開弦チャンネルの境界状態と弦の場の理論

礒野裕（中央大学）

今村洋介氏, 松尾泰氏, 横山修一氏（東京大学）との共同研究

2008 7/29 @ YITP

Index

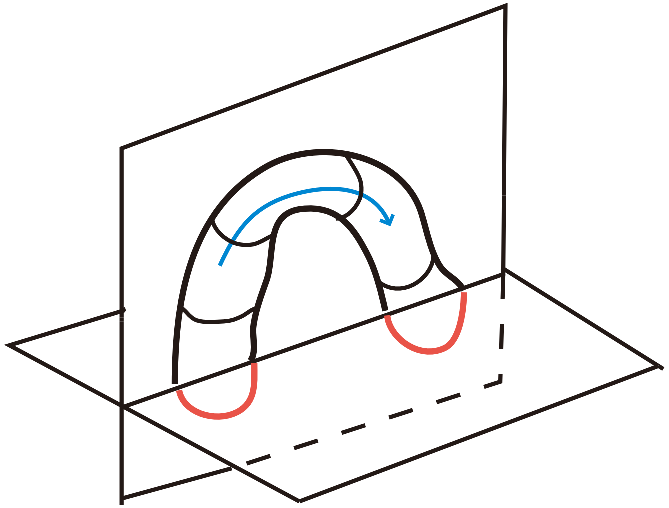
- OBS & SFT
- Shapiro-Thorn vertex
- Shapiro-Thorn vertex & OBS
- Discussion

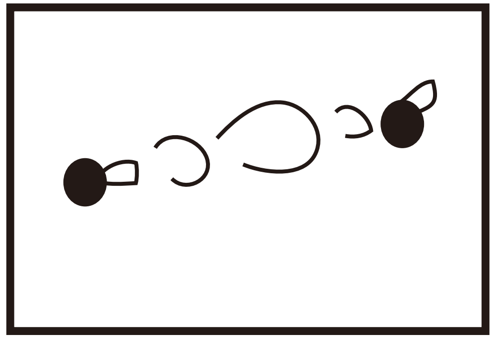
OBS

Open Boundary State (OBS)

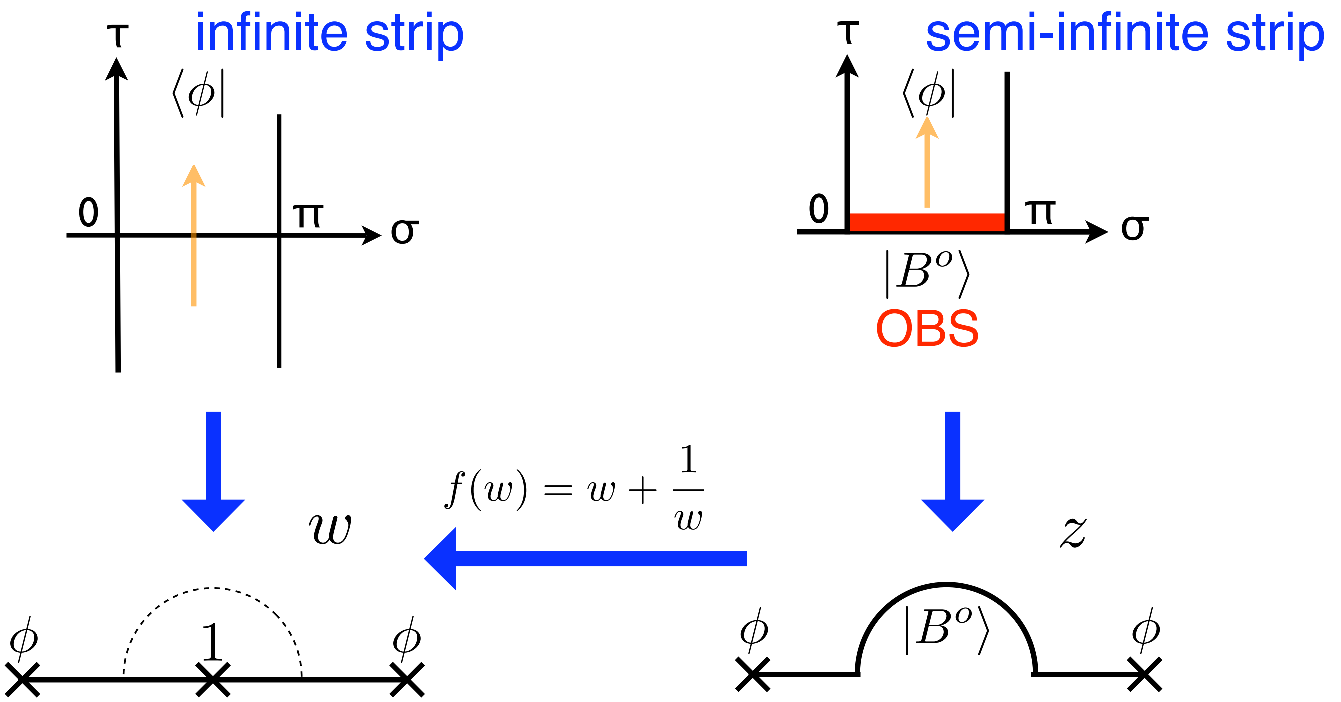
[I, Matsuo '05], [Imamura, I, Matsuo '06 '07]

複数の D-brane からなる系で、
D-brane による開弦の放出吸収をあらわす境界状態





Open Boundary State (OBS)



$$\langle f \circ \phi(\infty) \rangle = \langle \phi | B^o \rangle$$

$$|B^o\rangle = U_f^{-1} |0\rangle$$

実は nothing state

OBS and SFT

D-branes in SFT

closed string field theory & usual closed string boundary state

[Hata, Hashimoto] [Kishimoto, Matsuo, Watanabe] [Baba, Ishibashi, Murakami] etc.

If possible, we want to deal with D-branes in OSFT

OBS might be a tool for dealing with D-branes in OSFT

Concrete roles of OBS in OSFT are now unclear

OBS and SFT

Attempt

- OBS as a source term in EoM of OSFT

$$Q_B\Phi + \Phi * \Phi = B^o$$

OBS = source of open string

- idempotency $|B^o\rangle * |B^o\rangle \sim |B^o\rangle$

the same relation as usual boundary state [Kishimoto, Matsuo, Watanabe]

OBS and SFT

Attempt

- OBS as a source term in EoM of OSFT

$$Q_B\Phi + \Phi * \Phi = B^o$$ OBS = source of open string

- idempotency $$|B^o\rangle * |B^o\rangle \sim |B^o\rangle$$

the same relation as usual boundary state [Kishimoto, Matsuo, Watanabe]

This talk

(Closed) Boundary State & Shapiro-Thorn vertex

[Kawano-Kishimoto-Takahashi] [Ellwood]

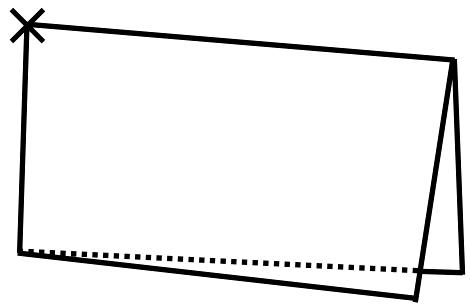
introduce naturally OBS to OSFT in the context of ST vertex

Shapiro-Thorn vertex

Shapiro-Thorn vertex

vertex specifying open-closed coupling

$$\langle V^c|\hat{\gamma}^{\rm ST}|V^o\rangle \equiv \langle I|\tilde{V}^c|V^o\rangle \quad =$$



(conventionally, $\langle\langle\gamma^{\rm ST}|V^c\rangle|V^o\rangle$)

For $\langle V^c|$: on-shell $\quad \langle V^c|\hat{\gamma}^{\rm ST}|\Phi_o\rangle$ is gauge-invariant.

[Hashimoto Itzhaki]

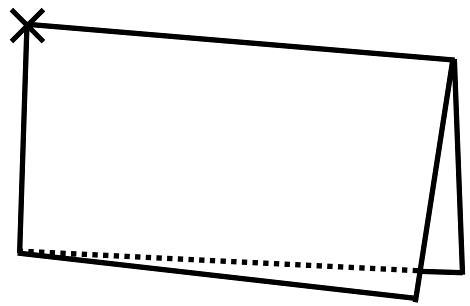
$$\langle V^c|\hat{\gamma}^{\rm ST}|\delta_\Lambda\Phi_o\rangle = 0$$

$$\delta_\Lambda\Phi_o = Q_B\Phi_o + [\Phi_0, \Lambda]_*$$

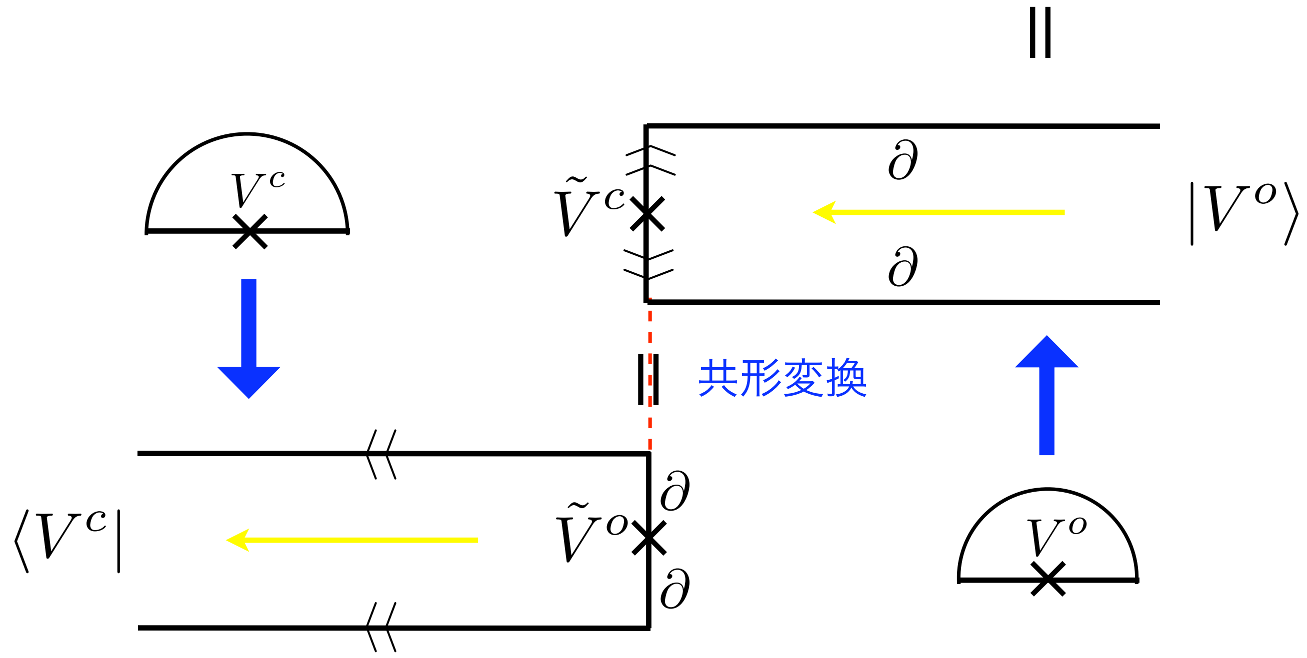
Shapiro-Thorn vertex

vertex specifying open-closed coupling

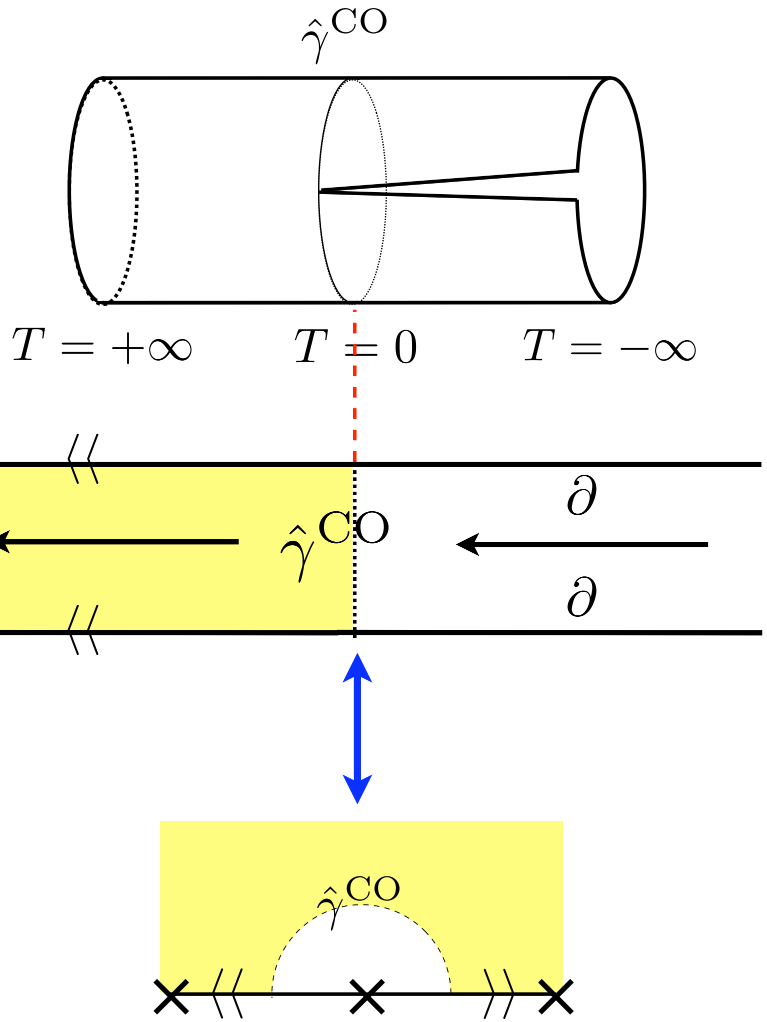
$$\langle V^c|\hat{\gamma}^{\rm ST}|V^o\rangle \equiv \langle I|\tilde{V}^c|V^o\rangle =$$



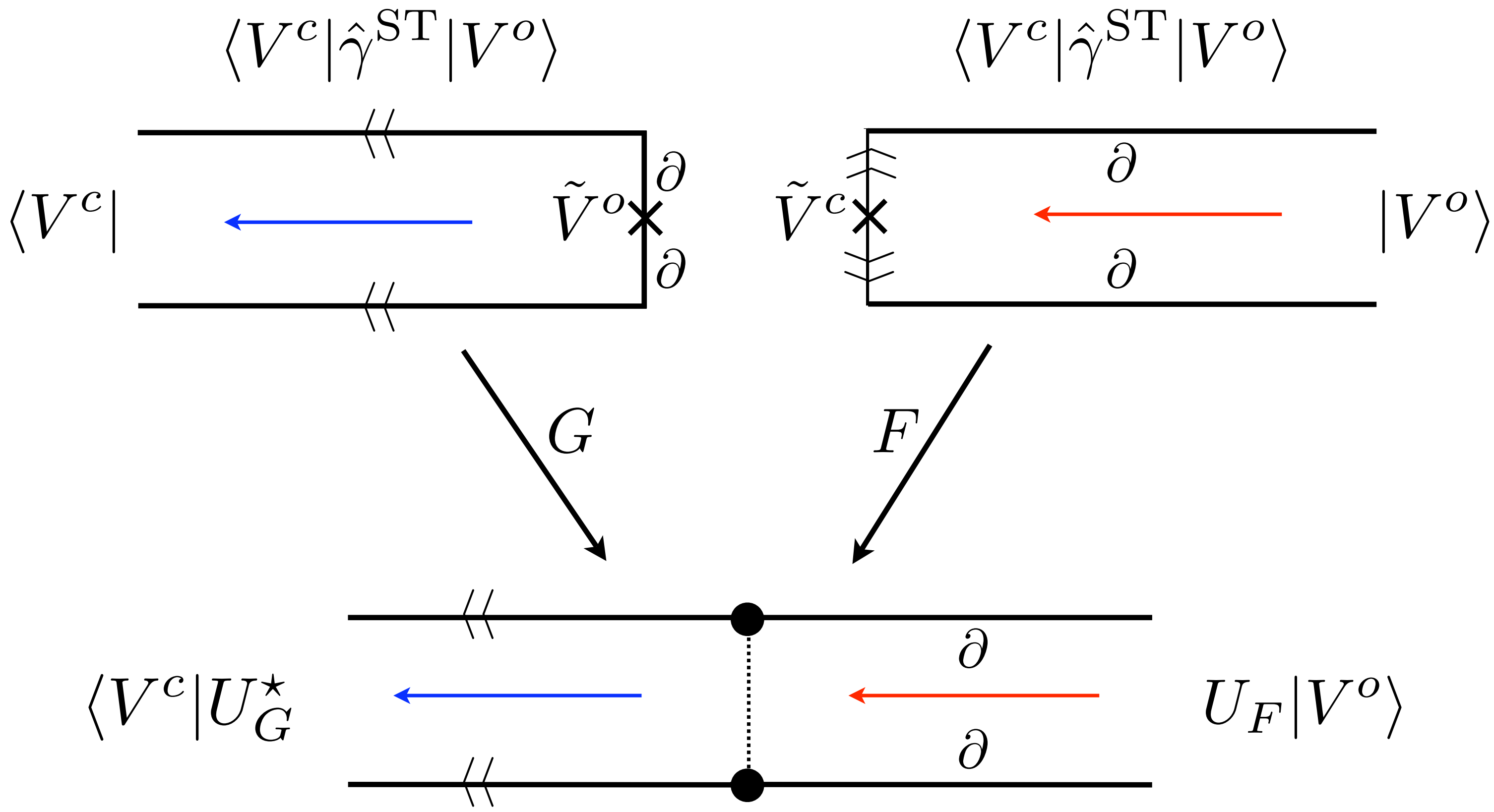
(conventionally, $\langle\langle\gamma^{\rm ST}|V^c\rangle|V^o\rangle$)



Open-Closed vertex

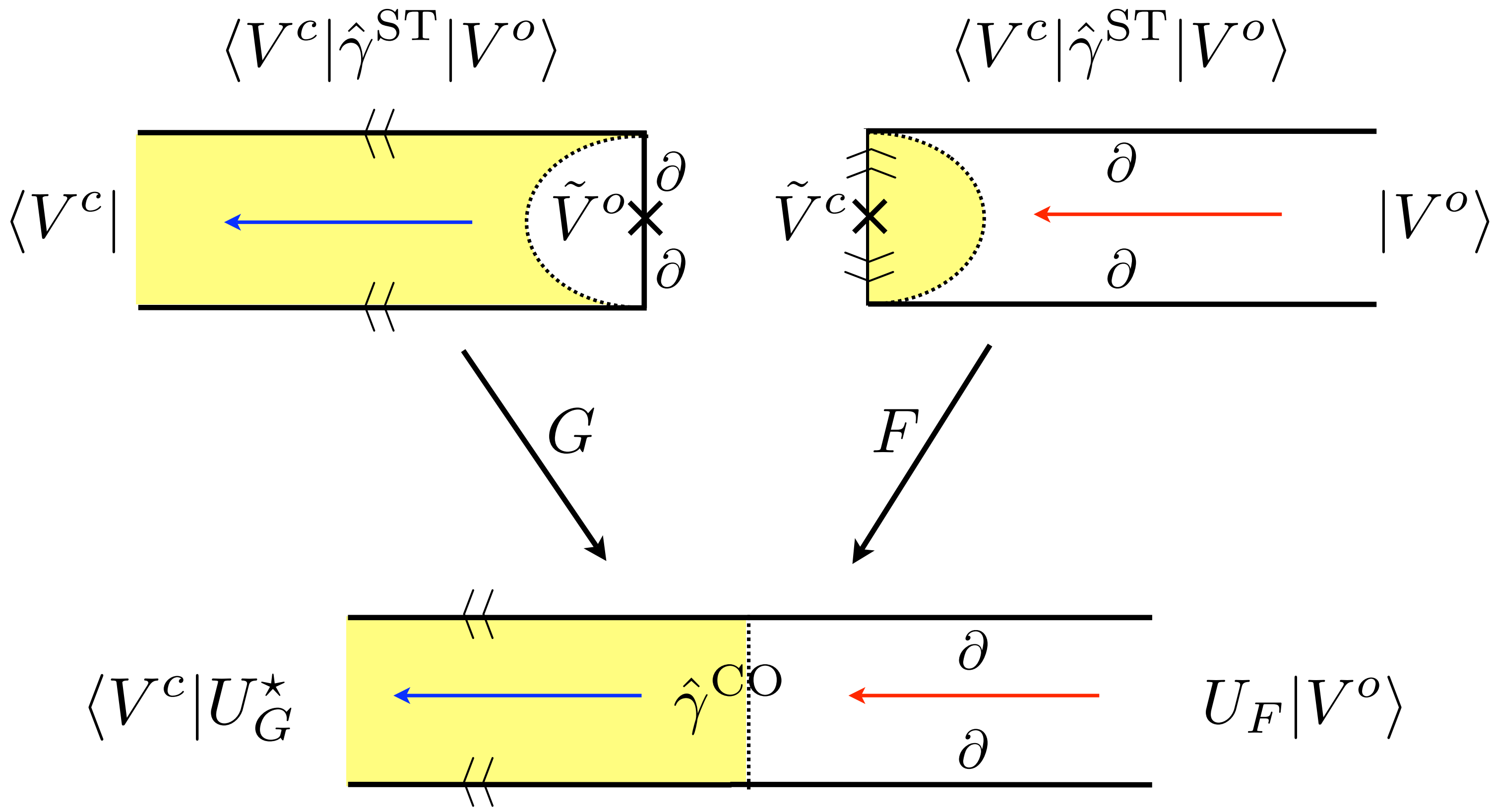


Open-Closed & Shapiro-Thorn



Both F , G map the semi-infinite strips to identical infinite strip.

Open-Closed & Shapiro-Thorn

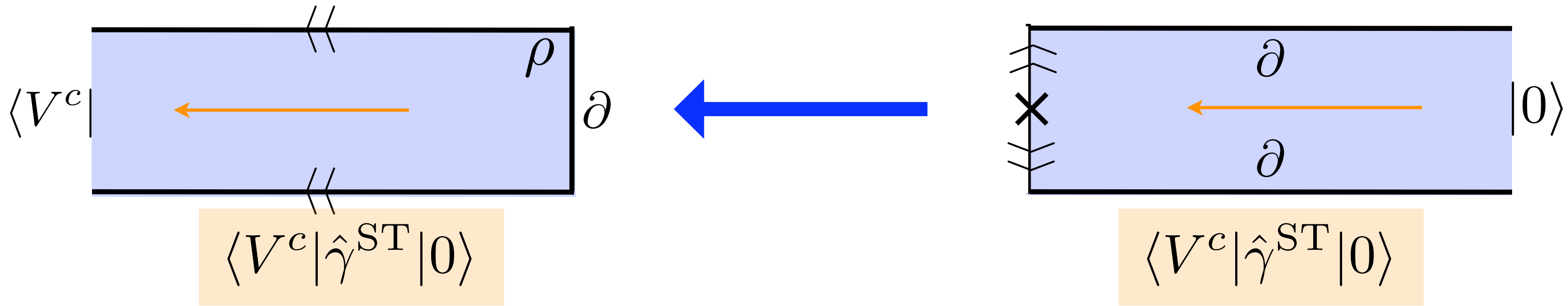


Both F , G map the semi-infinite strips to identical infinite strip.

Shapiro-Thorn vertex & OBS

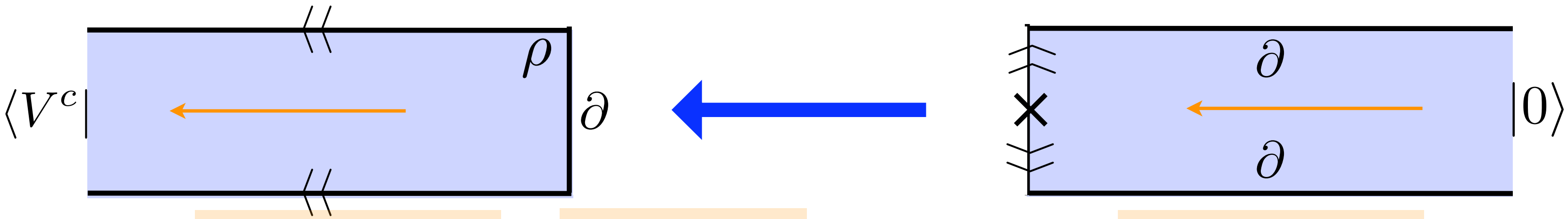
Shapiro-Thorn and OBS

$$\hat{\gamma}^{\mathrm{ST}}|0\rangle = |B^c\rangle$$



Shapiro-Thorn and OBS

$$\hat{\gamma}^{\mathrm{ST}}|0\rangle = |B^c\rangle$$



$$\langle V^c|\hat{\gamma}^{\mathrm{ST}}|0\rangle = \langle V^c|B^c\rangle$$

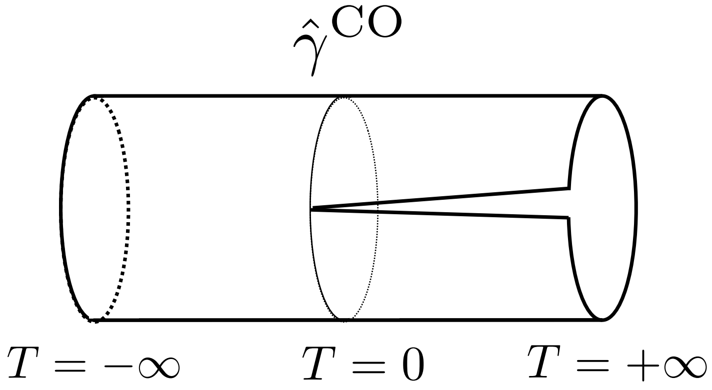
$$\langle V^c|\hat{\gamma}^{\mathrm{ST}}|0\rangle$$

Shapiro-Thorn and OBS

$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$

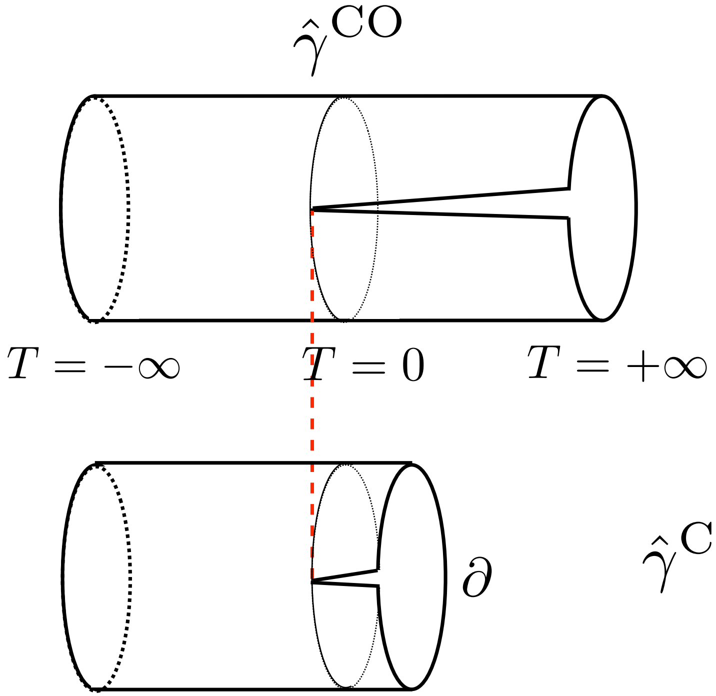
Shapiro-Thorn and OBS

$$\hat{\gamma}^{\rm CO}|B^o\rangle = |B^c\rangle$$



Shapiro-Thorn and OBS

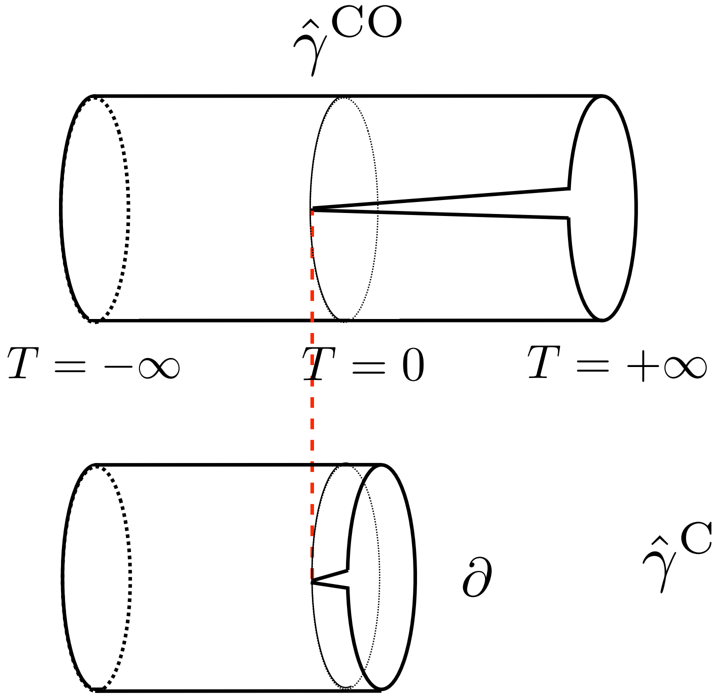
$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$



$$\hat{\gamma}^{\mathrm{CO}} e^{-i\epsilon H}|B^o\rangle$$

Shapiro-Thorn and OBS

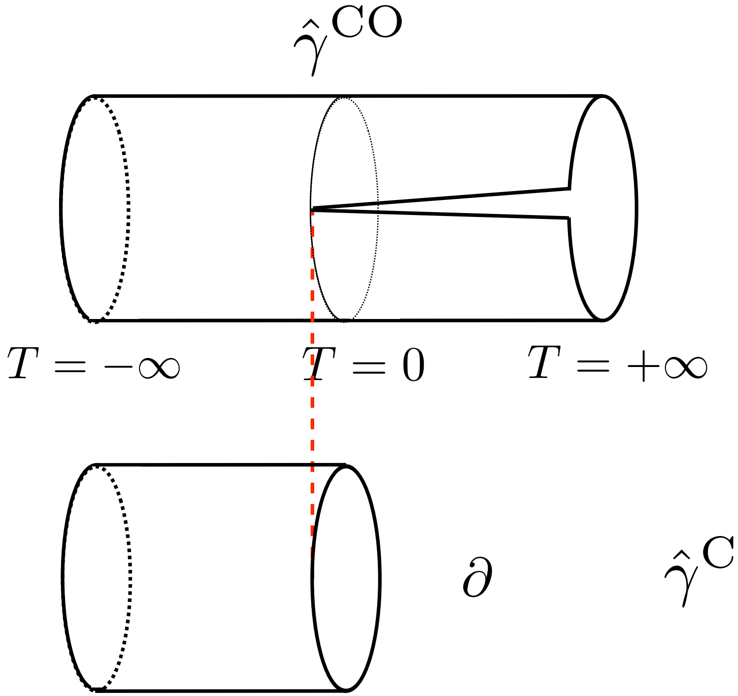
$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$



$$\hat{\gamma}^{\mathrm{CO}} e^{-i\epsilon H}|B^o\rangle$$

Shapiro-Thorn and OBS

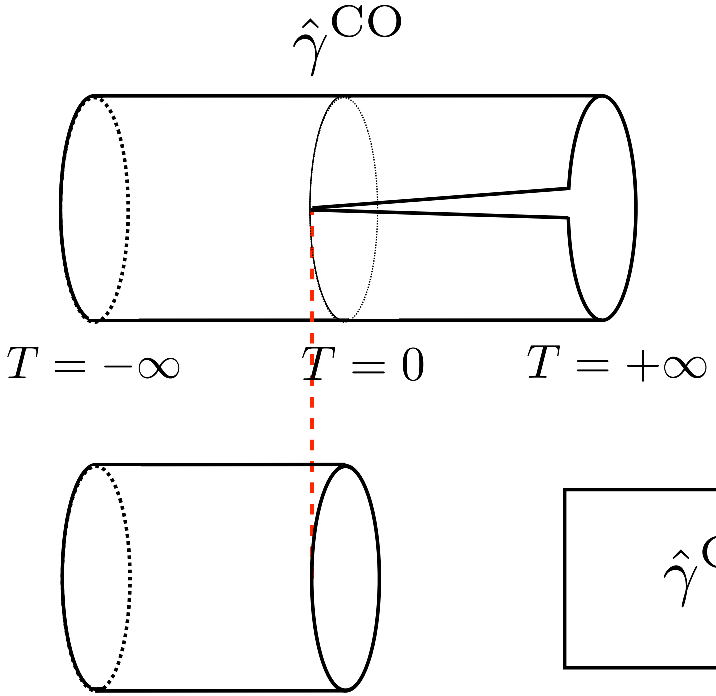
$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$



$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle$$

Shapiro-Thorn and OBS

$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$



$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$

Shapiro-Thorn and OBS

$$\hat{\gamma}^{\mathrm{ST}}|0\rangle = |B^c\rangle$$
$$\hat{\gamma}^{\mathrm{CO}}|B^o\rangle = |B^c\rangle$$

Shapiro-Thorn and OBS

$$\hat{\gamma}^{\rm ST}|0\rangle = |B^c\rangle$$

$$\hat{\gamma}^{\rm CO}|B^o\rangle = |B^c\rangle$$

$$\Downarrow$$

$$\hat{\gamma}^{\rm ST}|0\rangle = \hat{\gamma}^{\rm CO}|B^o\rangle$$

Discussion

Discussion

- In the context of Shapiro-Thorn vertex or open-closed vertex

  OBS(nothing state) naturally appears (can be introduced).

$$\hat{\gamma}^{\rm ST}|0\rangle = \hat{\gamma}^{\rm CO}|B^o\rangle$$

↓

Can we obtain any important information about branes in SFT ??

Discussion

- relation to Kawano-Kishimoto-Takahashi, Ellwood

$$\langle V^c|\hat{\gamma}^{\rm ST}|\psi_{\rm Sch}\rangle = \langle V^c|B^c\rangle$$ $\langle V^c|$: on-shell

$|\psi_{\rm Sch}\rangle$: Schnabl sol. of OSFT (corresp. to tachyon vacuum)

By using $\hat{\gamma}^{\rm ST}|0\rangle = \hat{\gamma}^{\rm CO}|B^o\rangle$ etc. naively ,

under $\langle V^c|$ (on-shell) and $\hat{\gamma}^{\rm CO}$ $|\psi_{\rm Sch}\rangle \cong |0\rangle$?!

↕ seems consistent

In the calculation by KKT, E

only $|0\rangle$ part in $|\psi_{\rm Sch}\rangle$ contributes to $\langle V^c|\hat{\gamma}^{\rm ST}|\psi_{\rm Sch}\rangle$

Discussion

- relation to Kawano-Kishimoto-Takahashi, Ellwood

$$\langle V^c|\hat{\gamma}^{\mathrm{ST}}|\psi_{\mathrm{Sch}}\rangle = \langle V^c|B^c\rangle$$ $\langle V^c|$: on-shell

$|\psi_{\mathrm{Sch}}\rangle$: Schnabl sol. of OSFT (corresp. to tachyon vacuum)

By using $\hat{\gamma}^{\mathrm{ST}}|0\rangle = \hat{\gamma}^{\mathrm{CO}}|B^o\rangle$ etc. naively ,

under $\langle V^c|$ (on-shell) and $\hat{\gamma}^{\mathrm{CO}}$ $|\psi_{\mathrm{Sch}}\rangle \cong |0\rangle$?!

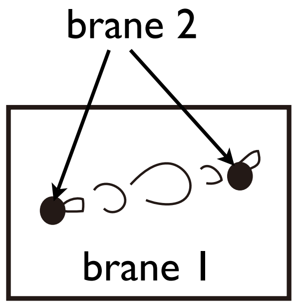
- How to interpret this result?

To what extent does $\langle V^c|\hat{\gamma}^{\mathrm{ST}}|\psi_{\mathrm{Sch}}\rangle$ contain the info. of the solution ?

on-shell closed vertex imposes very strong constraints

Discussion

・OBS : non-perturbative excitations on branes



e.g. D3-D(-1)-brane system

D(-1) as OBS

gauge field in open string emitted from D(-1)

↕

instanton solution

EoM on two-intersecting D-brane system

$$Q_B \mathbf{\Phi} + \mathbf{\Phi} * \mathbf{\Phi} = 0 \qquad \mathbf{\Phi} \equiv \begin{pmatrix} \Phi_{11} & \Phi_{12} \\ \Phi_{21} & \Phi_{22} \end{pmatrix}$$

solution Φ_{11} ⟷ instanon

relation with OBS ?