On numerical solutions in open string field theory

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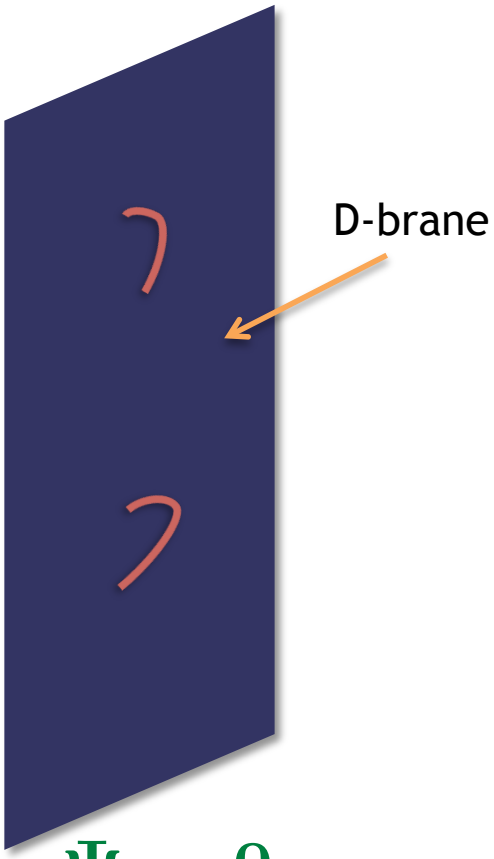
based on collaboration with
Tomohiko Takahashi (Nara Women's Univ.)
Refs.
I.K. and T.T. : arXiv:0910.3025, 0910.3026
(and recent numerical results)

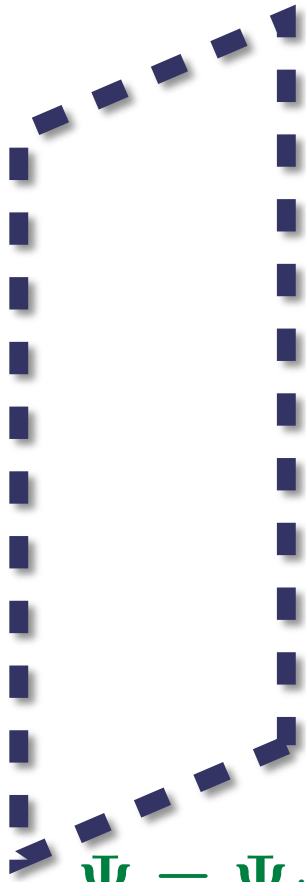
April 21 (2010) lunch seminar@YITP

Non-perturbative vacuum in open bosonic string field theory



$\Psi = 0$

Sen's conjecture (1999)



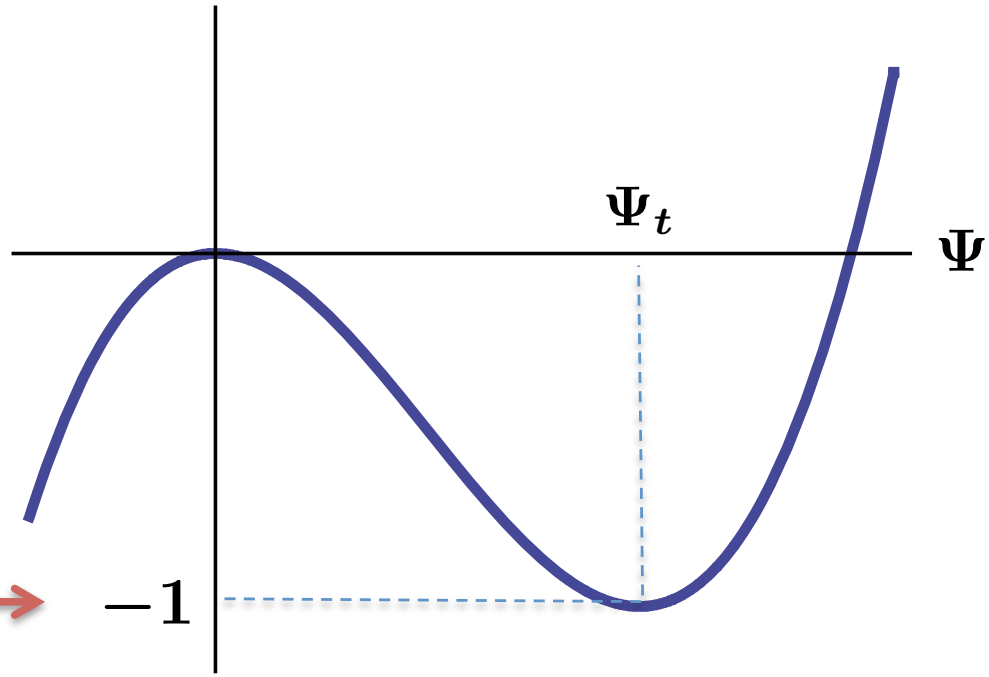
Solution to the EOM:

$$Q\Psi + \Psi * \Psi = 0$$

$\Psi = \Psi_t$

Potential height at the solution

$$V[\Psi] = -S[\Psi]/(T_{25}V_{26})$$ ← Normalized by D-brane tension



Conjecture →

Potential height for the tachyon vacuum solution in the Siegel gauge

L	$V[\Psi_t]$
0	-0.6846162
2	-0.9593766
4	-0.9878218
6	-0.9951771
8	-0.9979301
10	-0.9991825
12	-0.9998223
14	-1.0001737
16	-1.0003755
18	-1.0004937
20	-1.0005630
22	-1.0006023
24	-1.0006227

[Sen-Zwiebach(1999), Moeller-Taylor(2000), Gaitto-Rastelli(2002)]

RICC@RIKEN and PC cluster @Nara women's Univ. are used for our computation

[Kishimoto-Takahashi,arXiv:0910.3025]

[Kishimoto-Takahashi, talk@APCTP(2009.12)]

COMMENTS ON OUR NEW RESULTS

- Straightforward extrapolation of potential height

fitting function: $F_N(L) = \sum_{n=0}^{N} \frac{a_n}{(L+1)^n}$ [Gaiotto-Rastelli (2002)]

Using data for *L*=0,2,4,6,8,10,12,14,16 and *N*=9, we have

$$F_{N=9}(L=18) = -1.0004937$$

$$F_{N=9}(L=20) = -1.0005630$$

$$F_{N=9}(L=22) = -1.0006023$$

$$F_{N=9}(L=24) = -1.0006229$$

$$F_{N=9}(L=\infty) = -1.0000293$$

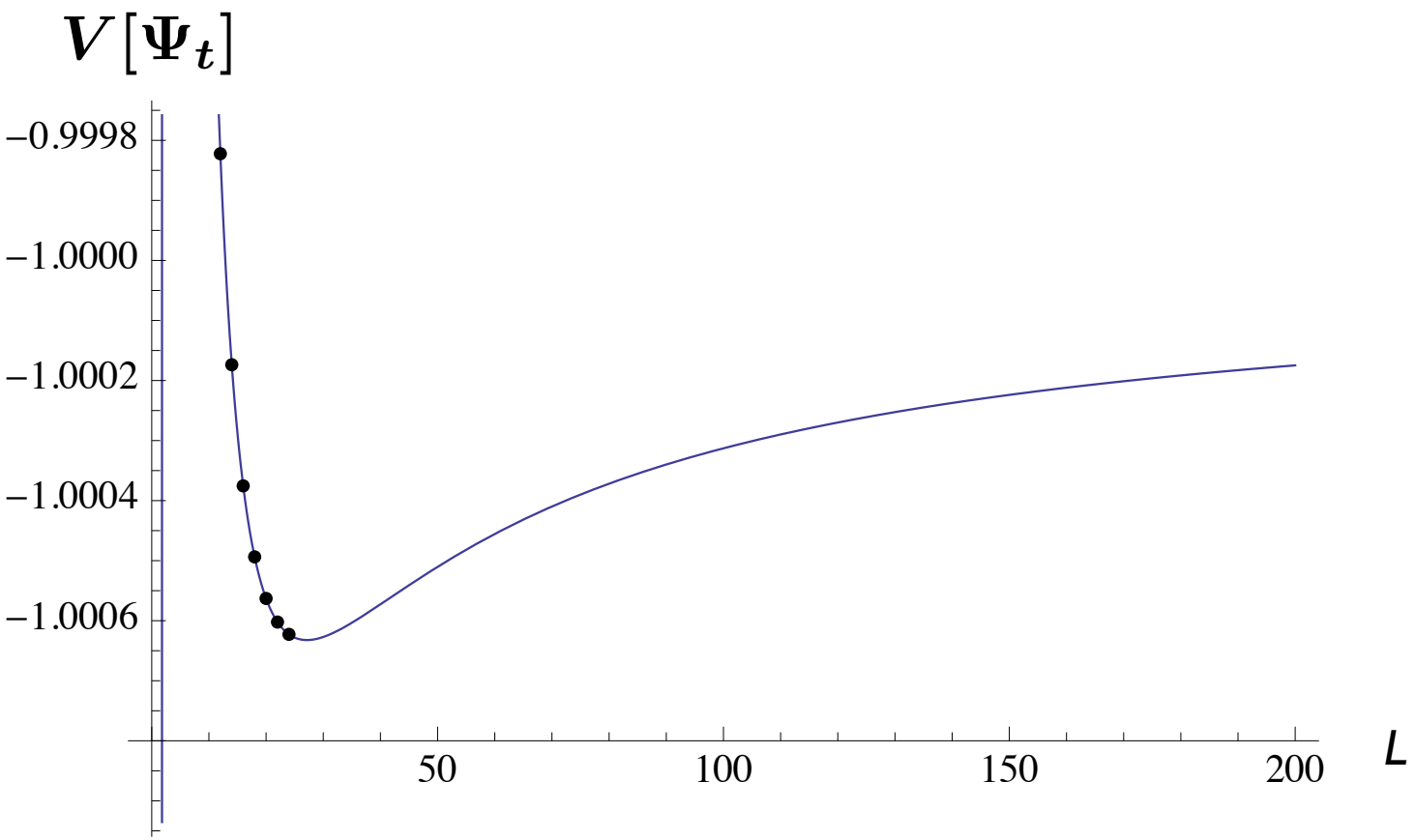
Good coincidence with our direct computation!

EXTRAPOLATION OF POTENTIAL HEIGHT

Using data for L=0,2,4,6,8,10,12,14,16,18,20,22,24 and N=13, we have

$$F_{N=13}(L=\infty) = -1.0000075$$

The extrapolated value further approaches -1.

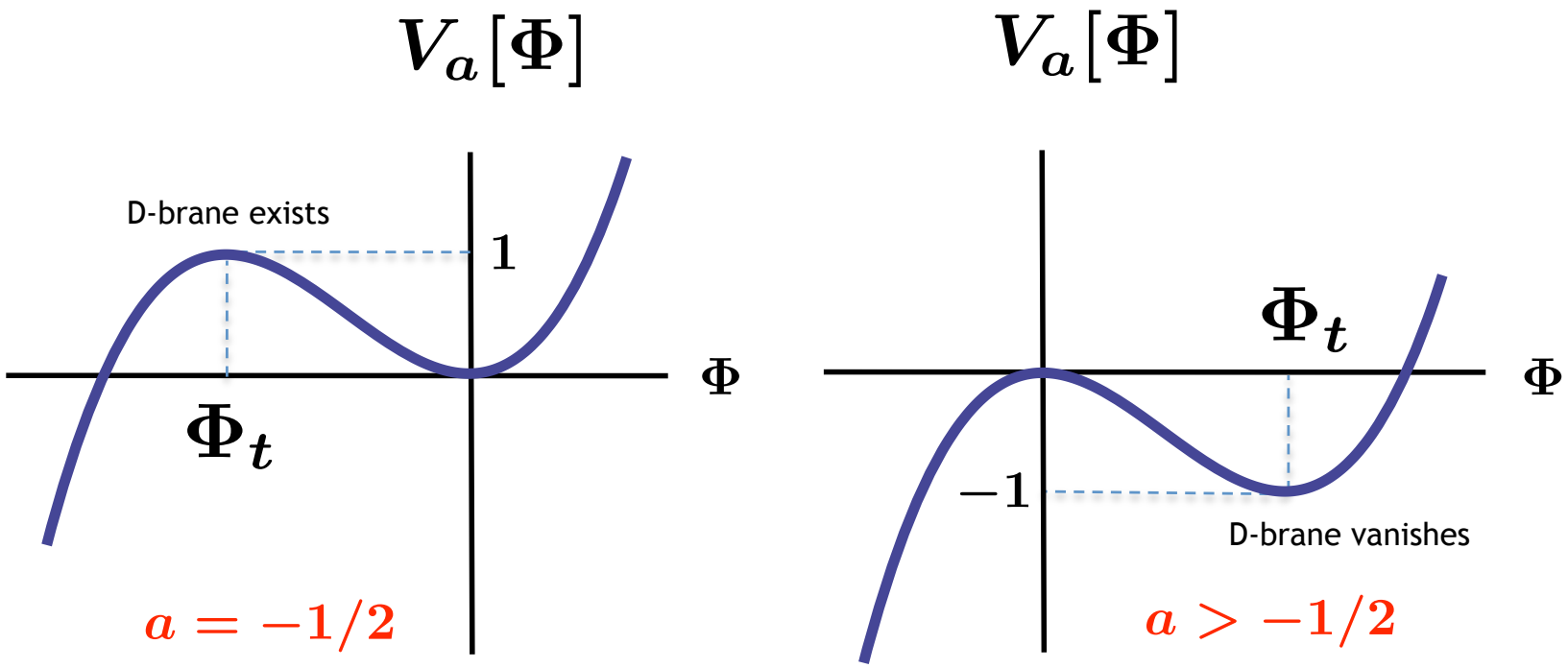


NON-TRIVIAL SOLUTION IN SFT AROUND $\Psi_{TT}(a)$

$$Q'(a)\Phi_t + \Phi_t * \Phi_t = 0$$

Conjectured behavior:

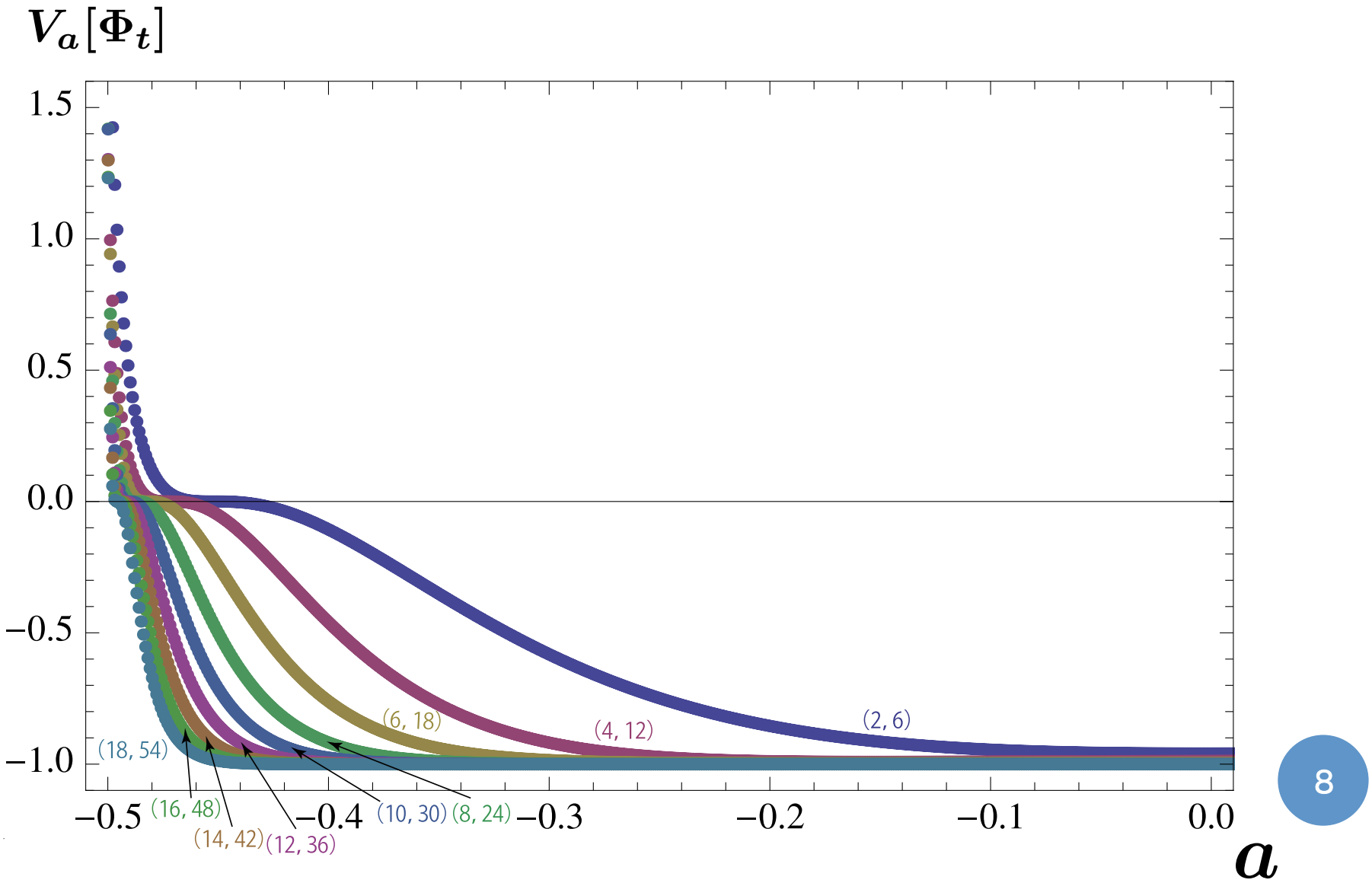
[Takahashi-Tanimoto(2002), Kishimoto-Takahashi (2002), Takahashi(2003),…]



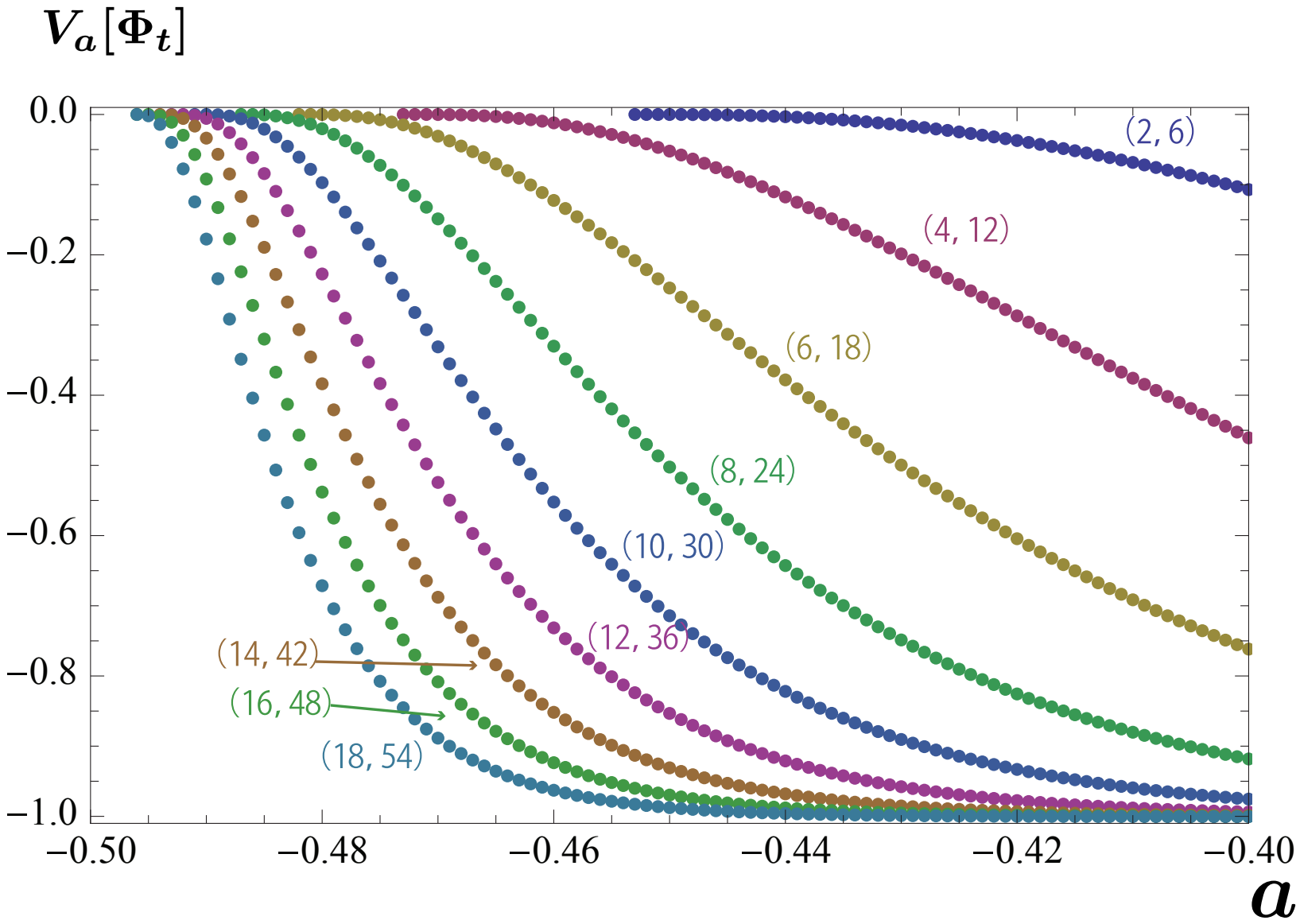
$\Psi_{TT}(a = -1/2)$: tachyon vacuum

$\Psi_{TT}(a > -1/2)$: pure gauge

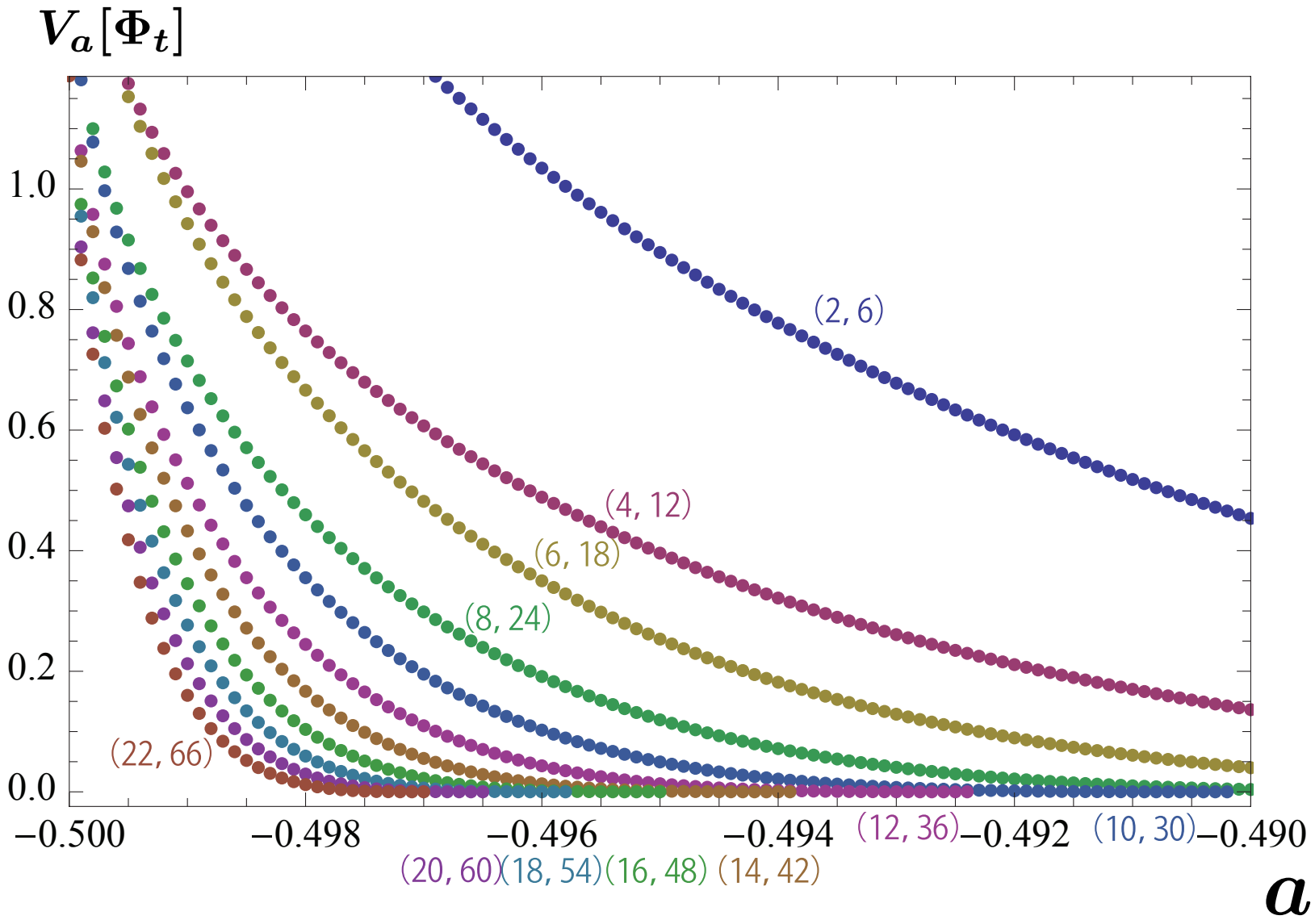
POTENTIAL HEIGHT AT Φ_t IN SFT AROUND $\Psi_{\mathrm{TT}}(a)$



POTENTIAL HEIGHT AT Φ_t IN SFT AROUND $\Psi_{\mathrm{TT}}(a)$



POTENTIAL HEIGHT AT Φ_t IN SFT AROUND $\Psi_{\mathrm{TT}}(a)$



POTENTIAL HEIGHT FOR $a = -1/2$

[cf. Zeze(2003), Drukker-Okawa(2005)]

L	$V_a[\Phi_t]$
0	2.3105795
2	2.5641847
4	1.6550774
6	1.6727496
8	1.4193393
10	1.4168893
12	1.3035715
14	1.2986472
16	1.2357748
18	1.2310583
20	1.1915648
22	1.1874828
24	1.1605884

[Kishimoto-Takahashi, arXiv:0910.3026]

[Kishimoto-Takahashi, talk@APCTP(2009.12)]

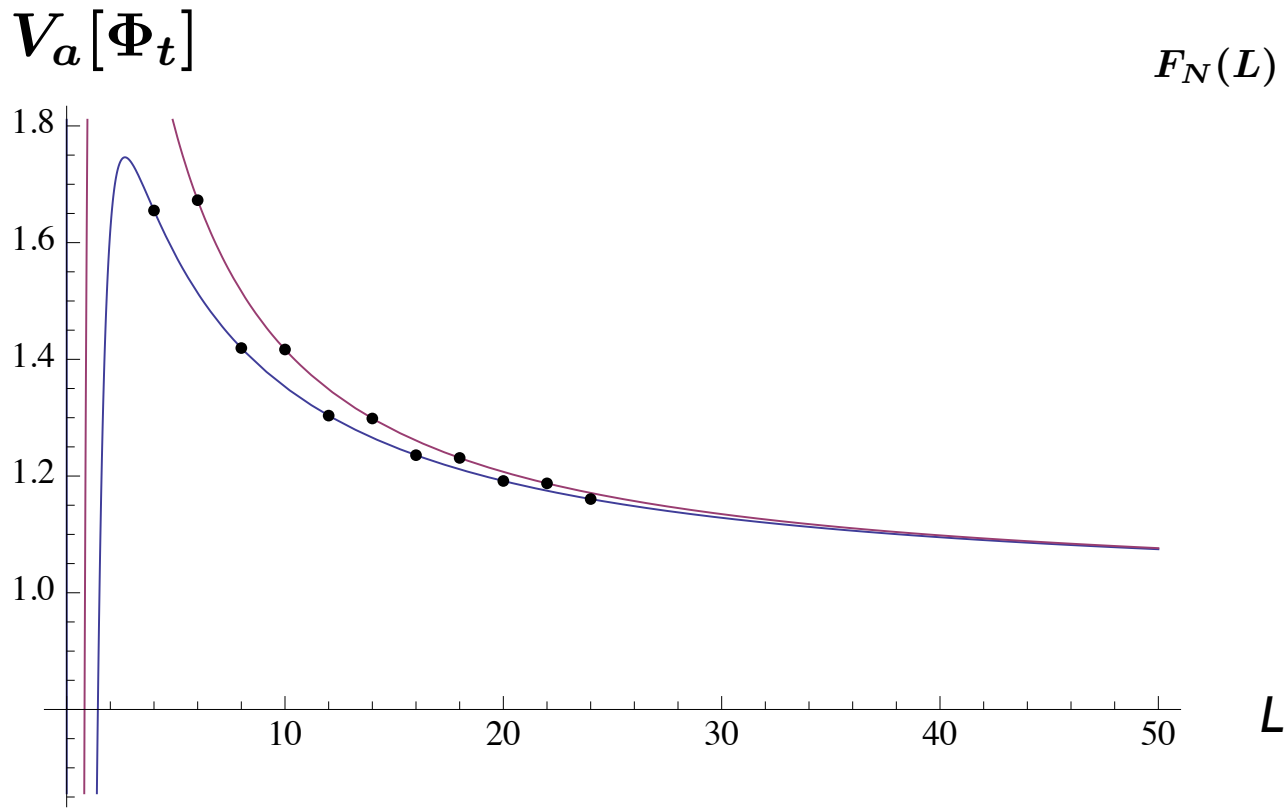
EXTRAPOLATION OF POTENTIAL HEIGHT FOR $a = -1/2$

L	Extrapolation of $V_a[\Phi_t]$	
4∞	0.9893181	← (L=0,4,8,12,16,20,24;N=7)
$4\infty + 2$	0.9891240	← (L=2,6,10,14,18,22;N=6)

The value approaches +1 (!?)

fitting function:

$$F_N(L) = \sum_{n=0}^{N} \frac{a_n}{(L+1)^n}$$



DIMENSION OF TRUNCATED SPACE FOR STRING FIELD

L	dim H^+_{univ}	dim H^+_{singl}
0	1	1
2	3	3
4	9	8
6	26	21
8	69	51
10	171	117
12	402	259
14	898	549
16	1925	1124
18	3985	2236
20	7995	4328
22	15606	8176
24	29736	15121

$\mathcal{H}^+_{\mathbf{univ}}$

twist even, universal space, Siegel gauge, ghost number 1

$\mathcal{H}^+_{\mathbf{singl}}$

twist even, universal space, Siegel gauge, ghost number 1, SU(1,1) singlet

The star product includes $\frac{1}{6}(\dim\mathcal{H}^+_{\mathbf{sing}})^3$ terms.