Split String Formalism & Closed String Vacuum

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New Solutions for closed string vacuum in open string field theory (generalizing Schnabl)

i) Reparameterizations (global symmetries)

ii) Large Gauge Transformations

Motivation: Split String Formalism

NCFT:

associative algebra $\mathcal{A} \longleftrightarrow$ fields on "manifold"

Operators linear functionals $\mathcal{A} \to \mathcal{A}$

If $\mathcal{A}$ NC, operators can be represented in terms of $\mathcal{A}$ itself

$$\underbrace{\partial_\mu}_{\text{operator}} \phi = -i\theta_{\mu\nu}[\underbrace{x^\nu}_{\in \mathcal{A}}, \phi]$$

In OSFT: associative $\mathcal{A}_{str}$ + many operators

Q_B, $\mathcal{L}_0$, b_{-1}, $c(x)$

Represent in terms of $\mathcal{A}_{str}$ $\Rightarrow$ SPLIT STRING FORMALISM

Solution in Split String Formalism (Okawa)

4 fields: $\underbrace{K \quad B \quad c}_{\text{operators}} \qquad F = F(K)$

Identities:

$$Bc + cB = 1 \qquad KB - BK = 0$$

$$dK = 0 \qquad dB = K \qquad dc = cKc \qquad d = Q_B$$

Solution:

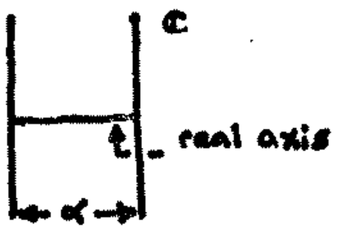
$$\boxed{\Psi = Fc\,\frac{KB}{1-F^2}\,c\,F}$$

For Schnabl: particular choice for $K\ B\ c$ and

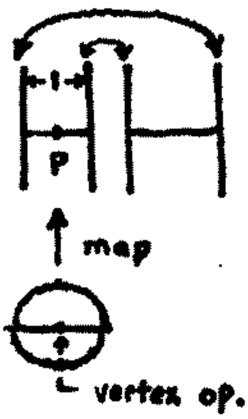
$$F = e^{K/2} = \Omega^{1/2} \leftarrow \text{"wedge state"}$$

$\uparrow$ $SL(2,\mathbb{R})$ vacuum

Map to CFT language:

$\Omega^{\alpha} \leftrightarrow$ 

strip



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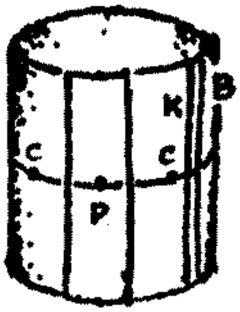
Probe strip w/ local coordinate: Correlator on cylinder

Schnabl in CFT:

$$\Psi = \sum_{\substack{\text{strip} \\ \text{length} \\ = n}}$$

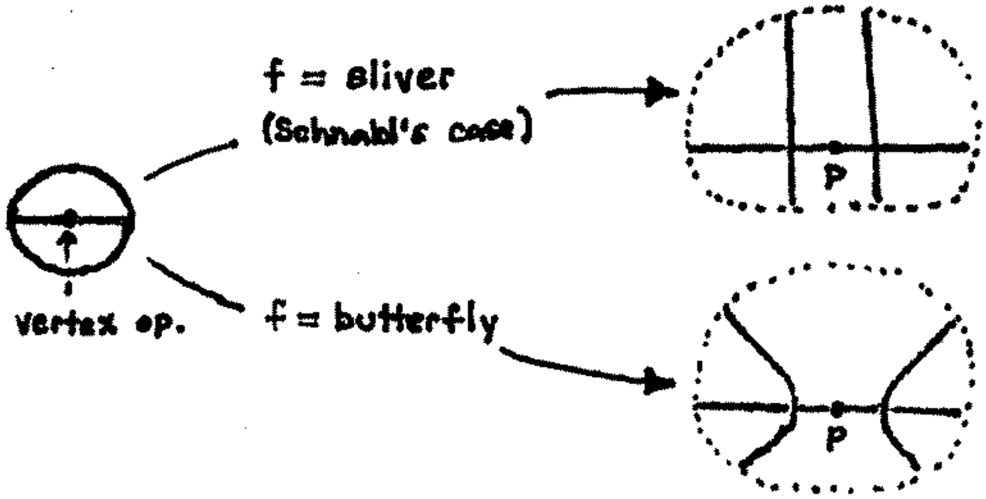


i) Generalizing K, B, c (Rastelli, Zwiebach, Okawa too)

$$K \longleftrightarrow \mathcal{L}_0 \longleftrightarrow f(\xi) \text{ s.t. } f(i) = \infty$$

Projector conformal frame

Projectors: $\Psi^2 = \Psi$



sliver $= \lim\limits_{\alpha\to\infty} \Omega^\alpha$

butterfly $= |\Omega\rangle_{\frac{1}{2}}\langle\Omega|_{\frac{1}{2}}$

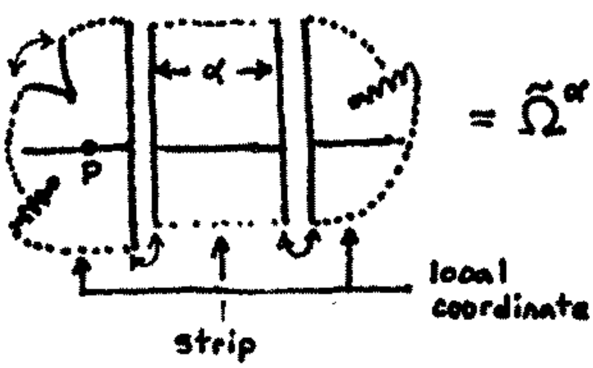
Need to understand:

$$F = e^{K/2} = \tilde{\Omega}^{1/2}$$

not $SL(2,\mathbb{R})$ vac. if $f \neq$ sliver

States $\tilde{\Omega}^\alpha$ not understood in CFT

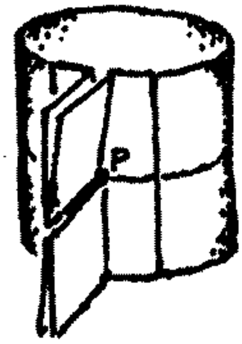
Strip Frame:



$= \tilde{\Omega}^\alpha$

- $\tilde{\Omega}^\alpha \Rightarrow$ strip of width α
- local coordinate may be complicated

e.g. butterfly frame $\Rightarrow$



$= \tilde{\Omega}^\alpha$

Construction of Schnabl's solution requires more ingredients than are actually necessary to get a solution in the split string formalism.

Suggests: Schnabl's is just one example of a huge class of new solutions.

What are they? Well-defined?

Rest of talk: 2 generalizations

i) Generalize K, B, c (reparameterizations)

ii) Generalize F (large gauge trans.)

ii) Generalizing F

Pure Wedge solutions:

$$F = e^{\gamma K/2} = \Omega^{\gamma/2}$$

$\gamma > 0$, $= 1$ for Schnabl $\longrightarrow$ reparameterizations

Composite wedge solutions:

$$F = \int dt\, f(t)\, \Omega^{t}$$

Pure wedge $\longrightarrow$ $f(t) = \delta(t - \frac{\gamma}{2})$

Conditions on $f(t)$:

1) $f(t<0) = 0$
2) $\int dt\, f(t) = 1$
3) $\int dt\, t f(t) = \frac{\gamma}{2} > 0$

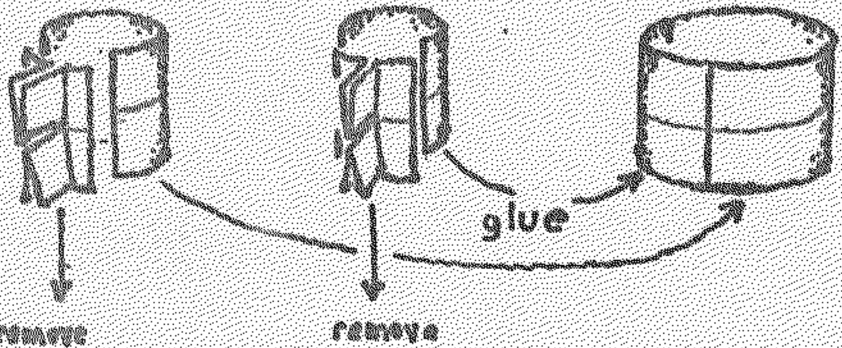
Energy: Requires $\lim_{n\to\infty} F^{n}$

If 1-3) satisfied, translates to

$$\lim_{n\to\infty} \underbrace{n f(nt)^{*n}}_{\text{convolution}} = \underbrace{\delta(t - \tfrac{\gamma}{2})}_{\text{pure wedge}}$$

All details of $f(t)$ washed out when calculating energy $\rightarrow$ Well defined energy agrees with D-brane tension

Energy: calculate inner prod. of $\tilde{\Omega}^{\alpha}$



Same cylinderical correlators, regardless of choice of projector frame $\therefore$ Same energy

Reparameterizations: (RZO) Related by symmetries of the type $L_n - (-1)^n L_{-n}$

$$K' = UKU^{+} \quad B' = UBU^{+} \quad c' = UcU^{+}$$

U = unitary string field $\quad dU = 0$

Conclusion

- Split string formalism suggests the existence of many solutions beyond the one constructed by Schnabl

- These solutions are not formal; can be given precise meaning in CFT and energies calculated