$H_{SSH} = \begin{pmatrix} 0 & v+w e^{-ik} \\ v+w e^{ik} & 0 \end{pmatrix}$

$k \in S^1$

or $k \in [-\frac{\pi}{a}, \frac{\pi}{a}]$

$v + w\cos k$

$-i w \sin k$

$v + w\cos k + i w \sin k$

$\phi 1 = \begin{pmatrix} e^{-i\phi} \\ \\ \end{pmatrix}$

$$\frac{v + w\cos k}{\sqrt{v^2 + w^2 + 2vw\cos k}} = \cos\phi$$

$\sim \begin{pmatrix} 0 & e^{-i\phi} \\ e^{i\phi} & 0 \end{pmatrix}$

$|\uparrow\rangle \frac{1}{\sqrt{2}} \begin{pmatrix} e^{-i\phi} \\ 1 \end{pmatrix}$

$(v + w\cos k) - i w \sin k$

$|E| e^{-i\phi}$

$|\downarrow\rangle = \frac{1}{\sqrt{2}} \begin{pmatrix} +1 \\ -e^{i\phi} \end{pmatrix}$

$A_k = i\langle\downarrow|\partial_k|\downarrow\rangle$

$|E| e^{i\phi}$

$= -\frac{\partial\phi}{\partial k}$

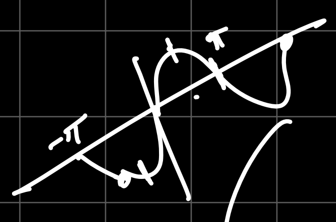
$\tan\phi = \frac{w\sin k}{v + w\cos k}$

$\phi = \tan^{-1}\left(\frac{w\sin k}{v + w\cos k}\right)$

$\int_{-\pi}^{\pi} -\frac{\partial\phi}{\partial k}\, dk$

$= \phi(-\pi) - \phi(\pi)$

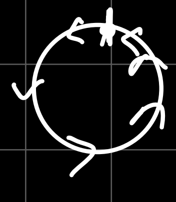
$\tan^{-1}\left(\frac{w \sin\pi}{v - w}\right)$



$\sim e^{-i\phi}$

$\begin{pmatrix} 0 & (v + w\cos k) - i w \sin k \\ (v + w\cos k + i w\sin k) & 0 \end{pmatrix}$

$\sim e^{i\phi}$



s.t. $\tan\phi = \frac{w\sin k}{v + w\cos k} = \frac{\sin k}{1 + \cos k}$

$= \tan\left(\frac{k}{2}\right)$

$$\phi = \tan^{-1}\left(\tan\frac{k}{2}\right)$$

$k \to \pi^{-\delta}$ $\quad -\pi$ $\quad +\infty$ $\quad -\pi$

$+\infty$ $\quad \left(\frac{\pi}{2}\right)$

$$\phi = \tan^{-1}\left(\frac{\omega \sin k}{v + \omega\cos k}\right)$$

$$\frac{(t-\delta t)\sin k}{2\delta t\, t}$$

$$\phi = \tan^{-1}\left(\frac{\omega \sin k}{(v-\omega) + \omega(1+\cos k)}\right)$$

$$(\ )\ \partial_k \begin{pmatrix} 1 \\ -e^{i\phi} \end{pmatrix} = (i)\, i\frac{\partial\phi}{\partial k} = -\frac{\partial\phi}{\partial k}$$

$$\frac{t + \delta t + (t-\delta t)\cos k}{t(\cos k + 1) + \delta t(1-\cos k)}$$

$(t-\delta t)\cos k$

$$\therefore\ e^{i\gamma} = \exp\left[-i\int_{-\pi}^{\pi}\frac{\partial\phi}{\partial k}\,dk\right]$$

$$= \exp\left[+i\ \left(\phi(-\pi) - \phi(\pi)\right)\right]$$

now $\quad \phi = \tan^{-1}\left(\frac{\omega \sin k}{(v-\omega) + \omega[1+\cos k]}\right)$

$$\frac{(t-\delta t)\ \sin k.}{2t\cos^2\frac{k}{2} + 2\delta t\sin^2\frac{k}{2}}$$

$k \to \pi$

$$\phi = \tan^{-1}\left(\frac{\omega \sin k}{v-\omega}\right)\Bigg|_{k\to\pi^{\ominus}}$$

if $\ v-\omega \neq 0,\ \sin k = \sin\pi^{\ominus} = 0^{+}$

$$\phi = \tan^{-1}\left(\# \times 0^{+}\right) \to \tan^{-1}(0) \to \underline{\underline{0}}$$

similarly for $k = -\pi$

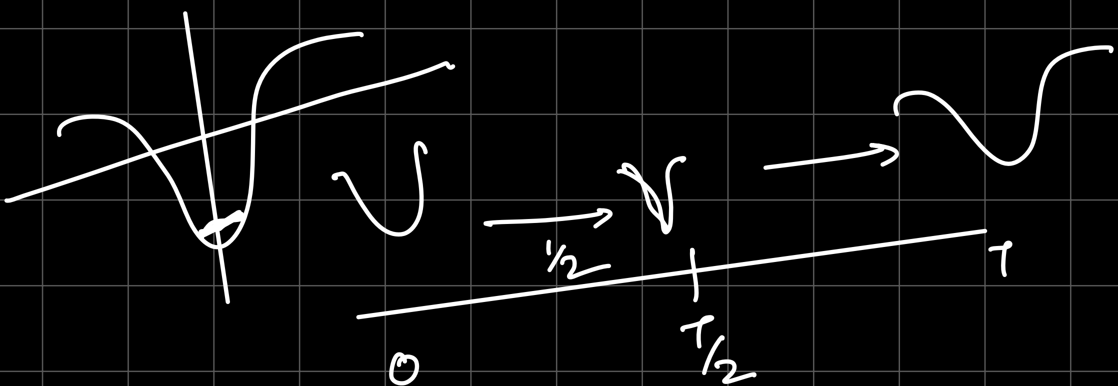
if $\underline{\underline{v = w}}$

$$\phi = \tan^{-1}\left(\tan\frac{k}{2}\right) \begin{cases} k \to \pi^- & \phi = \pi/2 \\ k \to -\pi^+ & \phi = -\pi/2 \end{cases}$$

$$\therefore \; e^{i\gamma} = \exp\left[\underline{\underline{i(-\pi)}}\right] \quad \therefore \; \gamma = \underline{\underline{\pi \text{ or } -\pi}}$$

$$\phi = \tan^{-1}\left(\underline{\underline{\frac{w\sin k}{v + \cos k}}}\right)$$

$$\frac{w\sin k}{v + \cos k}.$$



$$\int_0^T \langle s | \partial t \rangle \, dt$$

$$e^{-x^2}$$