

Various Brane Configurations

From

Tachyon Condensation

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hep-th/0102173, 0102174

§1. Motivation

§2. Minahan - Zwiebach model

§3. Boundary SFT

§4. Conclusion & Discussion

§1. Motivation

Success of Open String Tachyon Condensation

- Sen's conjecture:

[One can get anything via tachyon condensation]
 ↓ [from non-BPS D9 (IIB) / $D9 - \bar{D9}$ (IIB) system.]

Developments

- Check of the scenario / descent relations
by 3/C/V-SFT
- Discovery of Stable non-BPS states
- D-branes as Solitons \rightarrow NCYM, NCSFT
- Coincides with notion of K-theory

Conceptual Contributions

- Extension of the duality web.
~ closed string tachyon.
- "Open string theory can be fundamental"

Can one get really anything?



[Check if one can get various (important)
brane configurations.]

Summary of Results :

	MZ model	BSFT
D8	○	○
D6 - D8 bound state	○	○
(F, D8) bound state	○	○
String junction	○	○
D6 ending on D8	○	○
D6 suspended b.w. D8's	○	△
(F, D6) ending on D8	✗	○
NC generalization	○	○
D8 - D6 - D4 bound state w/ B	✗	○
Dielectric D8	✗	○
⋮	⋮	⋮

Toward :

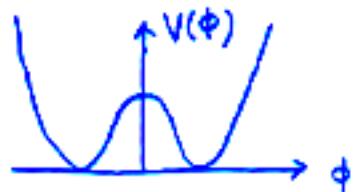
- New descriptions of lower-dim. branes ?
- Unified viewpoint of ADHM/Nahm formalism ?
- Fundamental strings ?

§2. Various Brane Configurations in Minahan-Zwiebach Model

§2-1. Minahan-Zwiebach model

(Proposed & Developed in 0008227 0008231
0009246 0011226)

$$S_{\phi=0} = \int d^Dx \left\{ \frac{1}{2} \partial_\mu \phi \partial^\mu \phi + V(\phi) \right\}$$



field
redefinition \downarrow

$$\begin{aligned} \phi &= \text{erf}(T) \\ (\partial\phi &\approx e^{-T^2} \partial T) \end{aligned}$$

$$S = \int d^Dx e^{-T^2/a} (1 + \partial_\mu T \partial^\mu T)$$

properties of this system:

- action = two derivative truncation of BSFT action on non-BPS branes
- Unstable vacuum: $T = 0$
- Stable minima: $T = \pm\infty$
- Exact kink solution: $T = \pm\infty$
- Exact spectrum around kink = equally spaced mass levels
 $M^2 = 0, 1, 2, \dots$
- Tension of the kink normalized by tachyon mass
 $\sim 1.128 \dots$

⇒ It's a nice toy model for tachyon condensation!

We employ the action

$$S = \mathcal{I} \int d^9x e^{-T^2/a} \left(1 + (\partial_\mu T)^2 + \frac{1}{2} F_{\mu\nu}^2 \right)$$

$$\begin{cases} a = 2d^3 \log 2 \\ \mathcal{I} = \sqrt{2} T Dg \end{cases} \rightsquigarrow \text{BSFT on } \underline{\text{non-BPS D9}}$$

→ Equations of motion :

$$\begin{cases} \partial_\mu^2 T + \frac{1}{a} T \left(1 - (\partial_\mu T)^2 + \frac{1}{2} F_{\mu\nu}^2 \right) = 0 \\ \partial_\mu \left(e^{-T^2/a} F_{\mu\nu} \right) = 0 \end{cases}$$

- Potential minima = Closed string vacuum

$$T = \pm \infty$$

- Kink solution = D8 (flat)

$$\begin{cases} T = \frac{g}{2} x_9 \quad w/ \quad g = 1 \\ A_\mu = 0 \end{cases} \quad \left(\frac{g}{2} \rightarrow \infty \text{ in BSFT} \right)$$

* energy :

$$\begin{aligned} E &= \mathcal{I} \int d^9x e^{-T^2/a} \left(1 + (\partial_i T)^2 + \frac{1}{2} F_{ij}^2 \right) \\ &= \mathcal{I} \int d^9x 2 e^{-x_9^2/a} \\ &= 2\sqrt{\pi} V_{D8} \mathcal{I} \quad \text{localized at } x_9 = 0 \end{aligned}$$

* CS coupling (RR charge)

$$\begin{aligned} S_{CS} &= \frac{\mathcal{I}}{\sqrt{2}} \text{Tr} \int e^{-T^2/a} C \wedge \exp[a_1 F + a_2 DT] \\ &= \frac{a_2 \mathcal{I}}{\sqrt{2}} \int C^{(9)} \wedge dx_9 e^{-x_9^2/a} = a_2 \sqrt{\frac{\pi}{2}} \mathcal{I} \int_{V_{D8}} C^{(9)} \end{aligned}$$

§2-2 D-brane bound states

① D8-D6 bound state

solution : $\begin{cases} F_{98} \text{ constant}, \\ T = \sqrt{1 + F_{98}^2} x_9. \end{cases}$

\Rightarrow RR charge:

$$S_{CS} = \frac{\alpha_1 \alpha_2 \mathcal{T}}{\sqrt{2}} \int d^9x e^{-\frac{T^2}{\alpha}} C_{01\dots 6}^{(7)} \wedge (F_{98} dx_9 \wedge dx_8) \wedge dx_7 T dx_9$$

$$+ \frac{\alpha_2 \mathcal{T}}{\sqrt{2}} \int d^9x e^{-\frac{T^2}{\alpha}} C_{0\dots 8}^{(9)} \wedge (\partial_9 T) dx_9.$$

① constant distribution of D6 charge at $x_9 = 0$.

② same D8 charge at $x_9 = 0$.

Energy : $E_{D8D6} = \underbrace{\sqrt{1 + F_{98}^2}}_{\text{Correct ratio}} \Sigma_{D8}$

Correct ratio

Another solution :

$$F_{98} = \text{const.}, \quad T = x_9 + F_{98} x_6.$$

note correct ratio? (BI? YM?)

BPS sol : $F_{98} = \partial_6 \pm \sqrt{\pm^2 - F_{98}^2} = \pm F_{98} x_6$

$$\text{energy} = 1 + \frac{1}{2} (\partial_6 \pm)^2 + \frac{1}{2} F_{98}^2 = 1 + F_{98}^2$$

$$\text{energy / unit volume} = \frac{1}{\sqrt{1 + F_{98}^2}} (1 + F_{98}^2) = \sqrt{1 + F_{98}^2}$$

② (F, D8) bound state

solution : $\begin{cases} F_{06} \text{ constant,} \\ T = \sqrt{1 - F_{06}^2} x_9 \end{cases}$

\Rightarrow Energy : $E_{(F,D8)} = \frac{1}{\sqrt{1 - F_{06}^2}} E_{D8}$

correct ratio

from DBI Hamiltonian
 $(H = Z - \bar{\pi}^\mu \dot{A}_\mu)$

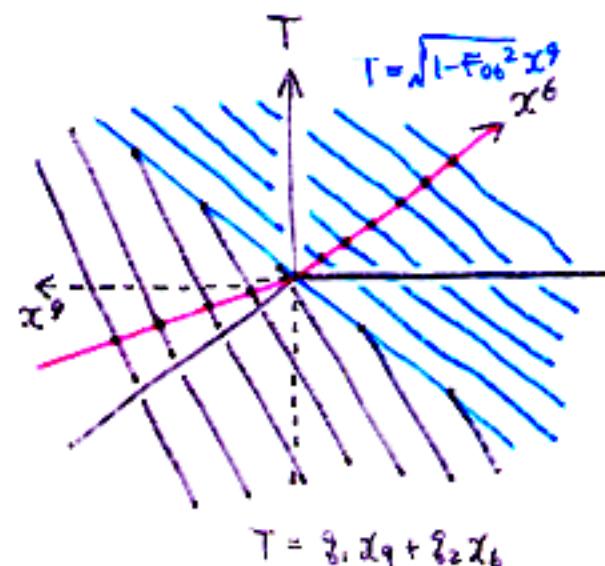
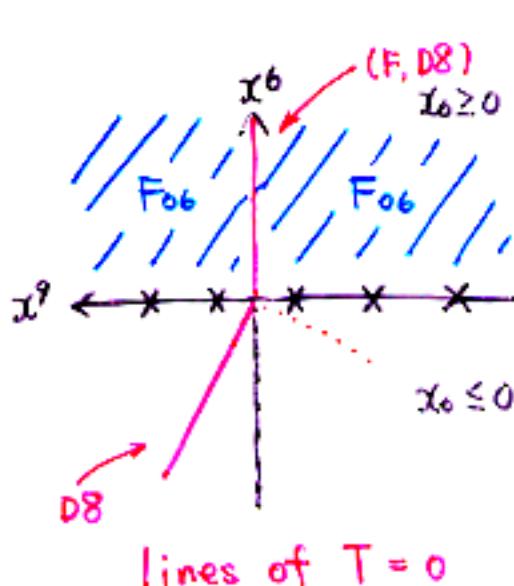
③ String junction (D8 web)

Assume that $\begin{cases} F_{06} \neq 0 \quad (x_6 \geq 0) \\ F_{06} = 0 \quad (x_6 \leq 0) \end{cases}$

\Rightarrow Solution in $x_6 \geq 0$: $T = \sqrt{1 - F_{06}^2} x_9$

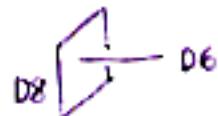
$x_6 \leq 0$: $T = g_1 x_9 + g_2 x_6$

- EOM requires $g_1^2 + g_2^2 = 1$
- Continuity requires $g_1 = \sqrt{1 - F_{06}^2}$ \Rightarrow Force balance



§2-3 Brane Ending on Brane

- D6 ending on D8

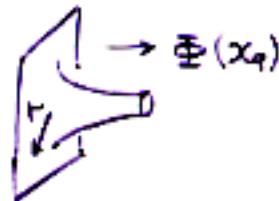


Intuition : As $g \rightarrow \infty$ in BSFT, the hyper-surface $T=0$ gives brane configurations.

Assumption : In view of BIon $\Phi = \frac{S}{r}$, we assume



$$T = g \left(x_9 - \frac{S}{r} \right)$$



Check :

$$B_i = g S \frac{x_i}{r^3} = 2i \left(\frac{-g S}{r} \right)$$

$$\begin{aligned} i &= 6, 7, 8 \\ r &= \sqrt{x_6^2 + x_7^2 + x_8^2} \\ g &= 1 \end{aligned}$$

makes EOMs satisfied.

* Bogomol'nyi bound and Energy

$$\begin{aligned} E &= \int V_{12345} \int d^4x e^{-T^2/a} \left[(1 - \partial_9 T)^2 + (\partial_i T - B_i)^2 \right] \\ &\quad + \int V_{12345} \int d^4x e^{-T^2/a} \left[\partial_9 T + \partial_i (T B_i) \right] \cdot 2 \end{aligned}$$

BPS-like equation :

$$1 = \partial_9 T, \quad \partial_i T = B_i$$

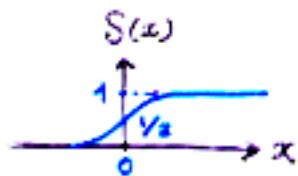
satisfied by the above sol.

The second term is in fact a surface term.

$$\text{Defining } \text{erf}(x) \equiv \frac{2}{\sqrt{\pi}} \int_0^x du e^{-u^2}$$

$$S(x) \equiv \frac{1}{2} (1 + \text{erf}(x))$$

smeared step function



then the energy is bounded by

$$E = 2\sqrt{\pi a} \int V_{12345} \left\{ d^3 x [S(T/\sqrt{a})] \right\}_{x_9=-\infty}^{\infty}$$

$$+ 2\sqrt{\pi a} \int V_{12345} \left\{ d x_9 \right\}_{r=\infty} \underbrace{d S_i}_{B_i} (B_i S(x_9/\sqrt{a}))$$

$$= 2\sqrt{\pi a} \int V_{D8} \quad \leftarrow \text{Energy of D8}$$

$$+ 8\pi s \sqrt{\pi a} \int V_{12345} \underbrace{\left\{ d x_9 S(x_9/\sqrt{a}) \right\}}_{\text{Energy of D6}}$$

Energy of D6 is distributed
only on $x_9 \geq 0, x_{678} = 0$

* RR charge for D6

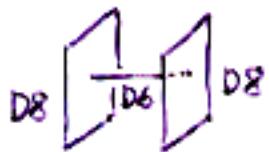
$$S_{CS} = \frac{1}{\sqrt{2}} \int e^{-T^2/a} C^{(6)} \wedge a_1 a_2 \underbrace{dT \wedge F}_{||} \\ \frac{S^2}{F^4} dx_6 \wedge dx_7 \wedge dx_8 + \dots$$

$$= \frac{a_1 a_2}{\sqrt{2}} \int d^6 x \int d x_9 \int d^3 x C_{0123459} \underbrace{\frac{S^2}{F^4} e^{-T^2/a}}_{2iT B_i}$$

$$= \frac{4\pi^{3/2} a_1 a_2}{\sqrt{2}} \int d^6 x \int d x_9 C_{0123459} \underbrace{S(x_9/\sqrt{a})}_{OK} \\ (\text{sharper in } g \rightarrow \infty)$$

§ 2-4 Brane Suspended Between Two Parallel Branes

- D8 - D6 - D8



We start with 2 D9-branes. Action:

$$S = \int \text{Str} \left\{ d^{10}x \ e^{-T^2/a} \left(\mathbb{1} + D_\mu T D^\mu T + \frac{1}{2} F_{\mu\nu} F^{\mu\nu} \right) \right\}$$

Symmetrization of U(2) matrices w.r.t.

T (in $e^{-T^2/a}$), $D_\mu T$ and $F_{\mu\nu}$.

↓

E.O.M.

$$\frac{\delta S}{\delta T} = \sum_{\text{sym}} \left[e^{-T^2/a} \left(-2 D_\mu D^\mu T - \frac{2}{a} T \left(\mathbb{1} - D_\mu T D^\mu T + \frac{1}{2} F_{\mu\nu} F^{\mu\nu} \right) \right) \right] = 0,$$

$$\frac{\delta S}{\delta A_\mu} = \sum_{\text{sym}} \left[D_\mu \left(e^{-T^2/a} F^{\mu\nu} \right) + [T, e^{-T^2/a} D_\nu T] \right] = 0.$$

↓

solution:

$$\begin{cases} T = x_9 \mathbb{1} + \Phi & \left(\Phi = x_a \frac{F(r)}{r} \frac{1}{2} \sigma_{a-5} \right) \\ A_i = \epsilon_{aij} x_j \frac{W(r)}{r} \frac{1}{2} \sigma_{a-5} \end{cases}$$

$$F(r) = \frac{c}{\tanh(cr)} - \frac{1}{r}, \quad W(r) = \frac{1}{r} - \frac{c}{\sinh(cr)}$$

Φ, A_i : 't Hooft - Polyakov SU(2) monopole

$$B_i + D_i \Phi = 0$$

⇒ BPS-like equation: $\partial_9 T = \mathbb{1}$, $D_i T + B_i = 0$

★ Energy

Substituting the BPS-like equations &
Arranging the energy formula in the same manner,
we have

$$\mathcal{E} = \text{Tr} \left(2\sqrt{\pi a} \int d^8x \left[S(T/\sqrt{a}) \right]_{x_9=-\infty}^{+\infty} - 2\sqrt{\pi a} \int_{r=\infty} d^5x \int dS_i [S(T/\sqrt{a}) B_i] \right)$$

(where we have defined the error function by its
Taylor expansion around the origin.)

- the first term :

$$x_9 \sim \pm\infty \Rightarrow T \sim x_9 \mp L \Rightarrow S(T/\sqrt{a}) \sim \begin{cases} \frac{1}{2} & (+\infty) \\ 0 & (-\infty) \end{cases}$$

$\Rightarrow 2 \times D8$ tension

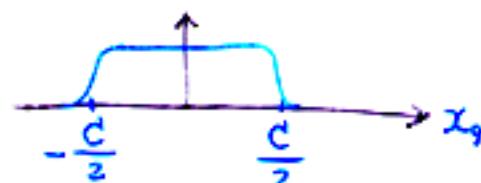
- the second term :

around $r \sim \infty$, we can diagonalize

$$T \cong \begin{pmatrix} x_9 + \frac{c}{2} & 0 \\ 0 & x_9 - \frac{c}{2} \end{pmatrix}, \quad B_i \cong \frac{-1}{2} \frac{x_i}{r^3} \sigma_3$$

$$\begin{aligned} \Rightarrow \mathcal{E}_{D6} &= 2\sqrt{\pi a} V_{12345} \text{Tr} \int dx_9 \begin{pmatrix} S\left(\frac{x_9+c/2}{\sqrt{a}}\right) & 0 \\ 0 & S\left(\frac{x_9-c/2}{\sqrt{a}}\right) \end{pmatrix} 2\pi \sigma_3 \\ &= 4\pi\sqrt{\pi a} V_{12345} \int dx_9 \left(S\left(\frac{x_9+c/2}{\sqrt{a}}\right) - S\left(\frac{x_9-c/2}{\sqrt{a}}\right) \right). \end{aligned}$$

D6 energy localizes
at $-\frac{c}{2} \leq x_9 \leq \frac{c}{2}$



§3. Lift to the Boundary SFT

§3-1. BSFT action & E.O.M.

In BSFT, a linear tachyon profile & constant field strength

gives

$$S = -T_{D9} \int d^{10}x \text{Tr} \left(e^{-T^2 2\pi \alpha'} \right) \times \frac{\prod_{r=1/2}^{\infty} \det(\eta_{\mu\nu} + 2\pi \alpha' F_{\mu\nu} + 4\pi (\alpha')^2 \frac{D_{\mu\nu} TD_{\nu\rho} T}{r})}{\prod_{n=1/2}^{\infty} \det(n(\eta_{\mu\nu} + 2\pi \alpha' F_{\mu\nu}) + 4\pi (\alpha')^2 D_{\mu\nu} TD_{\nu\rho} T)} \\ + \mathcal{O}(\partial F, \partial \partial T).$$

- If $A_\mu = 0$, $S = -T_{D9} \int d^{10}x e^{-2\pi \alpha' T^2} F [4\pi (\alpha')^2 \partial_\mu T \partial^\mu T]$.
 $(F[x] = x^4 \Gamma(x)^2 / 2\Gamma(2x))$

- If $F_{\mu\nu} \neq 0$ & $\partial_\mu T = 0$

$F_{ij} = 0 \quad \& \quad \partial_i T \neq 0,$

$S = -T_{D9} \int d^{10}x e^{-2\pi \alpha' T^2} F [4\pi (\alpha')^2 \partial_i T \partial^i T] \sqrt{-\det(\eta_{\mu\nu} + 2\pi \alpha' F_{\mu\nu})}$

- If F depends on $x_6, 7, 8$ & T depends on $x_6, 7, 8, 9$,

$S = -T_{D9} \int d^{10}x e^{-2\pi \alpha' T^2} \sqrt{-\det(\eta_{ab} + 2\pi \alpha' F_{ab})} \\ \times F \left[4\pi (\alpha')^2 \left\{ (\partial_9 T)^2 + \frac{((\partial_i T)^2 - (2\pi \alpha' \epsilon_{ijk} E_j \partial_k T)^2) + (2\pi \alpha' B_i \partial_i T)^2}{-\det(\eta_{ab} + 2\pi \alpha' F_{ab})} \right\} \right].$

$a, b = 0, 6, 7, 8 \quad i, j = 6, 7, 8$

★ E.O.M.

In all the solutions below,

$$T \propto g, \quad g \rightarrow \infty$$

\Rightarrow We can ignore the contributions of lower order in g .

\Rightarrow EOM for tachyon: $F - \partial_\mu T \frac{\delta F}{\delta \partial_\mu T} = 0$

may be trivially satisfied by the identity

$$F[a] = 2a F'[a] \quad \text{for } a \rightarrow \infty.$$

(note depending on the argument of F .)

$$\begin{cases} a \sim (\beta T)^2 \Rightarrow \text{trivial} \\ a \sim f(E, B) \propto (\beta T)^2 \Rightarrow \text{nontrivial.} \end{cases}$$

- Gauge EOMs

$$\epsilon_{ijk} \partial_j \frac{\delta \mathcal{L}}{\delta B_i} = 0, \quad \partial_i \frac{\delta \mathcal{L}}{\delta E_i} = 0.$$

- CS term

$$S_{CS} = T D^9 \int C \wedge Tr e^{2\pi i \alpha' (F - T^2 + DT)}$$

§ 3-2 Brane bound states in BSFT

- flat D8 $T = g \frac{x_9}{\sqrt{\alpha'}} \quad w/ \quad g \rightarrow \infty \quad : \text{kink sol.}$

D8-brane localizes at $x_9 = 0$.

$$\begin{aligned} \text{Energy} : \quad \mathcal{E} &= T_{D9} \int d^9x e^{-2\pi\alpha' g^2 x_9^2/\alpha'} F[4\pi\alpha' g^2] \\ &= T_{D8} \int d^9x \delta(x_9) \\ &\left\{ \begin{array}{l} F[4\pi\alpha' g^2] = \sqrt{4\pi^2 \alpha'} g + \frac{1}{8} \frac{\sqrt{\pi}}{\sqrt{4\pi\alpha'} g} + \mathcal{O}(g^{-3}) \\ T_{D8} = T_{D9} \sqrt{2\pi^2 \alpha'} \end{array} \right. \end{aligned}$$

- D8-D6 bound state $\left\{ \begin{array}{l} T = g \frac{x_9}{\sqrt{\alpha'}} \quad w/ \quad g \rightarrow \infty , \\ B_6 = \text{const.} \end{array} \right.$

$$\mathcal{E} = \sqrt{1 + (2\pi\alpha' B_6)^2} T_{D8} \int d^8x = \sqrt{T_{D8}^2 + (N T_{D6})^2} V_{D8} .$$

$$\therefore N_{D6} = B_6 / 2\pi .$$

$$S_{CS} \Big|_{D6} = T_{D9} \int e^{-2\pi\alpha' T^2} (2\pi\alpha')^2 dT \wedge F = T_{D6} \underbrace{\frac{B_6}{2\pi}}_{\sim} \int dx_7 dx_8 .$$

- (F, D8) bound state

$$T = g \frac{x_9}{\sqrt{\alpha'}} , \quad E_6 = \text{const.}$$

$$\text{conjugate momentum} \quad \Pi_A = \frac{(2\pi\alpha')^2 E_6}{\sqrt{1 - (2\pi\alpha' E_6)^2}} T_{D8} V_{D8} (= N\ell)$$

$$\Rightarrow \text{Energy} \quad \mathcal{E} = \Pi_A E_6 - \mathcal{L}$$

$$= \sqrt{(T_{D8} V_{D8})^2 + (N\ell / 2\pi\alpha')^2} .$$

§3-3 Brane Ending on Brane in BSFT

• D6 ⊥ D8

solution:
$$\begin{cases} T = g \left(\frac{x_9}{\sqrt{\alpha'}} + \pi N \frac{\sqrt{\alpha'}}{r} \right), \\ B_i = N \frac{x_i}{2r^3}, \quad i = 6, 7, 8 \end{cases}$$

★ tachyon EOM? BPS-like eq. $\partial_i T = \frac{-g}{\sqrt{\alpha'}} 2\pi\alpha' B_i$

argument of F :
$$\begin{aligned} a &= 4\pi(\alpha')^2 \left((\partial_9 T)^2 + \frac{(\partial_i T)^2 + (2\pi\alpha' B_i \partial_i T)^2}{1 + (2\pi\alpha' B_i)^2} \right) \\ &= 4\pi\alpha' g^2 \left(1 + \frac{(\pi N \alpha')^2}{r^4} \right) \end{aligned}$$

BPS-like eq. $\Rightarrow F[a] = 2a F'[a]$.

★ Energy

$$\begin{aligned} \mathcal{E} &= T_{D9} \int d^8x dx_9 e^{-2\pi g^2 \left(x_9 + \frac{\pi\alpha' N}{r} \right)^2} \underbrace{\sqrt{\pi\alpha'}}_{\text{from } F[a]} \underbrace{\sqrt{1 + \frac{(\pi\alpha' N)^2}{r^4}}}_{\substack{\text{from } \sqrt{\det(M+F)} \\ \rightarrow \text{perfect square}}} \\ &\quad = \underbrace{\dots}_{=} T_{D8} V_{D8} + N T_{D6} \int d^5x \underbrace{\int dx_9 \theta(-x_9)}_{\text{Now not smeared.}} \end{aligned}$$

★ RR charge

\rightarrow precisely the same except that now we have exact amount of charges.

§3-4. New Configurations in BSFT

① (F, D6) ending on D8

solution :
$$\begin{cases} T = \frac{g}{f\alpha'} \left(x_9 + \cosh \alpha \frac{\pi N \alpha'}{r} \right), \\ B_i = N \frac{x_i}{2r^3}, \quad E_i = \sinh \alpha \cdot N \frac{x_i}{2r^3} \end{cases}$$

EOM for E_i ?

$$\Pi_{Ai} = \frac{\delta \mathcal{L}}{\delta E_i} = T_{D9}(2\pi\alpha') e^{-2\pi g^2 \left(x_9 + \cosh \alpha \frac{\pi N \alpha'}{r} \right)^2} \times \sqrt{4\pi^2 \alpha'} g \sinh \alpha \frac{\pi N \alpha'}{r^3} x_i$$

$$\Rightarrow 0 = \partial_i \Pi_{Ai} \propto \partial_i \left(\delta \left(x_9 + \cosh \alpha \frac{\pi N \alpha'}{r} \right) \frac{x_i}{r^3} \right) \stackrel{?}{=} 0$$

Resolution: We missed $\Pi_9 \neq 0$! ← due to $E_i \partial_i T$ coupling

$$\Pi_9 = \frac{\delta \mathcal{L}}{\delta E_9} = T_{D9}(2\pi\alpha') e^{-2\pi g^2 \left(x_9 + \cosh \alpha \frac{\pi N \alpha'}{r} \right)^2} \times \sqrt{4\pi^2 \alpha'} g \cosh \alpha \sinh \alpha \frac{(\pi N \alpha')^2}{r^4}.$$

$$\Rightarrow \partial_i \Pi_{Ai} + \partial_9 \Pi_9 = 0 \quad \underline{\text{OK.}}$$

* Energy

$$E = \Pi_{Ai} E_i - L$$

$$= T_{D9} \sqrt{2\pi f\alpha'} \int d^8 x \quad \leftarrow D8$$

$$+ T_{D9} 2 (2\pi^2 \alpha')^{3/2} N \underbrace{\cosh \alpha}_{\sqrt{1 + \sinh^2 \alpha}} \int d^5 x \int d x_9 \theta(-x) .$$

\nearrow (F, D6)

② Non-Commutative Instanton

We can easily construct localized D4 on D8 w/ B-field.
 $(= \text{D4-D6-D8 bound state})$

$$T = \frac{g}{\sqrt{\alpha'}} x_9, \quad A_i = B_{ij}^{\text{NS}} x_j h(r)$$

$$i,j = 5, 6, 7, 8 \quad r = \sqrt{x_5^2 + \dots + x_8^2}$$

$h(r) : U(1)$ instanton solution

$$2h^2 - \left(1 + \frac{1}{(2\pi\alpha' B^+)^2}\right)h = \frac{4N}{(B^+)^2 r^4}.$$

③ Dielectric D8

Spherical D8 w/ D6 in uniform RR 9-form.

- solution: $\begin{cases} T = \frac{g}{\sqrt{\alpha'}} (r - R) & r = \sqrt{x_6^2 + x_7^2 + x_8^2}, g \rightarrow \infty \\ B_i = N \frac{x_i}{2r^3} & (F = \frac{N}{2} d\Omega_2) \end{cases}$

- EOMs are satisfied.
- Energy:

$$\mathcal{E} = T_{D9} \left\{ d^6x \left[4\pi \sqrt{2\pi^2 \alpha'} \sqrt{R^4 + (\pi\alpha' N)^2} - \frac{4\pi}{\sqrt{2\alpha'}} c R^3 \right] \right. \\ \left. (C^{(9)} = c dt \wedge dV_R \wedge R^3 d\Omega_2) \right)$$

This is the same as Myers' original expression.

$$\text{minimum: } R = \frac{3}{4} c N \quad (R \ll \sqrt{\pi\alpha' N} \text{ app.})$$

§4. Conclusion and Discussion

Result We've found various solutions representing stable D-brane configurations, in MZ model and boundary SFT.

||

Partial confirmation of Sen's conjecture.

Problems in our approach:

We have used low energy approximation.

→ Exact tachyon condensation?

- Inclusion of higher order terms
- Derivation of BSFT action in a different background
- Supersymmetry? → BPS-like equation.

Consistency w/ Terashima-Uesugi?

Observation of our results:

(1) New representation for D6?

- $C \rightarrow \infty$ in D8-D6-D8 $\Rightarrow F(r) \sim C - \frac{1}{r} \rightarrow \infty$ X
- $c \rightarrow 0$ in Dielectric D8 ?

(2) Unified view of Nahm construction?

(3) Fundamental strings?

- F1 ending on D8 X

Immediate Generalization of our results:

- Nahm construction of D8 from multiple D6's.
 - (1) Prepare 4 D9s.
 - (2) Produce 2 D6s via tachyon condensation.
 - (3) Turn on the fluctuation around it:

$$\dot{\Psi}_i = -\frac{1}{x_9} \sigma_i$$

satisfying Nahm equation (= BPS eq. on D6)

$$\partial_9 \Psi_i = \epsilon_{ijk} \Psi_j \Psi_k$$

- (4) Ψ 's form a D8 perpendicular to D6.

Solution: $T = \frac{1}{2} \left(\sigma_1 x_1 \otimes \mathbf{1} + \sigma_2 \otimes \sigma_3 / x_9 \right)$?
 making 2D6s Ψ

- 2 D6s intersecting with each other, sharing 4+1 d. w.v.

$$T = \frac{1}{2} \left[\sigma_1 \left(x_6 - s \frac{x_4}{x_4^2 + x_5^2} \right) + \sigma_2 \left(x_7 + s \frac{x_5}{x_4^2 + x_5^2} \right) + \sigma_3 x_8 \right] ?$$

- Tachyon condensation in IIB, $D9 - \bar{D9}$?

$$S = \int d^{10}x [e^{-T\bar{T}} (1 + D_\mu \bar{T} D_\mu T + (F_{\mu\nu}^+)^2 + (F_{\mu\nu}^-)^2)]$$

non-BPS reduction: $T = \bar{T}$, $F^+ = F^-$.

Future possibility

- "One-matrix" representation of IKKT/BFSS system