String Theory and Noncommutative QFT on Time-Dependent Backgrounds: a Big Bang Type Singularity

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- Null Boost Orbifold: Minkowskian 3D time-dependent orbifold

$$x = \begin{pmatrix} x^- \\ x^2 \\ x^+ \\ \vec{x} \end{pmatrix} \sim e^{nk^{NBO}} x = \begin{pmatrix} x^- \\ x^2 + n(2\pi\Delta)x^- \\ x^+ + n(2\pi\Delta)x^2 + \frac{1}{2}n^2(2\pi\Delta)^2 x^- \\ \vec{x} \end{pmatrix}$$

- Bosonic string amplitudes unexpectedly divergent at tree-level

$$A_{4T}^{closed} \sim \int^{q\sim\infty} \frac{dq}{|q|} q^{4-\alpha' \vec{p}_{\perp t}^{\,2}}$$

$$A_{4T}^{open} \sim \int^{q\sim\infty} \frac{dq}{|q|} q^{1-\alpha' \vec{p}_{\perp t}^{\,2}} \operatorname{tr}\left(\{T_1, T_2\}\{T_3, T_4\}\right)$$

- Origin of the divergences: failure of the standard perturbation theory à la Feynman

$$\mathcal{A}_N \propto \int_{u\sim 0} du\, |u|^{-\frac{N}{2}+1}$$

- Nonlinear sigma model: Kalb-Ramond background B-field

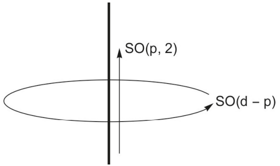
$$S = \frac{1}{4\pi\alpha'} \int_\Sigma d^2\sigma \, \left(g_{\mu\nu}\partial_a x^\mu \partial^a x^\nu - 2\pi i \alpha' \epsilon^{ab} B_{\mu\nu} \partial_a x^\mu \partial_b x^\nu\right)$$

- Well-defined noncommutative QFT arising as decoupling limit

$$\mathcal{A}_N \propto \int_{u\sim 0} du\, |u|^{-\frac{N}{2}+1} e^{i\frac{\theta f(p_{-i})}{u}}$$

- A.A., R.Finotello, I.Pesando - *On the Origin of the Divergences in Time-Dependent Orbifolds* - Eur.Phys.J.C 80, (2020)
- A.A., R.J.Szabo, I.Pesando - *The Role of Noncommutativity on the Null Boost Orbifold* - To appear, (2023)

Analytic Bootstrap in Line Defect CFTs



Broken Conformal Symmetry:

$$SO(d+1,1) \to SO(2,1) \times SO(d-1)$$

Constraints on correlators:

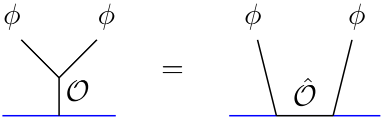
$$\langle \mathcal{O}(x) \rangle_D = \frac{a_{\mathcal{O}}}{|x_\perp|^{\Delta}}, \; \cdots$$

$$S_{bulk} = \int d^d x \left(\frac{1}{2} (\partial_\mu \phi_a)^2 + \frac{\lambda}{4!} (\phi_a \phi_a)^2 \right)$$

$$S_{D_1} = h \int d\tau \, \phi_1(\tau)$$

$$S_{D_2} = \log \mathrm{Tr}_R \, \mathcal{P} \exp \left(\gamma \int d\tau \phi_a(\tau) T_R^a \right)$$

Defect Bootstrap Equations:



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p-form gauge theories: duality and asymptotic symmetries

$$
\begin{array}{ccc}
\Omega^{p+1}(M_D) & \xrightarrow{\quad\star\quad} & \Omega^{D-p-1}(M_D) \\
\uparrow d & & \uparrow d \\
\Omega^{p}_{A^{(p)}_{rad}\neq 0,0}\left(S^{D-2}_u\right) & \xrightarrow{\quad\star_{D-2}\quad} & \Omega^{D-p-2}_{A^{(D-p-2)}_{rad}\neq 0,0}\left(S^{D-2}_u\right) \\
\downarrow \pi_1 & & \downarrow \pi_2 \\
\mathbb{R}^{n_p} & \xrightarrow{\quad f\quad} & \mathbb{R}^{n_{D-p-2}}
\end{array}
$$