$\langle j,(n+1)\varepsilon | j, n\varepsilon\rangle =$

$\exp\left(-\frac{i}{\hbar}(n+1)\varepsilon E'_j\right)\langle \phi'_j(\square,(n+1)\varepsilon)|\phi'_j(\square,n\varepsilon)\rangle \exp\left(\frac{i}{\hbar}n\varepsilon E'_j\right)$

$=\langle\phi'_j(\square,n\varepsilon)|\exp\left(\frac{i}{\hbar}\varepsilon H\right)|\phi'_j(\square,n\varepsilon)\rangle\exp\left(-\frac{i}{\hbar}\varepsilon E'_j\right)$

$\fallingdotseq 1+O(\varepsilon^2)$・・・$(t_2-t_1)/\varepsilon$乗しても$\varepsilon\to 0$で$\to 1$

$\therefore\ \int D\chi\ \overline{\mathrm{dar}(f;-3\varepsilon)\Phi_k[\chi]}\cdot\mathrm{dar}(g;2\varepsilon)\Phi_j[\chi]$

$\fallingdotseq\langle k,-3\varepsilon|f\rangle\,\delta_{jk}\langle g|j,2\varepsilon\rangle$

$\int D\chi\ \overline{\mathrm{dar}(f;-3\varepsilon)\Phi[\chi]}\cdot\mathrm{dar}(g;2\varepsilon)\Phi[\chi]$

$=\sum_j\sum_k\int D\chi\ \overline{\mathrm{dar}(f;-3\varepsilon)\Phi_k[\chi]}\cdot\mathrm{dar}(g;2\varepsilon)\Phi_j[\chi]$

$\fallingdotseq\sum_j\sum_k\langle g|j,2\varepsilon\rangle\,\delta_{jk}\langle k,-3\varepsilon|f\rangle$

$=\sum_j\langle g|j,2\varepsilon\rangle\langle j,-3\varepsilon|f\rangle$

$=\sum_j\exp\left(\frac{i}{\hbar}2\varepsilon E'_j\right)\langle g|\phi'_j(\square,2\varepsilon)\rangle\langle\phi'_j(\square,-3\varepsilon)|f\rangle\exp\left(\frac{i}{\hbar}3\varepsilon E'_j\right)$

$=\sum_j\langle g|U(2\varepsilon,-3\varepsilon)|\phi'_j(\square,-3\varepsilon)\rangle\langle\phi'_j(\square,-3\varepsilon)|f\rangle\exp\left(\frac{i}{\hbar}5\varepsilon E'_j\right)$

$=\langle g|U(2\varepsilon,-3\varepsilon)|f\rangle\exp\left(\frac{i}{\hbar}5\varepsilon E'_j\right)$