M-theory S-Matrix from 6d CFT

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Based on arXiv:1805.00892 with E. Perlmutter

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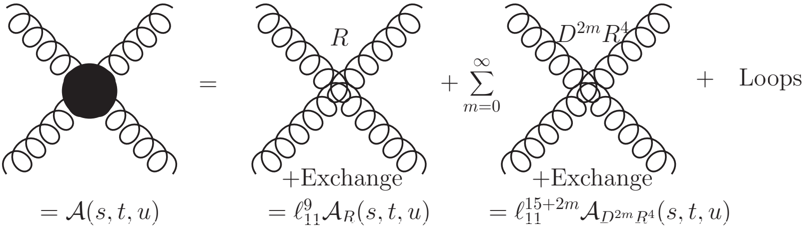
- M-theory is a quantum theory of interacting supergravitons in 11d with no dimensionless coupling.
- Graviton S-matrix in small momentum ($\ell_{11} \ll 1$) expansion:



- Protected terms from type IIA string theory + duality [Green,Tseytlin] :
  $\mathcal{A}_{R^4} = \mathcal{A}_R \frac{stu}{3 \cdot 2^7}\,, \quad \mathcal{A}_{D^2R^4} = \mathcal{A}_{D^4R^4} = 0\,, \quad \mathcal{A}_{D^6R^4} = \mathcal{A}_R \frac{(stu)^2}{15 \cdot 2^{15}}.$
- Goal: Find all tree level terms $\mathcal{A}_{D^{2m}R^4}$ for $m > 3$ using AdS/CFT.

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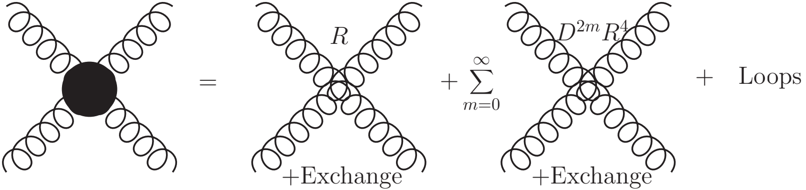

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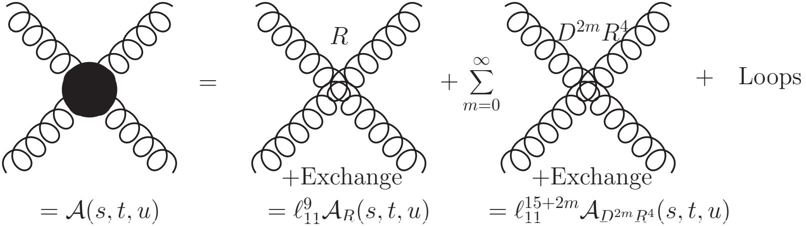

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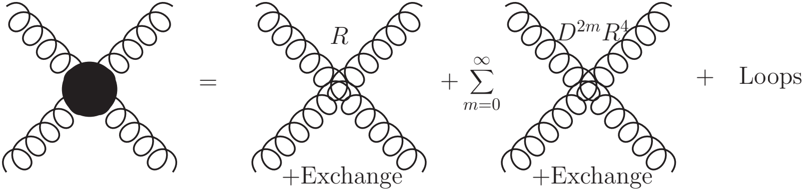

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AdS/CFT for M-theory

- M-theory contains two non-perturbative dynamical objects: M2 branes and M5 branes.
- We study $(2,0)$ A_{N-1} 6d SCFT that describes stack of N M5 branes, and is dual at large N to M-theory on $AdS_7 \times S^4$.
- We compute: $\mathcal{G}_k(U,V) = x_{12}^{2k} x_{34}^{2k} \langle \mathcal{O}_k^1 \mathcal{O}_k^2 \mathcal{O}_k^3 \mathcal{O}_k^4 \rangle$ of k-th lowest dimension half-BPS operators in CFT$_6$ in large N expansion.
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Tree Level Half-BPS Four Point functions: Constraints

- We use Mellin transform $\mathcal{G}_k(U,V) \to M_k(s,t,u)$ [Mack, Penedones] , where s,t,u are like Mandelstam variables in Mellin space.
- For N large, let $M_k^{\text{tree}}(s,t,u) \equiv \sum_{p=1}^{\infty} M_k^{(p)}(s,t,u)$, where p is degree in $s,t,u \to \infty$, and $M_k^{(p)}$ fixed in terms of CFT$_6$ data by:
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Conclusion

Results:

- Tree level $D^{2m}R^4$ contributions to 11d M-theory S-matrix for $m < 6$ in terms of CFT$_6$ data.
- Known half-BPS CFT$_6$ data precisely reproduces R^4 contribution.

Future Directions:

- Derive loop Mellin amplitudes $\Rightarrow$ loop 11d S-matrix terms.
- 6d numerical bootstrap [Beem, Lemos, Rastelli, van Rees] to fix CFT$_6$ data $\Rightarrow$ 11d S-matrix coefficients.
- Apply method to AdS$_{d+1}$/CFT$_d$ for other d.
  - See Silviu Pufu's talk tomorrow for $d = 3$ case [SCM, Pufu, Yin] .

See my poster for more details!