma .$$

U @ F @ ,

$$ {}^2 \quad \frac{\pi}{\ } \int_{-\infty}^{\infty} \frac{\omega^2}{4} \ \omega \quad \omega, $$ (6)

(3)

$$ G \quad {}^2 \quad \frac{\pi}{\ } \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{\ } \ 2\pi\omega \quad 2 \quad \omega. $$

C @ @ f @ @ $2\pi\omega$,

$$ G \quad {}^2 \quad \frac{\pi}{\ } \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{\ } \ 2\pi\omega \quad 2 \quad 2\pi\omega \quad \omega \quad {}^2 \quad \frac{\pi}{\ } \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{\ } \ 2\pi\omega \ \hat{\ } \ \frac{\ }{\pi} \quad \omega \quad \omega. $$ (8)

f G f $\frac{\pi^2\omega^2}{\ }$ @ (8)

F ϵ, @ (8) (-

) $\omega <$, ϵ / π $\leqslant \frac{1}{2}$, $f \hat{\ } \xi$

$$ \xi < \frac{\ }{2\pi} \quad \frac{\quad \epsilon}{\pi}. $$ (9)

W f A A L G

$\lambda >$ γ_λ λ^2, F f $\hat{\gamma}\ \xi$, (A 4))

$$ {}_{\lambda}\ \xi \quad \sum_{\in \mathbb{Z}} \hat{\gamma}_\lambda\ \xi \quad {}^2. $$ (10)

U @ A @ 3, f $\xi \leqslant \frac{N}{2}$

$$ \hat{\ } \ \xi \approx \frac{1}{{}_{\lambda}\ \frac{\xi}{vN}} \quad \hat{\ } \ \gamma_\lambda \ v\xi \quad , $$ (11)

gn A 26) N v A A @N

@ - f(9) N 2, (11) (8)

$$ G \approx \tilde{G} \quad {}^2 \quad \frac{\pi}{\ } \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{\ } \ 2\pi\omega \quad \hat{\ } \ \frac{\gamma_\lambda \ v \frac{\ }{\pi} \quad \omega}{{}_{\lambda}\ \frac{\ /\pi \quad \omega}{vN}}. $$ (12)

C @ @ @ (12)

$$ \tilde{G} \quad {}^2 \quad \frac{\pi}{\ } \quad \hat{\ } \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{\ } \ 2\pi\omega \ \frac{\gamma_\lambda \ v \ \frac{\ }{\pi} \quad \omega}{{}_{\lambda}\ \frac{\ /\pi \quad \omega}{vN}} \quad \omega. $$ (13)

@ 1 (A A), , λ ξ f $\xi < \frac{1}{4}$ G A ,
@ (1 3) ; fG @ f
N ,

$$\frac{\pi}{} \int_{-\infty}^{\infty} \frac{\pi^2\omega^2}{} \; 2\pi\,\omega \quad \lambda \quad v^2 \; \frac{}{\pi} \quad \omega \qquad ^2 \quad \frac{\pi\omega^{\;2}}{vN^{\;2}\lambda} \quad \omega$$

$$\frac{vN \quad \lambda\pi}{\kappa} \times \frac{\lambda^2 v^2 N^2 \; \pi \quad w \;^2 \quad \lambda \;^2\pi^2 \quad ^2\pi^2 \; \lambda v^2 N^2 \quad ^2}{\kappa}$$

$$\times \quad 2\, \frac{^2 \; \pi^2 \quad \lambda^2 v^4 N^2 \quad \pi \; \lambda^2 v^3 N^2}{\kappa} \;,$$

$$\kappa \quad \pi^2 \lambda v^2 N^2 \quad \pi^2 \quad \lambda^2 v^4 N^2 \;. \qquad 14$$

[,

$$\tilde{G} \quad \frac{vN \quad \lambda\pi}{\kappa} \quad \frac{\pi^2 \; \lambda v^2 N^2 \quad ^2 \quad 2 \quad \pi^2 \quad \lambda^2 v^4 N^2}{\kappa} \quad ^2$$

$$\times \quad \tilde{\Gamma} \quad \frac{\lambda^2 v^2 N^2 \; \pi \quad w \;^2}{\kappa} \quad \frac{2 \; \pi \; \lambda^2 v^3 N^2}{\kappa} \;, \qquad 1$$

$$\tilde{\Gamma} \quad \tilde{\Gamma} \quad \frac{\lambda \; \pi^2 \;^2}{\kappa} \;. \qquad 16$$

[f (3) (1) f
@ 4 1 99 84 6 [9 9626 9 9626 81 2283491 1 6 [() [F 4 4( )-2 31 (433)-3331 (@ F 1 38 9644 3 -

(1) W @ @

f @ , $\frac{1}{}$ W @ @ $\frac{1}{2}, \frac{1}{2}$,

@ f , @ f , fa

(@)

M f , f @ ϵ, x s_j, f

$^2 \leqslant \epsilon$,

$\leqslant \frac{\epsilon}{}$.

f , K C_k,

s ϵ 4 4 9 (M - 3 2 1

$\frac{1}{2}, \frac{1}{2}$

. iW @ f FF Γ @ f

iW f @ f f f
@ Γ - f @ .
N = 1 2 M f FF Γ , f @ f 3 FF Γ
f N = 1 28 FF Γ f N = 8192
F Γ 1 @ 3, -
,
Γ 1 , a <1 38 Γ f , Γ 1 -
f

5. Conclusions

iW -8 8 8 iW 8 8-4 1 4 (iW)-239 (8) 3 f ,

@ Γ @ f

, , , ,

F

M f ,

λ ξ $\hat{\gamma}_\lambda$ ξ , ^{2}, **A** .4

$\in\mathbb{Z}$

A f ' f (A 9) @

$$\mathscr{P}^{v} \int_{-\infty}^{\infty} 2\pi \; \xi \; \hat{} \; vN\xi \; \hat{\gamma}_{\lambda} \; \xi \quad \xi, \qquad (A\ 1)$$

, ,

$$\mathscr{P}^{v} \int_{-\frac{1}{2}}^{\frac{1}{2}} 2\pi \; \xi \sum_{, \in \mathbb{Z}} \hat{} \; vN \; \xi \; , \; \hat{\gamma}_{\lambda} \; \xi \; , \; \xi. \qquad (A\ 11)$$

W @ $\mathbb{R}$ (A 1) (A 11), f fλ, ξ , $\hat{\gamma}_{\lambda}$ ξ , 1 / ,
@ @ , @ f(A 11) f F , f f

$$F \; \xi \sum_{\in \mathbb{Z}} \mathscr{P}^{v} \,) \; 2\pi \; \xi, \qquad (A\ 12)$$

$$F \; \xi \sum_{, \in \mathbb{Z}} \hat{} \; vN \; \xi \; , \; \hat{\gamma}_{\lambda} \; \xi \; , \; . \qquad (A\ 13)$$

@ f(A 13) , ξ @

Then

$$E_\infty \leqslant 1 \quad \hat{\varphi} \ \alpha \quad \frac{1}{C \ , \alpha} \ {}_{\in \mathbb{Z}} \quad C \ , , \alpha \ \hat{\varphi} \ , \quad \alpha .$$

f$\hat{\varphi}$ f @ , 1 $\hat{\varphi}$ α

@ 1 = 1

@ ξ f $\xi \leqslant \frac{N}{2}$, α α $\frac{1}{2v}$

F @ f $v = 2$, $\xi < \frac{1}{4}$, $\hat{\varphi}$ ξ -

, $\hat{\varphi}$ $\xi \pm 1$, $\lambda <$ 1 4 F $\lambda =$ 1 4

fγ_λ 1 6,1 6 , A 9) @ f33 ,

23 f - , f

(2) C

$$F\ \xi \quad \sum_{-\frac{\nu N}{2}}^{\frac{\nu N}{2}\ 1} \mathscr{P}^{\nu} \quad 2\pi\ \xi \qquad \text{A 1 6}$$

FFT

(3) $F(\xi_j)$ $\lambda\ \xi$

A.2.2. Fast evaluation of the Fourier series at unequally spaced points

W @ @ f f

f , @

L f T

$$\xi \quad \frac{F\ \xi/\nu}{\lambda\ \xi/\nu},$$

$F(\xi)$ f A 1 2) $a_{\lambda}(\xi)$ A 4) C f @

$$\hat{f}\ \xi \quad \sum^{\frac{N}{2}\ 1}$$

∞ ∞∞∞ ∞∞∞∞ ∞∞∞ ∞ /∞∈∞

$$\ell, \qquad \int_{\infty}^{\infty} \hat{G}\,\frac{\xi}{v}\,\tilde{\mathscr{P}}^{v} \quad \xi \quad \xi, \tag{A.2}$$

$$\hat{G}\;\xi \qquad \sum_{\ell\;\frac{N}{2}}^{\frac{N}{2}\;1} \frac{\ell}{\quad \lambda\;\frac{1}{vN})} \quad \frac{2\pi\;\xi}{N}. \tag{A.21}$$

(A 19) (A 2)

$$\ell, \qquad \int_{\infty}^{\infty} \sum_{\in\mathbb{Z}} \hat{G}\;\frac{}{v}\;\gamma_{\lambda}\;vN\tilde{} \quad \tilde{} \quad \tilde{} \quad \hat{} \quad N\xi\;, \quad), \tag{A.22}$$

$$\hat{} \quad \xi \qquad \sum_{\in\mathbb{Z}} \hat{G}\;\frac{}{v}\;\gamma_{\lambda}\;v\xi \qquad . \tag{A.23}$$

N f$\hat{G}$ $\frac{}{v}$ ( ) ,

$$\tilde{}_{\ell} \qquad \frac{\ell}{\lambda\;\frac{}{vN}}, \qquad \frac{N}{2} \leqslant \ell \leqslant \frac{N}{2} \quad 1\,; \tag{A.24}$$

, .

A FF $\tilde{}_{\;,\;}{}^{\frac{vN}{2}\;1}_{\frac{vN}{2}}$ $\hat{G}\;\frac{}{v}$
W f f F

Algorithm 2.

(1) C $\tilde{}_{\ell}$ (A 24)
(2) A FF $\hat{G}\;\frac{}{v}$
(3) C $\hat{}$ ξ (A 23)

A.2.3. Evaluation of unequally spaced FFT at unequally spaced points

W f f f f(A 14),
$\in \frac{1}{2}, \frac{1}{2}$ f $\xi \in \frac{N}{2}, \frac{N}{2}$ -

Algorithm 3.

(1) C

$$\mathscr{P}^{v} \qquad \gamma_{\lambda}\;vN \quad 1 \quad \frac{}{vN} \quad , \qquad \frac{v^2N}{2}, \ldots, \frac{v^2N}{2} \quad 1 \tag{A.2}$$

$\frac{v}{2}, \frac{v}{2}$ ( )

(2) f λ,

$$\ell \qquad \frac{\mathscr{P}^{v}}{\quad \lambda\;\frac{}{v^2N})}$$