I 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 Γ f
A A W (A) A 8) A A 1)

δ , 4

F f

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

U @ F @ ,

$\quad ^2 \quad \frac{\pi}{} \int_{\infty}^{\infty} \frac{\omega^2}{4} \quad \omega \quad \omega,$ 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

Γ f G f $\frac{\pi^2\omega^2}{}$ @ (8)
F ϵ, @ (8) (-
) $\omega <$, ϵ/π $\leqslant \frac{1}{2}$, f $\hat{\ }$ ξ

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

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

$\quad \lambda \ \xi \quad \hat{\gamma}_\lambda\ \xi \quad ^2.$ 1

$\in \mathbb{Z}$

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

g n A 26) N v A A @N
@ - f(9) N 2, (11) (8)

$G \approx \tilde{G} \quad ^2 \quad \frac{\pi}{} \int_{\infty}^{\infty} \frac{\pi^2\omega^2}{} \ 2\pi\,\omega \quad \hat{\ } \ \frac{\gamma_\lambda\ v\ \frac{}{\pi}\quad \omega}{\lambda\ \frac{/\pi\ \ \omega}{vN}}.$ 1 2

C @ @ @ (1 2)

$\tilde{G} \quad ^2 \quad \frac{\pi}{} \quad \hat{\ } \int_{\infty}^{\infty} \frac{\pi^2\omega^2}{} \ 2\pi\,\omega \ \frac{\gamma_\lambda\ v\ \frac{}{\pi}\quad \omega}{\lambda\ \frac{/\pi\ \ \omega}{vN}} \quad \omega.$ 1 3

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

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

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

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

$$\kappa \quad \pi^2 \lambda v^2 N^2 \quad \pi^2 \quad \lambda^2 v^4 N^2 \; . \qquad (1\,4)$$

[,

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

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

$$\tilde{\Gamma} \quad \Gamma \quad \frac{\lambda \; \pi^2 \; {}^2}{\kappa} \; . \qquad (1\,6)$$

[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 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 FFΓ @ f

ℹW f @ f f f @ Γ - f @ .
N = 1 2 M fFFΓ , f @ f 3 FFΓ
f N = 1 28 FFΓ 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 8-4l 4 (ℹW)-239 (8) 3 f ,

@ Γ @ f

, , , ,

F

M f ,

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

, ∈ℤ

A f ' f (A 9) @

$$\mathscr{P}^{v} \quad \infty \quad 2\pi \quad \xi \; \hat{} \; vN\xi \; \hat{\gamma}_{\lambda} \; \xi \quad \xi, \quad \infty \tag{A 10}$$

, ,

$$\mathscr{P}^{v} \quad \tfrac{1}{2} \quad 2\pi \quad \xi \quad \hat{} \; vN \; \xi \quad , \quad \hat{\gamma}_{\lambda} \; \xi \quad , \quad \xi. \quad \tfrac{1}{2} \quad , \in \mathbb{Z} \tag{A 11}$$

W @ $\mathbb{R}$ (A 10) (A 11), f fλ,
ξ , $\hat{\gamma}_{\lambda}$ ξ , 1 / 4,
@ @
, @ f(A 11) f F , f f

$$F \; \xi \quad \in \mathbb{Z} \quad ' \; \mathscr{P}^{v} \;) \quad 2\pi \quad \xi, \tag{A 12}$$

$$F \; \xi \quad , \in \mathbb{Z} \quad \hat{} \; vN \; \xi \quad , \quad \hat{\gamma}_{\lambda} \; \xi \quad , \quad . \tag{A 13}$$

@ f(A 13) , ξ @

Then

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

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 λ = 1 4
fγ_λ 1 6,1 6 , A 9) @ f33 ,
23 f - , f

(2) C

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

FFΓ

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

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

W @ @ f f

f , @

L T

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

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

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

∞ ∞∞∞ ∞∞∞∞∞ ∞∞∞ ∞ /∞∈∞

$$\int_{\infty}^{\infty} \hat{G}\left(\frac{\xi}{v}\right) \tilde{\mathscr{P}}^{v} \; \xi \; \xi, \qquad \text{A .2}$$

$$\hat{G} \; \xi \quad \sum^{\frac{N}{2}\;1}_{\frac{N}{2}} \frac{}{\lambda \; \frac{1}{vN})} \; \frac{2\pi \; \xi}{N}. \qquad \text{A .21}$$

(A 1 9) (A 2)

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

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

N Ĝ ( ) ,

$$\frac{}{\lambda \; \frac{}{vN}}, \quad \frac{N}{2} \leqslant \; \leqslant \frac{N}{2} \; 1 ; \qquad \text{A .24}$$

A FFT $\frac{vN}{2}\;1$ $\frac{vN}{2}$ $\hat{G}\;\frac{}{v}$ W F

Algorithm 2.

(1) C (A 24)
(2) A FFT $\hat{G}\;\frac{}{v}$
(3) C ξ (A 23)

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

W (A 1 4), $\in \frac{1}{2},\frac{1}{2}$ $\xi \in \frac{N}{2},\frac{N}{2}$

Algorithm 3.

(1) C

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

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

(2) λ,

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