Flat-space limit of defect correlators and stringy AdS form factors

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2411.04378

Journal club

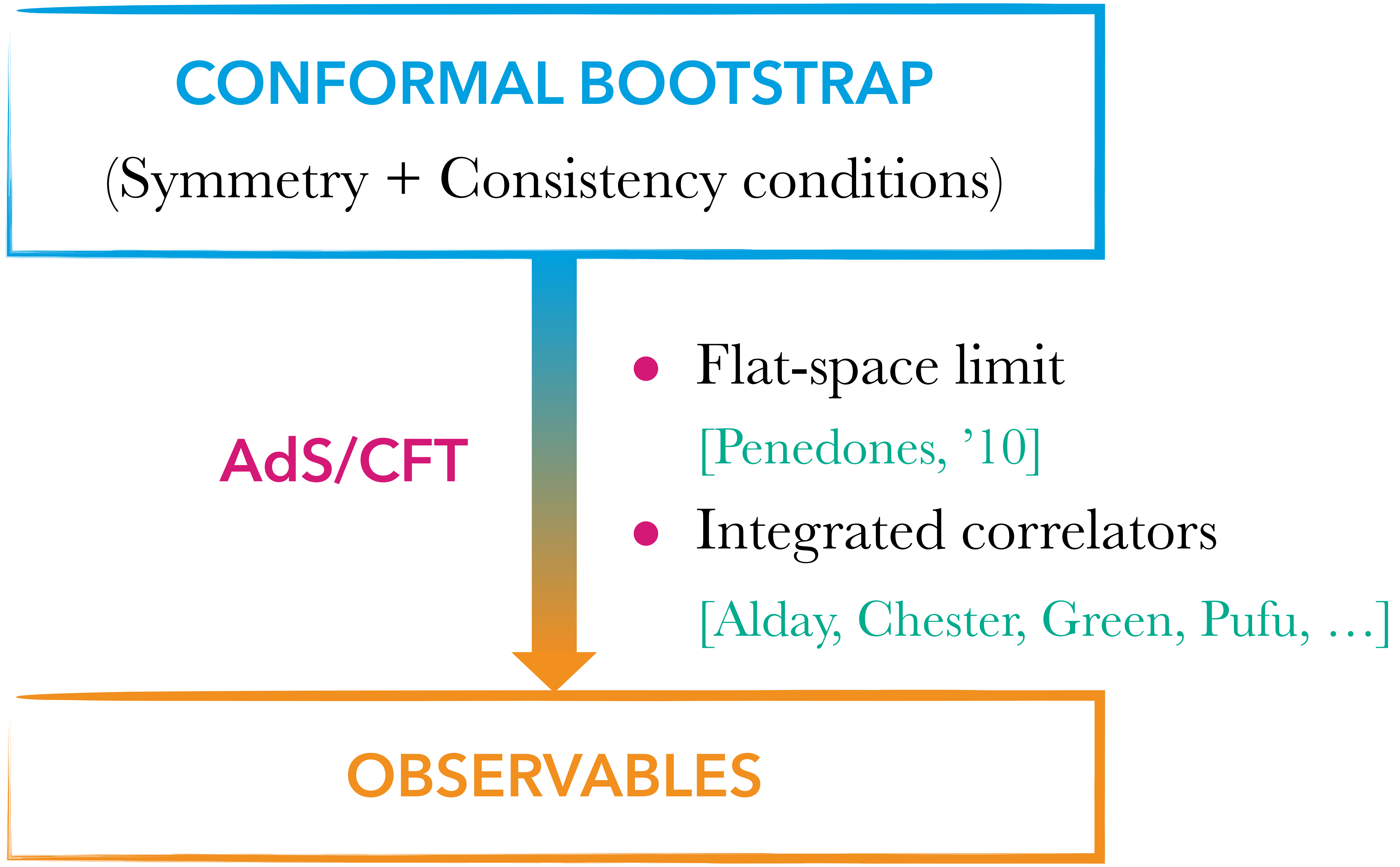
Julien Barrat

DESY.

3.12.24

Motivations

HOLOGRAPHIC CORRELATORS



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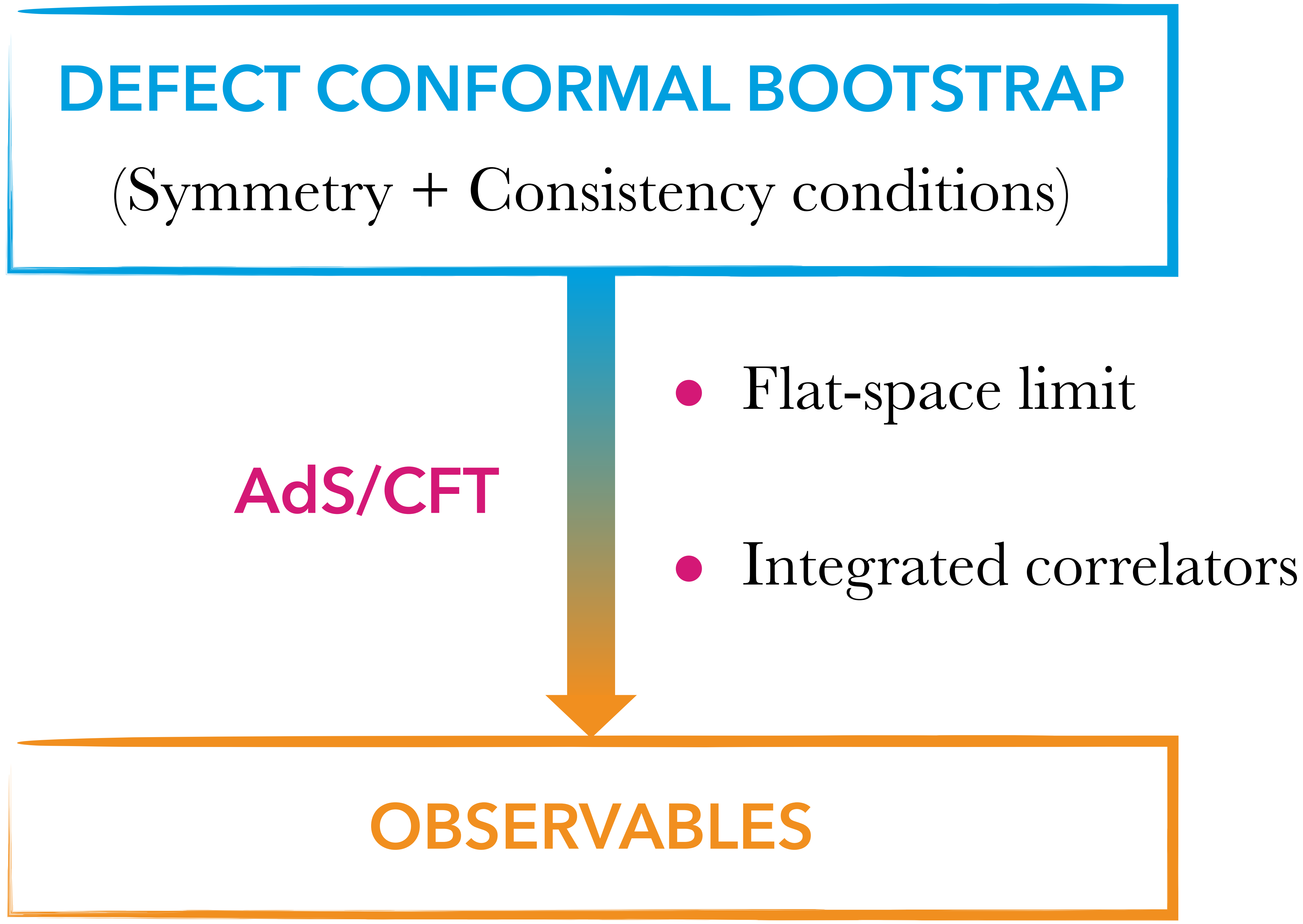

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HOLOGRAPHIC DEFECT CORRELATORS

DEFECT CONFORMAL BOOTSTRAP

(Symmetry + Consistency conditions)

AdS/CFT

- Flat-space limit
- Integrated correlators ✓

  [Billò, Dorigoni, Drukker, Gromov, …]

OBSERVABLES

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- Flat-space limit ✗ **This paper!**
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FLAT-SPACE LIMIT OF FOUR-POINT FUNCTIONS

Mellin amplitude: $$\mathcal{M}(s_{ij}) \propto \int_0^\infty d\beta \beta^{\frac{1}{2}\sum_i \Delta_i - \frac{d}{2} - 1} e^{-\beta} \mathcal{A}\left(S_{ij} = \frac{2\beta}{R^2} s_{ij}\right) , \quad R \to \infty$$

[Penedones, ’10]

Review

FLAT-SPACE LIMIT OF FOUR-POINT FUNCTIONS

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Mandelstam variables

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Borel transform

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Sketch of the derivation:
- Assume that such a formula exists

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Sketch of the derivation:
- Assume that such a formula exists
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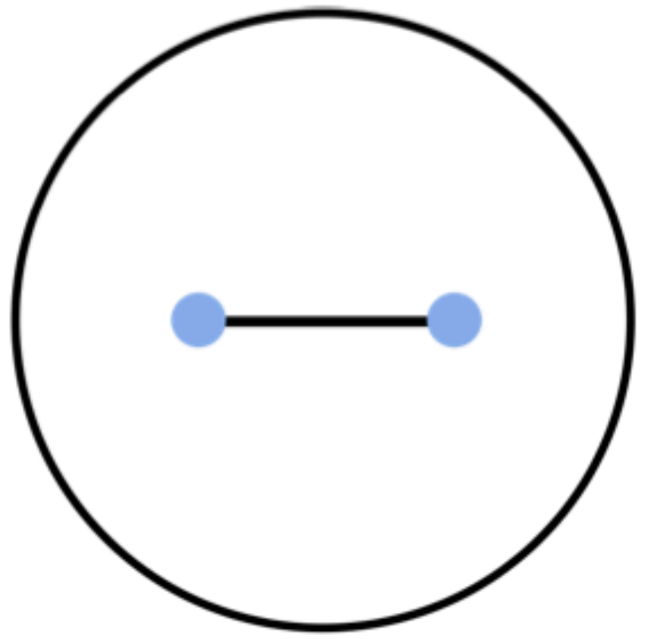

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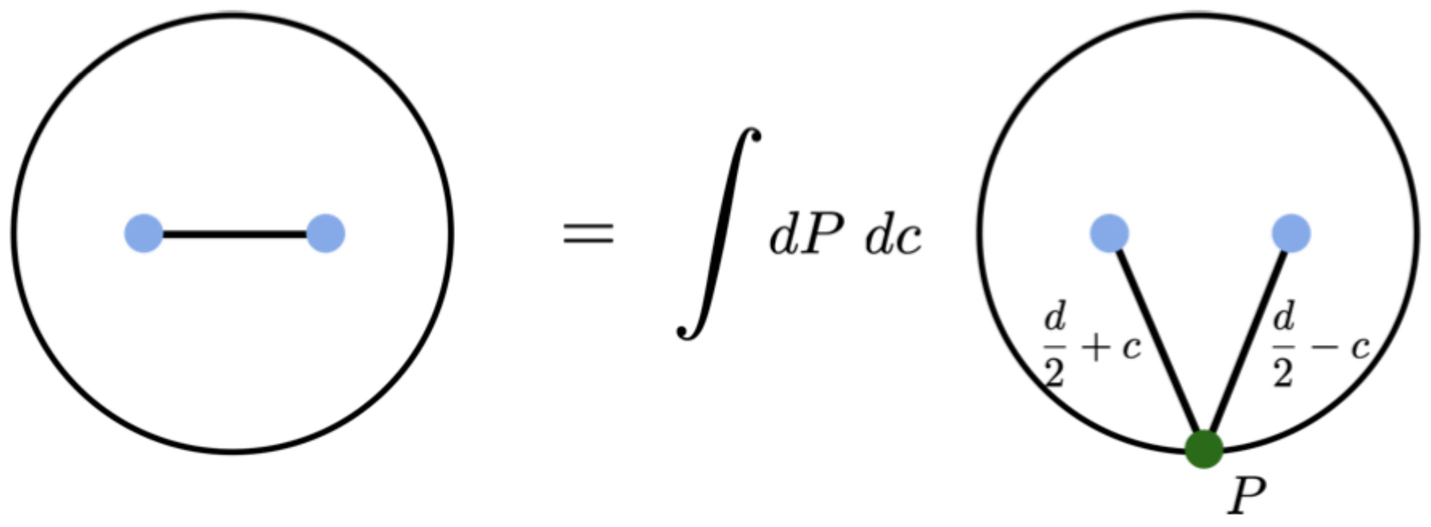
- Use the split representation



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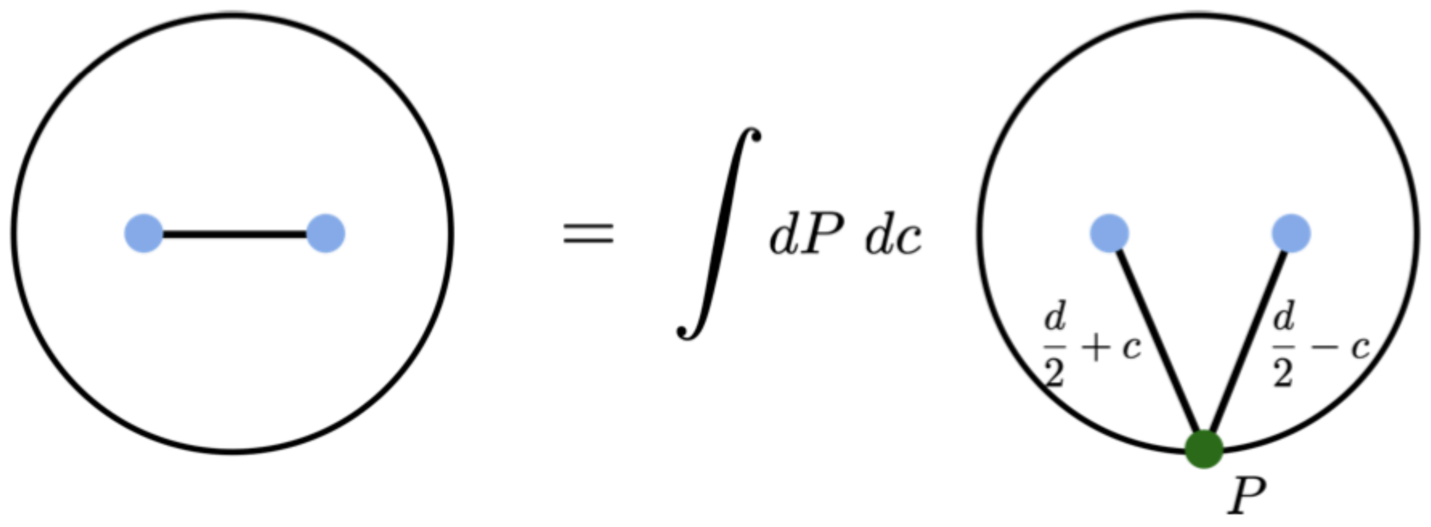
Sketch of the derivation:

- Assume that such a formula exists
- Consider the Witten diagram of a propagator
- Use the split representation
- Massage to make the flat propagator appear:



$$\mathcal{M}(s) \approx \frac{R^{3-d}}{\Gamma(\frac{\sum_i \Delta_i - d}{2})} \int_0^\infty \frac{dK}{K} \left(-\frac{K^2 R^2}{2s}\right)^{\frac{\sum_i \Delta_i - d}{2}} e^{\frac{K^2 R^2}{2s}} \boxed{\frac{1}{\Delta^2/R^2 + K^2}}$$

Main result

DEFECT CORRELATORS

Two-point function: $\langle\langle \mathcal{O}_{\Delta_1}(x_1)\mathcal{O}_{\Delta_2}(x_2)\rangle\rangle = \dfrac{\mathcal{F}(\xi,\chi)}{|x_1^i|^{\Delta_1}|x_2^i|^{\Delta_2}}$ with $\xi = \dfrac{x_{12}^2}{|x_1^i||x_2^i|}\,,\quad \chi = \dfrac{2x_1^j x_2^j}{|x_1^i||x_2^i|}$

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Spacetime cross-ratios

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Two local operators in presence of a defect

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Mellin space: $\mathcal{F}(\xi,\chi) = C_{\Delta_1\Delta_2}\int \frac{d\delta d\gamma}{(2\pi i)^2}\xi^{-\delta}\chi^{-\gamma+\delta}\mathcal{M}(\delta,\gamma)\Gamma(\delta)\Gamma(\gamma-\delta)\prod_{i=1}^{2}\Gamma\left(\frac{\Delta_i-\gamma}{2}\right)$ [Gonçalves, Itsios, '18]

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Main idea: Conjecture a defect flat-space limit from tree-level Witten diagrams

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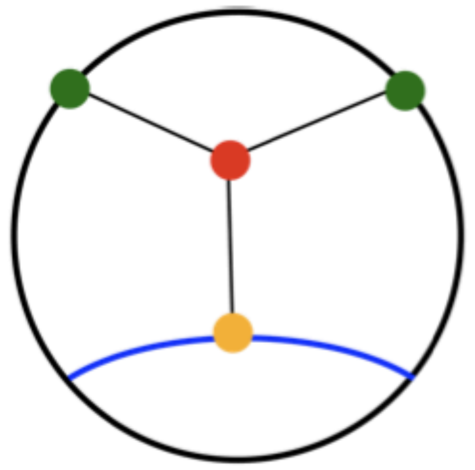
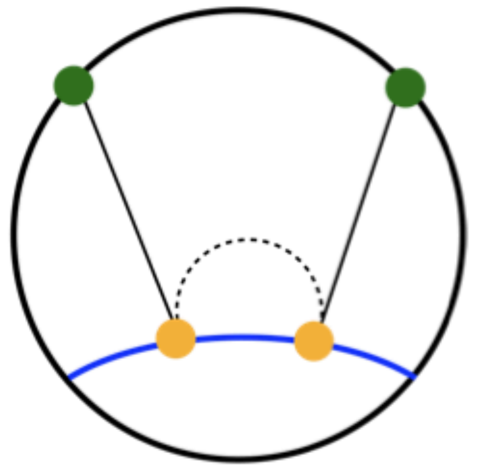
Main idea: Conjecture a defect flat-space limit from tree-level Witten diagrams

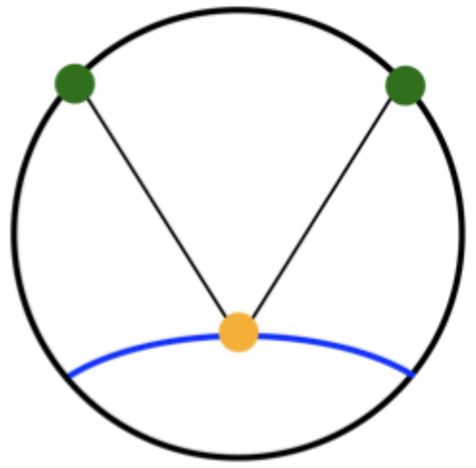
Tree-level Witten diagrams:



(a) Bulk channel exchange Witten diagrams



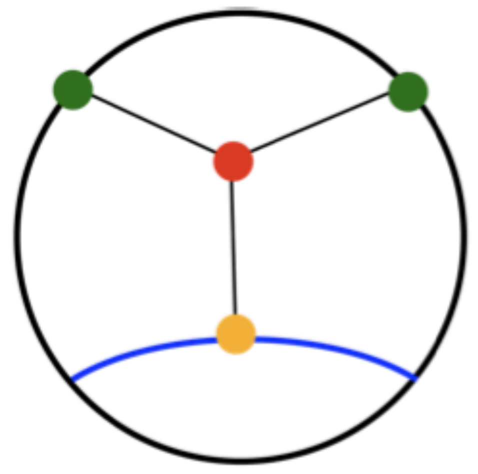
(b) Defect channel exchange Witten diagrams

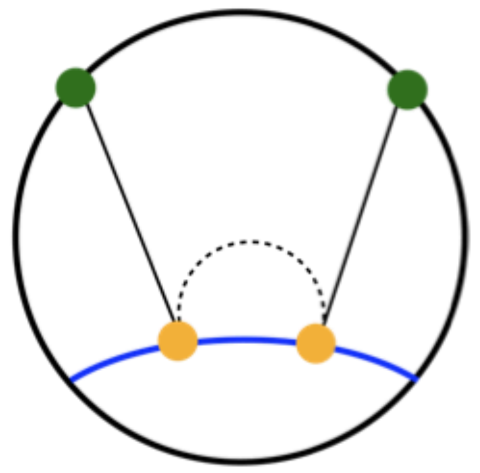


(c) Contact Witten diagrams

Main result

FLAT-SPACE LIMIT OF DEFECT CORRELATORS





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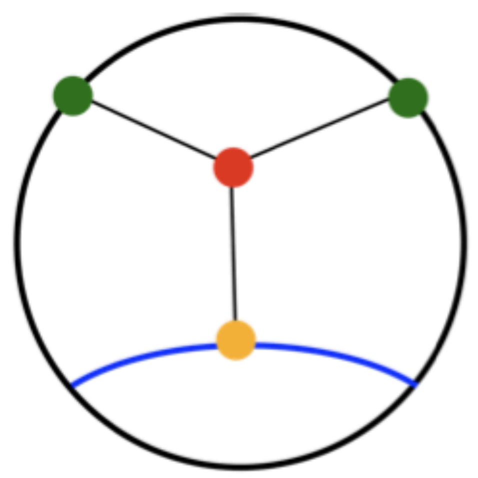
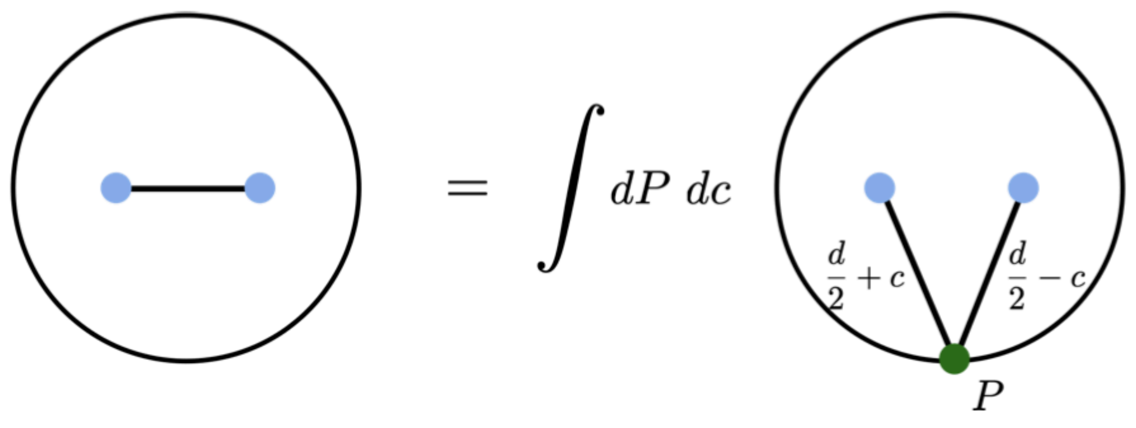
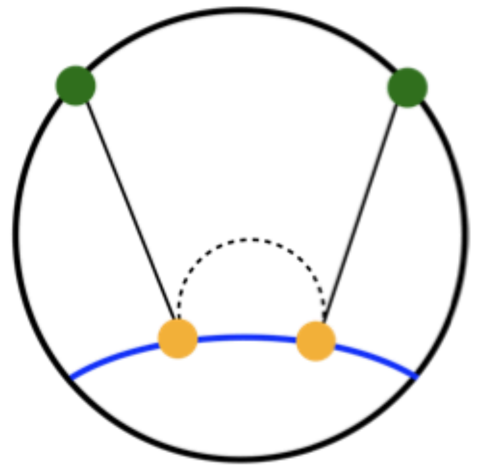


$$\mathcal{M}^{\Delta,0}_{\Delta_1,\Delta_2} \approx \frac{\pi^{p/2} R^{p-d+2} C^{-1}_{\Delta_1 \Delta_2}}{4\Gamma(\Delta_1)\Gamma(\Delta_2)} \int_0^\infty d\beta \beta^{\frac{1}{2}(\Delta_1+\Delta_2)-\frac{p}{2}-1} e^{-\beta} \frac{1}{\mu^2 + 4\delta\beta/R^2}$$





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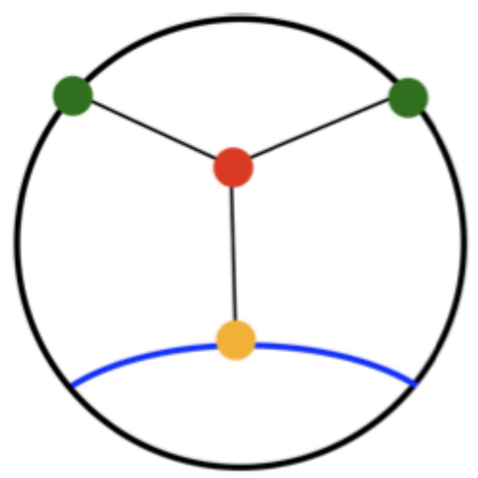

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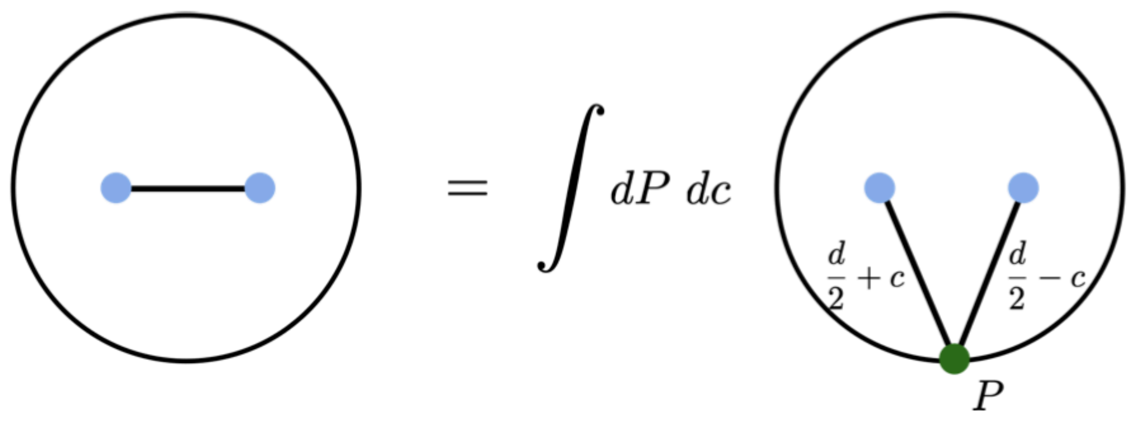

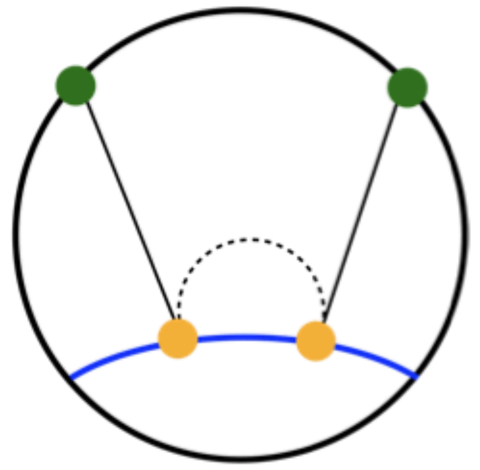

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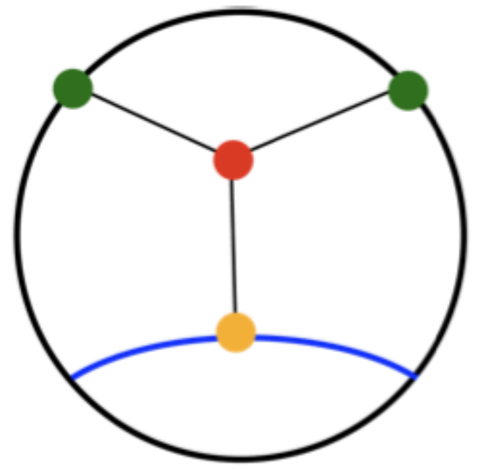

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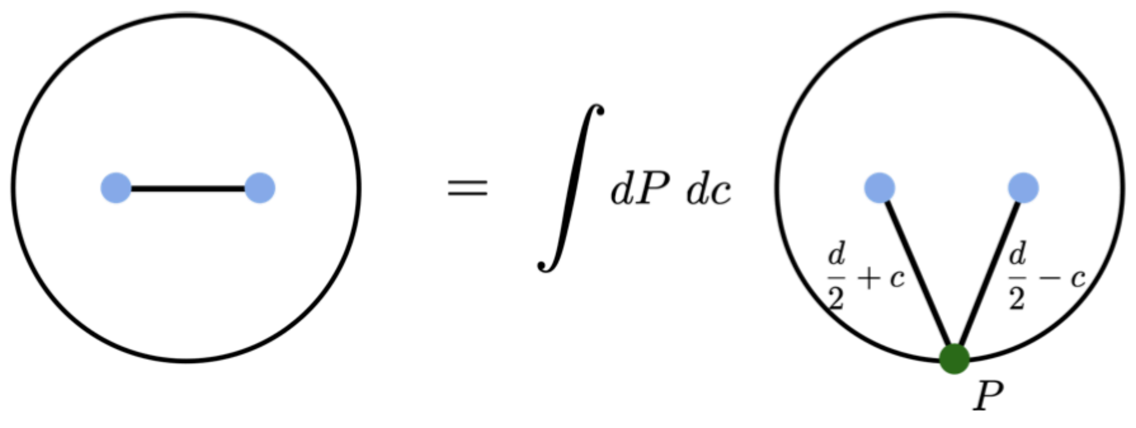

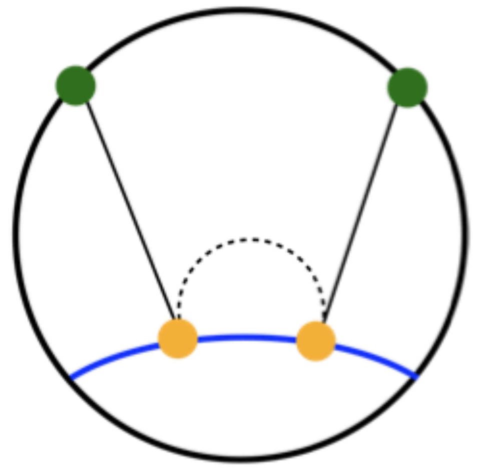

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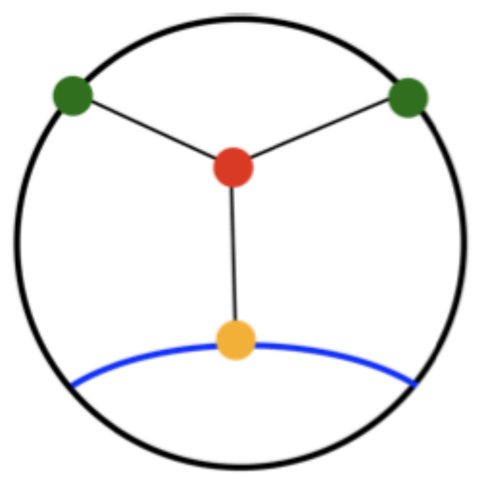

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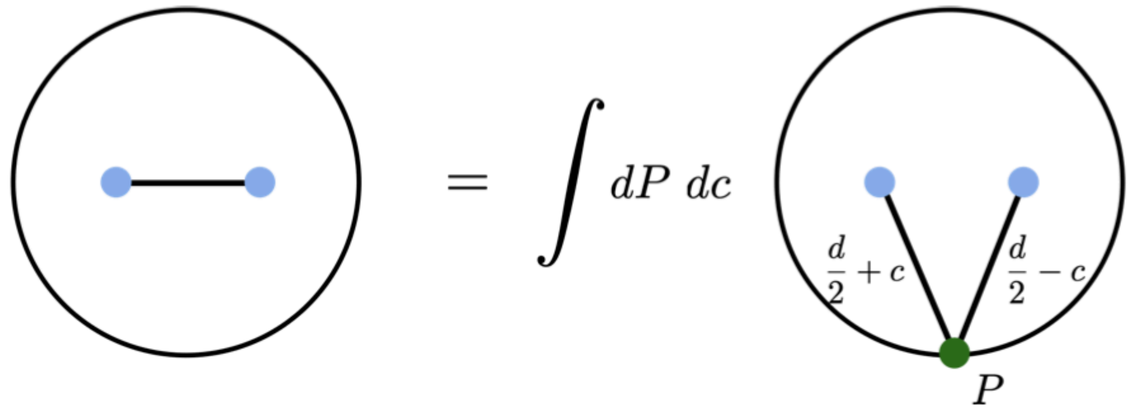

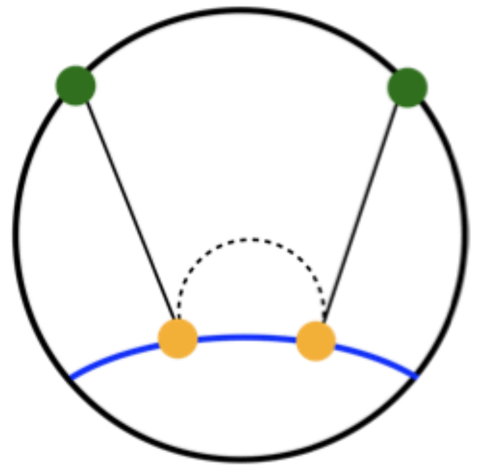

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Conjecture:

$$\boxed{\mathcal{M}(\delta,\gamma) \propto \int_0^\infty d\beta\, \beta^{\frac{1}{2}(\Delta_1+\Delta_2)-\frac{p}{2}-1} e^{-\beta} \mathcal{A}\left(S = -\frac{2\delta\beta}{R^2}, Q = \frac{2\gamma\beta}{R^2}\right) \,, \quad R \to \infty}$$

Main result

FLAT-SPACE LIMIT OF DEFECT CORRELATORS

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CHECKS

Main result

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CHECKS

- Higher-derivative contact diagrams

Main result

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- Higher-derivative contact diagrams
- Exchange diagrams of spinning fields

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CHECKS

- Higher-derivative contact diagrams
- Exchange diagrams of spinning fields
- One-loop amplitude ($6d$ $\mathcal{N} = (2,0)$ with a $1/2$-BPS surface defect)

New results

TWO 20′ IN PRESENCE OF A 'T HOOFT LINE

New results

TWO 20′ IN PRESENCE OF A 'T HOOFT LINE

Correlator: $$\langle\!\langle S(x_1,u_1)S(x_2,u_2)\rangle\!\rangle = \frac{(u_1\cdot\theta)^2(u_2\cdot\theta)^2}{|x_1^i|^2|x_2^i|^2}\mathcal{F}(\zeta,\eta;\sigma)$$

New results

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20' operators

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spacetime cross-ratios

R-symmetry cross-ratio

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ANSATZ

$$\mathcal{M} = \mathcal{M}_{\text{sugra}} f(\lambda) + \lambda^{-1}\mathcal{M}^{\text{h.d.}}_{L=2} + \lambda^{-\frac{3}{2}}\mathcal{M}^{\text{h.d.}}_{L=3} + \lambda^{-2}\mathcal{M}^{\text{h.d.}}_{L=4} + \dots$$

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$$\mathcal{F}^{\text{h.d.}}_L = \sum_{j=0}^{2}\sum_{M=0}^{L}\sum_{A=0}^{M} c_{j,M,A}\,\sigma^j\,\mathcal{B}_{M,A}$$

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$(L(L+1)/2$ open coefficients$)$

New results

TWO 20′ IN PRESENCE OF A 'T HOOFT LINE

Correlator: $$\langle\langle S(x_1,u_1)S(x_2,u_2)\rangle\rangle = \frac{(u_1\cdot\theta)^2(u_2\cdot\theta)^2}{|x_1^i|^2|x_2^i|^2}\mathcal{F}(\zeta,\eta;\sigma)$$

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$$\mathcal{M} = \mathcal{M}_{\text{sugra}} f(\lambda) + \lambda^{-1}\mathcal{M}^{\text{h.d.}}_{L=2} + \lambda^{-\frac{3}{2}}\mathcal{M}^{\text{h.d.}}_{L=3} + \lambda^{-2}\mathcal{M}^{\text{h.d.}}_{L=4} + \dots$$

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✓ ✓ ✓ ✗

(1 open coefficient)

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THANK YOU!