

Pure Gauge Configurations and Tachyon Solutions to String Field Theories Equations of Motion

Grigoryev Dmitry

Steklov Mathematical Institute RAS

April 13, 2009

Set Up

- ▶ $\langle\langle \dots \rangle\rangle = \langle Y_{-2} \dots \rangle$
- ▶ Action for fermionic string

$$S(\Phi_+, \Phi_-) = \frac{1}{2} \langle\langle \Phi_+, Q\Phi_+ \rangle\rangle + \frac{1}{2} \langle\langle \Phi_-, Q\Phi_- \rangle\rangle + \frac{1}{3} \langle\langle \Phi_+, \Phi_+ * \Phi_+ \rangle\rangle - \langle\langle \Phi_+, \Phi_- * \Phi_- \rangle\rangle \quad (1.1)$$

- ▶ Equations of motion

$$\begin{cases} Q\Phi_+ + \Phi_+ * \Phi_+ - \Phi_- * \Phi_- = 0, \\ Q\Phi_- + \Phi_+ * \Phi_- - \Phi_- * \Phi_+ = 0. \end{cases} \quad (1.2)$$

Relations needed for calculations

$$\begin{aligned} \{B, c\} &= 1, & [K, B] &= 0, & B^2 &= c^2 = 0, \\ [B, \gamma] &= 0, & [c, \gamma] &= 0, \\ dK &= 0, & dB &= K, \\ dc &= cKc - \gamma^2, \\ d\gamma &= cK\gamma - \frac{1}{2}\gamma Kc - \frac{1}{2}\gamma cK, \\ d\gamma^2 &= cK\gamma^2 - \gamma^2 Kc, \end{aligned} \tag{1.3}$$

Notations

$$\begin{aligned}\zeta'_0 &= FcKBcF + FB\gamma^2F, \\ \xi'_0 &= FcKB\gamma F + \frac{1}{2}FB\gamma KcF + \frac{1}{2}FB\gamma cKF, \\ \zeta'_n &= \psi'_n + \chi'_n, \quad n > 0, \\ \xi'_n &= \vartheta'_n + \eta'_n, \quad n > 0,\end{aligned}\tag{1.4}$$

$$\begin{aligned}\psi'_n &= Fc\Omega^n KBcF, \quad n > 0, \\ \chi'_n &= F\gamma\Omega^n KB\gamma F, \quad n > 0, \\ \vartheta'_n &= F\gamma\Omega^n KBcF, \quad n > 0, \\ \eta'_n &= Fc\Omega^n KB\gamma F, \quad n > 0.\end{aligned}\tag{1.5}$$

AGM solution

- ▶ Pure-gauge solution for $\lambda < 1$

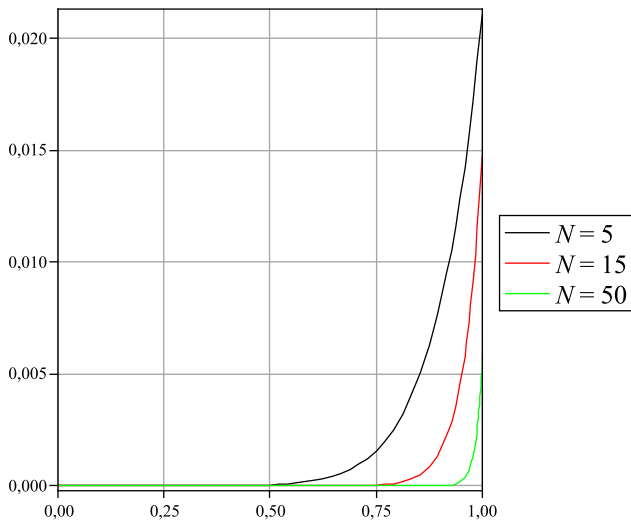
$$\begin{aligned}\Phi_{+,N}(\lambda) &= \sum_{n=0}^N \lambda^{n+1} \zeta'_n, \\ \Phi_{-,N}(\lambda) &= \sum_{n=0}^N \lambda^{n+1} \xi'_n;\end{aligned}\tag{1.6}$$

- ▶ Regularized non pure-gauge solution for $\lambda = 1$

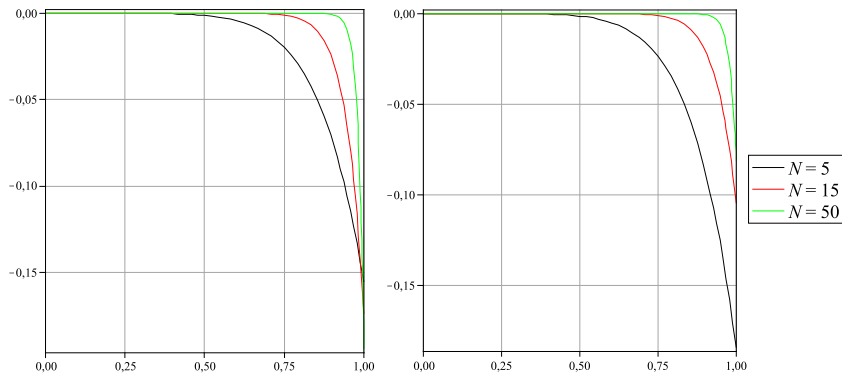
$$\begin{aligned}\Phi_{+,N}^R &= \sum_{n=0}^N \zeta'_n - \zeta_N - \frac{1}{2} \zeta'_N, \\ \Phi_{-,N}^R &= \sum_{n=0}^N \xi'_n - \xi_N - \frac{1}{2} \xi'_N.\end{aligned}\tag{1.7}$$

- ▶ hep-th/0804.2017

Contraction of equations of motion for $\Phi_{+,N}(\lambda)$,
 $N = 5, 10, 15, 20, 50$ with ζ'_0

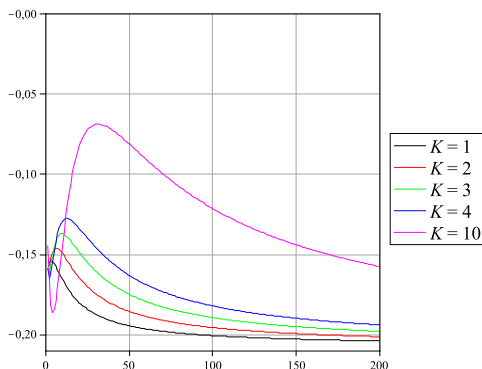


Contraction of equations of motion for $\Phi_{+,N}(\lambda)$,
 $N = 5, 10, 15, 20, 50$ with ψ_1 and ψ_{10}



Necessity of phantom terms

Contraction of equations of motion for $\Phi_{+,N}(\lambda = 1)$ with ψ_K for $K = 1, 2, 3, 4, 10$



K	1	2	10
contraction for $\Phi_{+,1000}(\lambda = 1)$	-0.20649	-0.20594	-0.19605

Finding phantom terms

- ▶ Solution with "unknown" phantom terms

$$\Phi_{+,N}^R(a, b) = \sum_{n=0}^N \zeta'_n + a\zeta_N + b\zeta'_N, \quad (2.8)$$

$$\Phi_{-,N}^R(c, d) = \sum_{n=0}^N \xi'_n + c\xi_N + d\xi'_N.$$

- ▶ We contract E.O.M. for these configurations with different states

$$\begin{cases} \text{contraction with } \zeta'_0 = 0, \\ \text{contraction with } \psi_1 = 0. \end{cases} \quad (2.9)$$

Finding phantom terms - results

► $GSO(+)$

N	a	b
1	-1.009276758	-0.4947687297
5	-1.002887587	-0.4802195028
10	-1.001361647	-0.4839491795
50	-0.999973303	-0.5013822672
100	-0.999996393	-0.5003673241

► $GSO(-)$

N	c	d
1	-1.021127911	-0.4547206603
5	-0.9958034182	-0.5258588923
10	-0.9996956796	-0.5033484993
50	-0.999993154	-0.5000348047
100	-0.999999396	-0.5000061487

► Exact values are $a = c = -1$ and $b = d = -\frac{1}{2}$.

Calculation of action

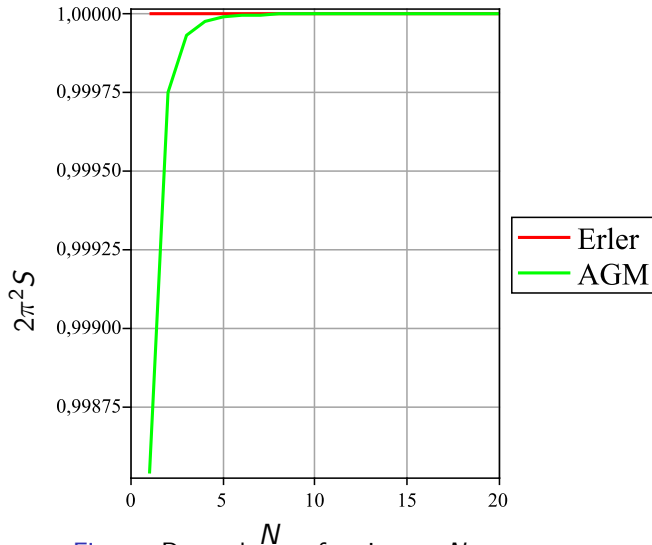


Figure: Dependence of action on N .

Calculation of action

N	$2\pi^2 S(\Phi_{+,N}, \Phi_{-,N})$
1	0.998538383
5	0.999990263
10	0.999999488
15	0.999999919
20	0.999999979
30	0.999999997

Schnabl's solution(2005)

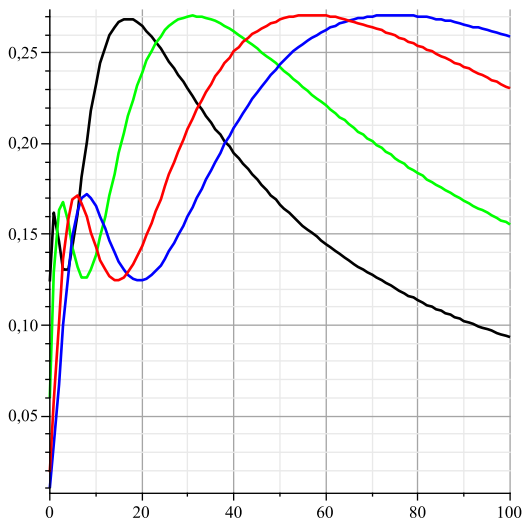


Figure: Residual of equations of motion for Φ_N contracted with φ_K depending on N for $K = 4, 8, 15, 20$