AMPLITUDES 2026

29 June – 3 July 2026

Queen Mary
University of London
Est. 1785

SAGEX
Scattering Amplitudes:
from Geometry to Experiment

Welcome to the Gong Show: Part II

AMPLITUDES 2026

Yuanche Liu

Next: Carl Jordan Eriksen

Amplitudes 2026 Gong Show
Yuanche Liu@USTC

CHESS

CHEbyshev pSeudo-Spectral transportation for Feynman Integral Differential Equations

Canonical Differential Equation → 1 Dimension Path pull-back → Chebyshev Collocation → Boundary Regularize

$$\partial_t J^{(r)} = D_m J^{(r)}$$

Differential to Linear

$$|J - J_0| \sim \rho^{-m}$$

Exponentially accurate

$$B(t) \sim \frac{R_c}{t-c} + M_c$$

Semi-Analytic Regularize

~10x faster wall time

100 stable digits
1 minute

734 integrals
Large family capable

Tests based on:
315p [Chicherin, Wu, Wu, Xu, Zhang, Zhang, 2025]
216p [Liu, Matijasic, Peraro, Xu, Yang, Zhang, 2026]

Yuanche Liu and Yang Zhang @ USTC

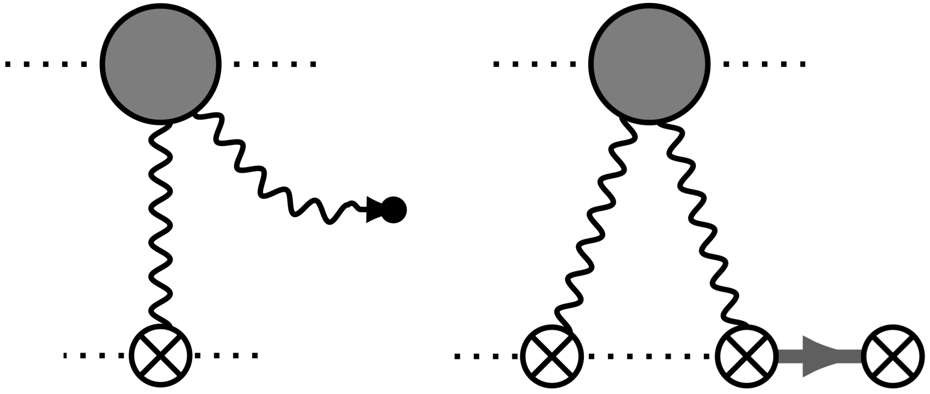
Carl Jordan Eriksen

Next: Yu Wu

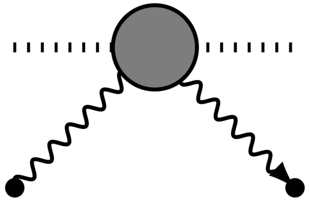
Black hole response theory

A worldline quantum field theory approach to the self-force expansion

*Lara Bohnenblust, **Carl Jordan Eriksen**, Jitze Hoogeveen, Gustav Uhre Jakobsen, Jan Plefka*



In a shockwave background



$$\sim \int \mathrm{d}^{D-2}\boldsymbol{x}_\perp\, \mathrm{e}^{-\mathrm{i}\boldsymbol{q}_\perp\cdot\boldsymbol{x}_\perp}\left[\mathrm{e}^{-\mathrm{i}\,2G(P\cdot k_1)f(\boldsymbol{x}_\perp^2)}-1\right]$$

Yu Wu

Next: Tobias Scherdin

Giant Correlator at Two loops

$$\mathcal{D}(x_i) \equiv \det(Y_i\cdot\phi(x_i))$$ Giant Graviton

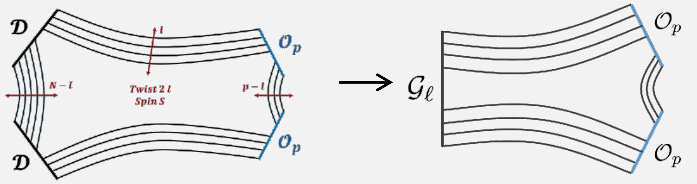
$$G_{\{p,q\}} = \langle \mathcal{D}(x_1,Y_1)\,\mathcal{D}(x_2,Y_2)\,\mathcal{O}_p(x_3,Y_3)\,\mathcal{O}_q(x_4,Y_4)\rangle$$

harmonic superspace

$$\left\langle \det(\tilde{q}_1^+)\det(q_2)\,\mathrm{tr}\left[(\tilde{q}_3^+)^r (q_3^+)^{p-r}\right]\mathrm{tr}\left[(\tilde{q}_4^+)^r (q_4^+)^{p-r}\right]\right\rangle$$

partial contraction

$$\sum_{\ell=0}^{N_c}(-1)^{\ell+1}\left(\frac{[12]^2}{8\pi^2 x_{12}^2}\right)^{N_c-\ell}\frac{(N_c-\ell)!}{\ell}\left\langle \mathrm{tr}\left[(\tilde{q}_1 q_2)^\ell\right]\mathcal{O}_p\mathcal{O}_p\mathcal{L}_5\mathcal{L}_6\right\rangle$$



Planarity

Harmonic analyticity

One-loop: only one diagram

Two-loop: 26 diagrams

Manifestly SUSY

Harmonic PCGG Method

Weak-coupling integrands exhibit a defect version of 10D hidden conformal symmetry

generating function

$$\mathbf{I}^{(\ell)}(\lambda_1,\lambda_2) = \left(-\frac{x_{12}^6}{4\pi^2 x_{13}^2 x_{14}^2 x_{23}^2 x_{24}^2 x_{34}^2}\times H^{(\ell)}_{\{2,2\}}\Big|_{x_{ij}^2\to\hat{x}_{ij}^2}\right)\Bigg|_{Y_3\to\frac{\lambda_1}{\sqrt{2}}Y_3,\,Y_4\to\frac{\lambda_2}{\sqrt{2}}Y_4}$$

replacement rules

$$x_{34}^2 \to x_{34}^2 - 2y_{34}^2\,,$$
$$\frac{x_{13}^2x_{23}^2}{x_{12}^2} \to \frac{x_{13}^2x_{23}^2}{x_{12}^2} + \frac{2y_{13}^2y_{23}^2}{y_{12}^2}\,,$$
$$\frac{x_{14}^2x_{24}^2}{x_{12}^2} \to \frac{x_{14}^2x_{24}^2}{x_{12}^2} + \frac{2y_{14}^2y_{24}^2}{y_{12}^2}\,,$$
$$\frac{x_{13}^2x_{24}^2+x_{14}^2x_{23}^2}{2x_{12}^2} \to \frac{x_{13}^2x_{24}^2+x_{14}^2x_{23}^2}{2x_{12}^2} + \frac{y_{13}^2y_{24}^2+y_{14}^2y_{23}^2-y_{12}^2y_{34}^2}{y_{12}^2}$$

4D distances are uplifted to 10D defect distances

Integrability check

OPE analysis
$$\mathcal{H}(u,v;\tau,\sigma)=\sum_{a=0}^{\infty}g^{2a}\sum_{L=1+n}^{2p-2}\sum_{b=0}^{a}\sum_{S=0}^{\infty}\mathcal{P}^{(a,b)}_{nm,L,S}f^{(b)}_{L,S}(z,\bar{z},\mu)Y_{nm}(\sigma,\tau)$$

Integrability prediction
$$\sum_{a=0}^{\infty}g^{2a}\sum_{b=0}^{a}\mu^b\,\mathcal{P}^{(a,b)}_{L,S}=\sum_{\mathbf{u}}\mathrm{d}_{L,S}(\mathbf{u})\mathrm{c}_{L,S}(\mathbf{u})e^{\delta\Delta_{L,S}(\mathbf{u})\,\mu}$$

Bethe roots

Perfect agreement with integrability predictions up to twist six

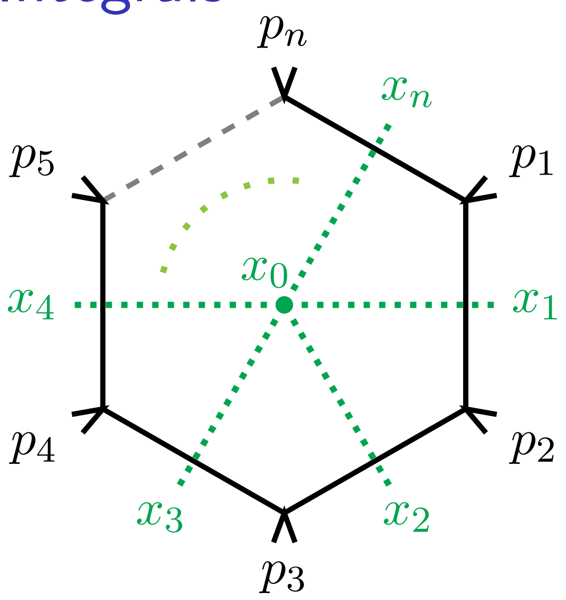
[Yunfeng Jiang, Chang Liu, **Yu Wu**, Yang Zhang, JHEP 03 (2026) 097, arxiv: 2509.23161]

Tobias Scherdin

Next: Michael Reichenberg Ashby

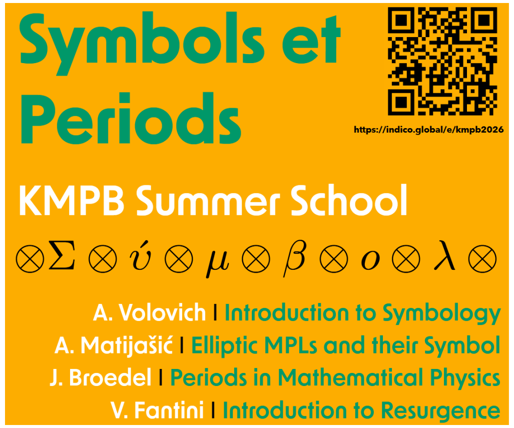
Yangian Symmetry of Polygonic Feynman Integrals

In collaboration with Anne Spiering [260X.XXXXX]



- we use Yangian symmetry to compute the symbol of star integrals
- we find the angles of these hyperbolic simplices as solutions to the Yangian differential equations
- **general interests:** hidden symmetries of amplitudes & loop integrals, symbology, hexagon ansatz in $\mathcal{N} = 4$ SYM, intersection theory, WQFT

We organise the "KMPB School 2026: Symbols & Periods" in Berlin, August 8 – September 4!



Tobias Scherdin, Humboldt-Universität zu Berlin

Michael Reichenberg Ashby

Next: Marcelo dos Santos

Non-local non-stabiliserness in gluon and graviton scattering:

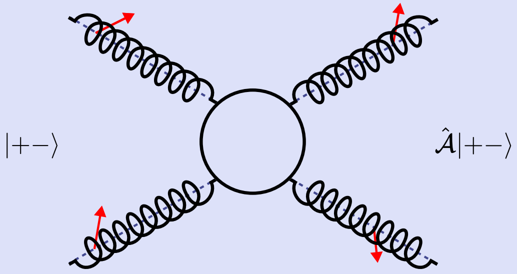
arXiv: 2603.04148

Michael Reichenberg Ashby
Queen Mary University of London, UK

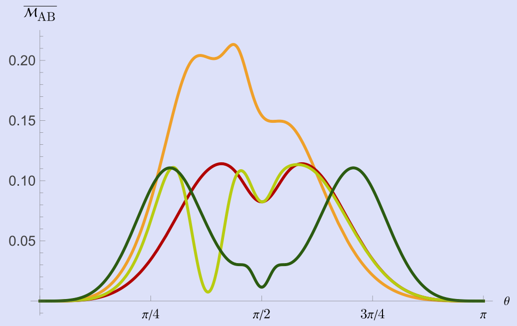
Magic from helicity scattering

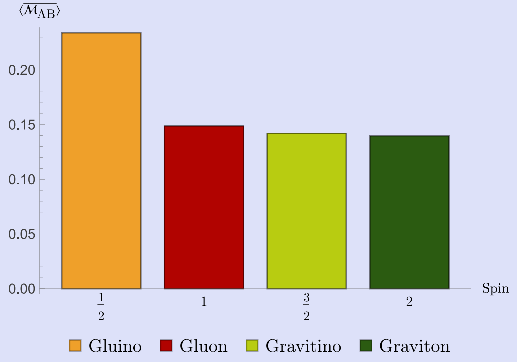
$$M_2[|\psi\rangle] = -\log_2\left(\frac{1}{2^N}\sum_{\hat{P}\in\mathcal{P}^{(N)}}\left|\langle\psi|\hat{P}|\psi\rangle\right|^4\right)$$

$$\mathcal{M}_{AB} = \min_{U_A\otimes U_B} M_2[(U_A\otimes U_B)|\psi\rangle]$$

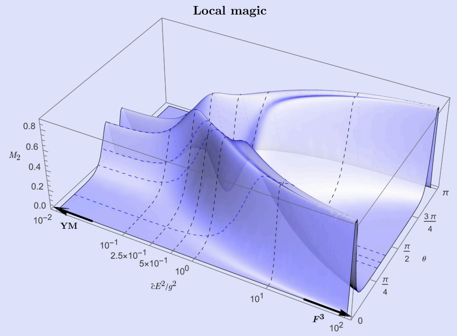


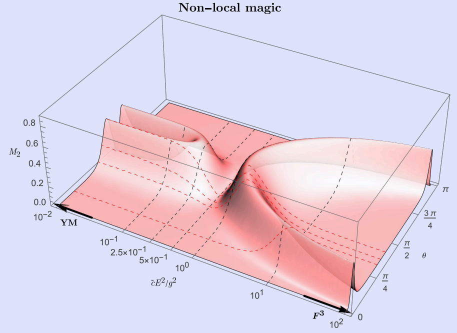
Spin vs. Magic





$\mathrm{YM} + F^3$





Marcelo dos Santos

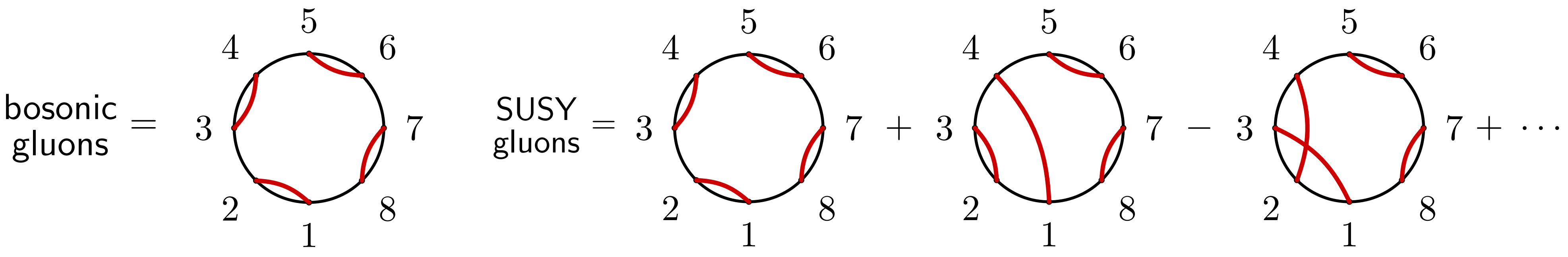
Next: Matthew Rochford

Combinatorics of the Scaffolded Superstring

Marcelo dos Santos, UC Davis

Based on work with Jaroslav Trnka

Curve integral formalism $\Rightarrow$ Non-planar SYM integrand?



Continuation of [1]: native understanding of factorization and F^3 cancellation. **Loops?**

[1] Q. Cao, J. Dong, S. He, C. Zhu, *Superstring amplitudes meet surfaceology*, 2025.

Matthew Rochford

Next: Aakash Kumar

Light-like Wilson loop correlators in $\mathcal{N} = 4$ SYM

Matthew Rochford
In collaboration with James Drummond, Ömer Gürdoğan and Rowan Wright, based on 2512.12655, 2601,23210, 2602.18423
School of Physics and Astronomy, University of Southampton

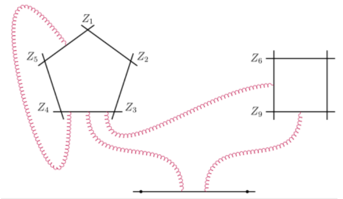
University of Southampton

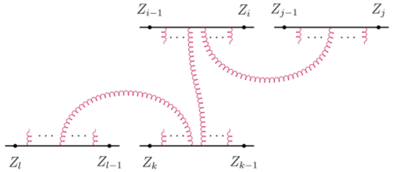
MOTIVATION

- Wilson loop definition: $\mathcal{L}(C) = \frac{1}{N}\,\mathrm{tr}\,\mathcal{P}\exp i\oint_C dx^\mu A_\mu$
- Wilson loop correlator: $\mathcal{W}_{n_1,\ldots,n_m} = \langle \mathcal{L}(C_1)\ldots\mathcal{L}(C_m)\rangle$
- Scattering Amplitude/Wilson loop duality: $A(p_1,\ldots,p_n) \Leftrightarrow \mathcal{W}_n$
- $\mathcal{W}_n$ satisfies the same properties as scattering amplitudes.
- *Do Wilson loop correlators satisfy analogous properties?* Yes!
- *Why are we interested?* From taking limits of the correlator, we may be able to reproduce Wilson loop-Lagrangian correlators, and they may tell us about the spectrum of operators.

COMPUTING CORRELATORS

Work in twistor space and compute Feynman diagrams of the form:





$$= \quad [*, i-1, \widehat{i}_j, k-1, \widehat{k}_l]$$

PROPERTIES OF $\mathcal{W}_{n_1,\ldots,n_m}$

- Chiral box expansion and tree-level singularities

$$\mathcal{W}^{1-\text{loop}}_{n_1,n_2} = \sum\left(f^1_{a,b,c,d}\, I^1_{a,b,c,d} + f^2_{a,b,c,d}\, I^2_{a,b,c,d}\right) + \mathcal{W}^{tree}_{n_1,n_2}\sum I^{div}_a$$

where f's are tree-level correlators and I's are simple integrands/integrals.

- Recursion relation:

$$\begin{aligned}\langle\mathcal{L}[1,2,3,4]\mathcal{L}[\tilde{1},\ldots,\tilde{n}_2]\rangle^c &= \langle\mathcal{L}[1,2,3]\mathcal{L}[\tilde{1},\ldots,\tilde{n}_2]\rangle^c\\ &+\sum_{\tilde{j}}[3,4,1,\tilde{j}-1,\tilde{j}]\langle\mathcal{L}[1,2,3,\hat{4},I_{\tilde{j}},\tilde{j},\ldots,\tilde{j}-1,I_{\tilde{j}}]\rangle\end{aligned}$$

- $\bar{Q}$ equation

$$\begin{aligned}\bar{Q}^{A'}_A\mathcal{R}^{(k,1)}_{n_1,n_2} &= \int\left[d^{2|3}\mathcal{Z}_{X_1}\right]^{A'}_A\left[\mathcal{R}^{(k+1,0)}_{n_1+1,n_2} - \mathcal{R}^{(k,0)}_{n_1,n_2}\mathcal{R}^{(1,0)}_{n_1+1}\right] + \mathrm{cyc}_1\\ &+\int\left[d^{2|3}\mathcal{Z}_{X_2}\right]^{A'}_A\left[\mathcal{R}^{(k+1,0)}_{n_1,n_2+1} - \mathcal{R}^{(k,0)}_{n_1,n_2}\mathcal{R}^{(1,0)}_{n_2+1}\right] + \mathrm{cyc}_2\end{aligned}$$

FUTURE WORK

- Find geometry for $\mathcal{W}_{n_1,n_2}$.
- Reproduce $\langle\mathcal{L}(C_1)O(x)\rangle$ by taking limit of $\langle\mathcal{L}(C_1)\mathcal{L}(C_2)\rangle$.
- Compute $\mathcal{W}^{2\text{-loop}}_{n_1,n_2}$ using $\bar{Q}$ equation.

Aakash Kumar

Next: Felix Forner

SMaSH : Simplify Massive Spinor Helicity

Aakash Kumar[1], Arnab Rudra and Rahul Shaw
Indian Institute of Science Education and Research, Bhopal, India

- Explicit massive little group indices
- Index contraction, spinor derivatives, massive & massless helicity scaling operators etc.
- Implementation of RAMBO algorithm to generate numerical kinematics
- High energy behavior and C, P, T transformations
- Computing any n-point higher spin scattering amplitude
- Finding contact terms and manifesting gauge invariance
- Simplification of Mandelstam variables

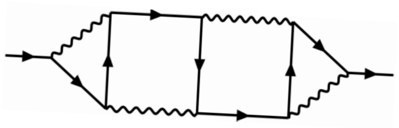
[1] *github.com/aakash-kmr/SMaSH*

Felix Forner

Next: Chanon Hasuwannakit

Felix Forner
Amplitudes 2026, QMUL

Collaboration with A. von Manteuffel, C. Nega, L. Tancredi



QED self-energies
@ 4 loops

ε-factorized
differential equations

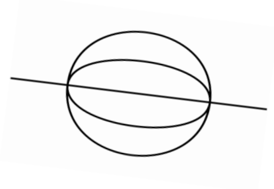
$$\mathrm{d}\log(\alpha(z))$$

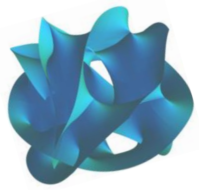
$$y^2 = (x-a_1)(x-a_2)(x-a_3)(x-a_4)$$

$$\frac{\mathrm{d}x}{y} \qquad \frac{x\,\mathrm{d}x}{y} \qquad \frac{x^2\,\mathrm{d}x}{y}$$

integrand analysis &
leading singularities

geometry





special functions
(beyond MPLs)

Deutsche
Forschungsgemeinschaft
German Research Foundation

TUM

Chanon Hasuwannakit

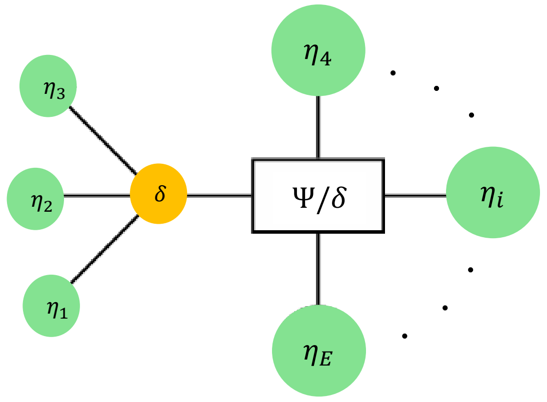
Next: Kathrin Stoldt

Berends-Giele current for Gravity

Gravity → Chiral Einstein-Cartan $S[e,A] = \frac{1}{16\pi G}\int \Sigma^i \wedge (dA^i + \frac{1}{2}\epsilon^{ijk}A^j \wedge A^k)$

Gravity solution

$J(-++\ +\cdots+)$



$$\sum_{\eta\ \text{perms}} \frac{1}{\Box}\frac{(q|\eta_1|\Psi|q)}{(1+\Psi)^2}\cdot\prod_{j=1}^{E-2}\frac{(q|\eta_{j+1}|1+\Psi+\eta_1+\cdots+\eta_j|\delta_j)}{(1+\Psi+\eta_1+\cdots+\eta_j)^2(q\delta_j)}\cdot\frac{(q|\eta_E|\Psi+\eta_1+\cdots+\eta_{E-1}|q)}{(1+\Psi+\eta_1+\cdots+\eta_{E-1})^2}$$

$$A_{MHV}(01|\mathcal{K}) = (01)^6\sum_{\Gamma_\mathcal{K}}\prod_{i\in\mathcal{K}}(0i)^{\alpha_i-2}(1i)^{\alpha_i-2}\prod_{\langle ij\rangle\in\Gamma_\mathcal{K}}\frac{[jk]}{(jk)}$$

AMPLITUDES 2026

Kathrin Stoldt

Next: Enrico Zunino

Radiated Angular Momentum from the Impact Parameter in WQFT

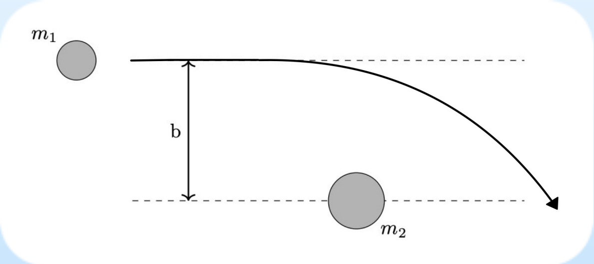
Kathrin Stoldt

Amplitudes 2026

Radiated angular momentum is interesting for gravitational wave modelling

It is non-vanishing only for dissipative effects

$$L^\mu = -\frac{1}{E}\epsilon^\mu{}_{\nu\alpha\beta}(\overbrace{b_2^\nu - b_1^\nu}^{b^\nu})p_1^\alpha p_2^\beta$$



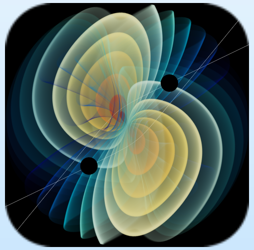
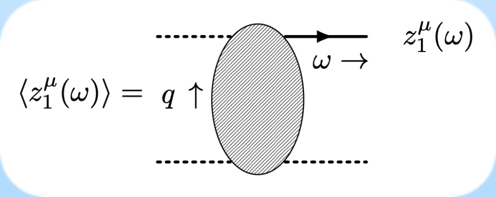


Image credit:
Mathias Driesse

Goal: Use Worldline Quantum Field Theory (WQFT) formalism to compute Δb_i^μ with a new method to obtain ΔL^μ

$$\Delta b_i^\mu = \lim_{\omega\to 0}\frac{\mathrm{d}}{\mathrm{d}\omega}\Big(i\omega^2\langle z_i^\mu(\omega)\rangle\Big)$$



Systematic organisation of terms related to the wave memory with k - point correlators

Methods:

- Worldline and bulk vertices
- IBPs for three-loop integrals
- Differential equations

Results:

- ΔL^μ at $\mathcal{O}(\alpha^3)$ in Electrodynamics
- Reproduced $\mathcal{O}(G^3)$ result in gravity

[Jakobsen, KS '26]

In progress (with Bohnenblust, Eriksen, Jakobsen, Yanovets):

- ΔL^μ at $\mathcal{O}(G^4)$ in gravity

Enrico Zunino

Next: Hector Puerta-Ramisa

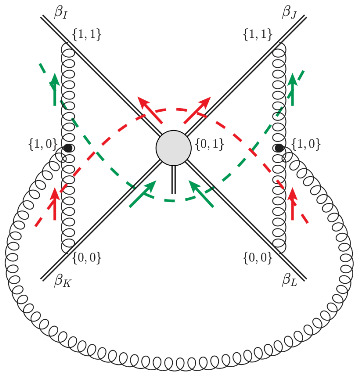
With L. Magnea, ...

Celestial Holography

$$\rho_{ijkq} = \frac{s_{ij}s_{kq}}{s_{ik}s_{jq}} = z\bar{z},$$
$$\rho_{iqjk} = \frac{s_{iq}s_{jk}}{s_{ik}s_{jq}} = (1-z)(1-\bar{z}),$$

Soft QCD

Soft Anomalous Dimension



With E. Gardi, A. McLeod,...

Enrico Zunino, University of Edinburgh

Amplitudes 2026, QMUL

Hector Puerta-Ramisa

Next: Rahul Balaji

Analytic Superspace Methods in (A)dS/(S)CFT

Superior tool for solving constraints from (super)conformal symmetry

$\rightarrow$ (S)Conformal group acts linearly
$\rightarrow$ Shortening conditions **automatic**

(S)CFT

- Weight shifting operators [Hansen,Heslop,HPR '25]
- New **non-renormalisation** thms [Bissi,Fardelli,HPR (WIP)]

Non-SUSY included!

- Unified formalism for any $\mathrm{SU}(m, m|2n)$, $\mathrm{OSp}(4m|2n)$
- Use **harmonic analyticity** to solve constraints, then turn off SUSY [Heslop,HPR'25 + WIP]

+ (Super) Conformal tensor products (OPEs) from **very** simple **combinatorics** [WIP]

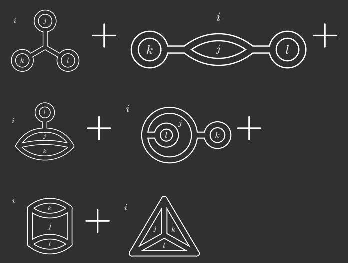
Rahul Balaji

Next: Dhruv Pathak

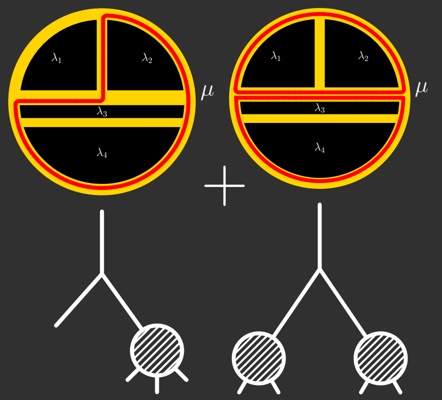
Towards Open String Integrals on Moduli Space

Rahul K Balaji
Princeton University, IAS
Amplitudes 2026

$$K_{0,n}(\lambda) = \sum_{\Gamma} \frac{1}{|\operatorname{Aut}\Gamma|} \prod_{e=(ij)\in E(\Gamma)} \frac{2}{\lambda_i+\lambda_j}$$

$K_{0,4}(\lambda_1,\lambda_2,\lambda_3,\lambda_4) =$ 

$$= \sum_{i=1}^{4} \frac{1}{\lambda_i^3} \prod_{j\neq i} \frac{1}{\lambda_j}$$



$K_{0,5}(\mu,\lambda_1,\cdots,\lambda_4)$

Next up: $A^{\alpha'}_{g,n} = \int_{\mathcal{M}_{g,n}} \Omega_{WP} \prod_C u_C^{\alpha' X_{ij}}$

Information about α' corrections contained in the leading order terms.

IAS
INSTITUTE FOR ADVANCED STUDY

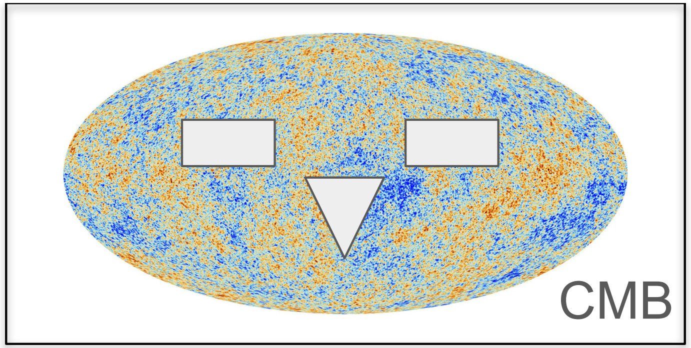
Dhruv Pathak

Next: Gabriel Menezes

Dhruv Pathak Govardhan
King's College London

Higher Point Feynman Diagrams

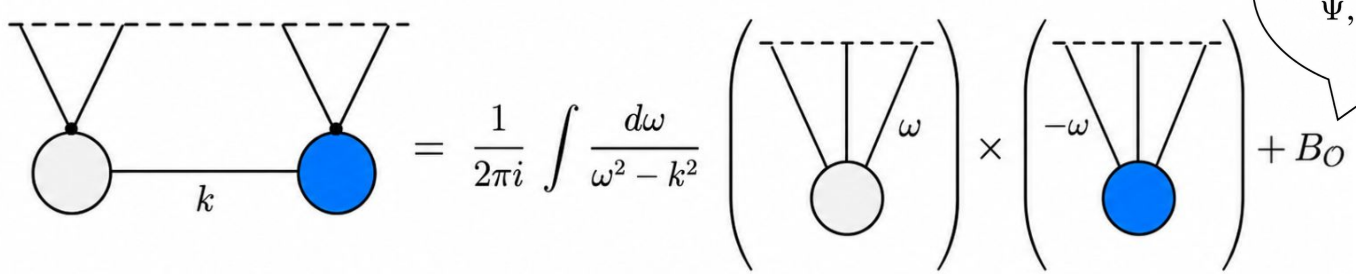
Problem



Precision Cosmology Observables

V vertices ⇒ V integrals

One Integral?

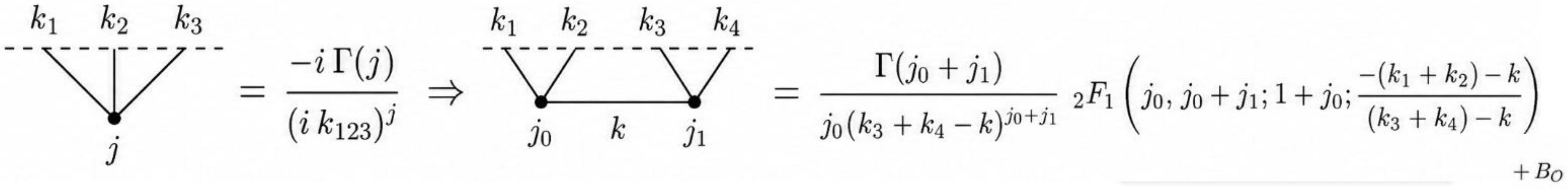


Selects observable

$\Psi, \quad G_F, \quad \langle \varphi^n \rangle$

E.g. Conformal Scalar ϕ^3

Scale factor $a(\tau) = \tau^{j-1}$



Gabriel Menezes

Next: Maegan Anderson

Higher-Spin Soft Charges as Kerr Multipole Dressing

Gabriel Menezes | Based on 2607.XXXXX

Department of Mathematical Physics
USP's Institute of Physics
FAPESP
FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO
CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

One-minute message

Kerr scattering selects an exponentiated soft tower

- **VV recovered:** s = 0 gives the Veneziano-Vilkovisky supertranslation.
- **Subleading:** only the electric Diff(S^2) component is fixed, naturally in generalized BMS.
- **Ward/dressing:** charges reproduce the exponentiated Kerr soft kernel and generate the linearized Kerr field.
- **Meaning:** the algebra composes canonical/intrinsic Kerr frame shifts.

Key equations

KERR SOFT MULTIPOLE DRESSING

$$S^{\mathrm{cl}}_{\mathrm{Kerr}}(k) = S^{(0)}_{\eta}\, e^{-i\omega W_{\eta}(q)}, \quad M_\ell + iS_\ell = M(ia)^\ell$$

CHARGE ALGEBRA

$$\{Q^{\mathrm{tot}}_s(t), Q^{\mathrm{tot}}_{s'}(t')\} = Q^{\mathrm{tot}}_{s+s'-1}([t,t']_\star) + \mathcal{K}_{s,s'}[t,t';C]$$

LOCAL CHIRAL REDUCTION

$$\{F_{m,s}, F_{n,s'}\} = \big((s'-1)m - (s-1)n\big) F_{m+n,s+s'-2}$$

local check

Takeaway: the w_{1+infty}-like structure is the composition law for Kerr soft frame shifts.

Maegan Anderson

Next: Zhihao Zhang

Conformally flat limit of Quadratic Gravity

Maegan Anderson
University of Edinburgh
with Sam Bateman, Franz Herzog and Neil Turok

Web of related theories

$$\mathcal{S}_{\mathrm{QG}} = -\int d^4x\, \sqrt{-g}\left(\frac{1}{2\gamma}C^2 + \frac{1}{\xi}R^2\right)$$

$$\gamma \to 0$$

$$\mathcal{S}_{\mathrm{PS}} = -\frac{1}{2}\int d^4x\, \left(\Box\varphi + \lambda(\partial\varphi)^2\right)^2$$

$$\mathcal{S}_{\Omega\Upsilon} = -\int d^4x\, \left(\partial\Omega\,\partial\Upsilon - \frac{\lambda^2}{2}(\Omega\Upsilon)^2\right)$$

$$\mathcal{S}_{\mathrm{CSQ}} = -\int d^4x\, \left(\partial\phi\partial\phi^* + g(\phi^*\phi)^2\right)$$

Beta-functions

All agree given the following relationships between couplings:

$$\xi = 72\lambda^2 \qquad g = -\frac{\lambda^2}{2}$$

(1-loop) ⟶ (3-loop) ⟶ (6-loop)

Perfect square theory (CFQG)

- Renormalisable, asymptotically free theory of Gravity (albeit without gravitons)
- To all loops is Euclidean IR finite

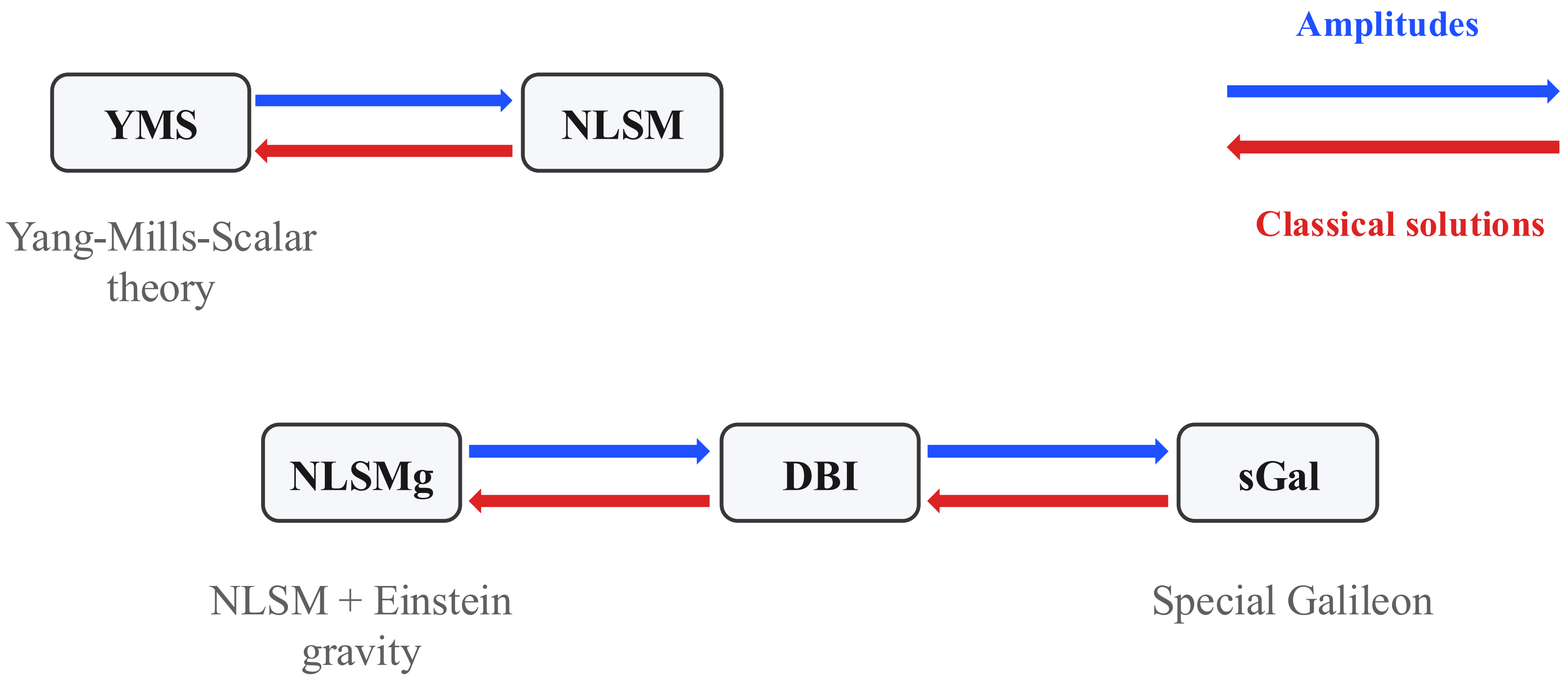
Zhihao Zhang

Next: Sebastien Timothy MacDonald

Geometric duality between effective field theories

Speaker: Zhihao Zhang

Woking with: Tomas Brauner, Diederik Roest, Tianzhi Wang, Yang Li



Sebastien Timothy MacDonald

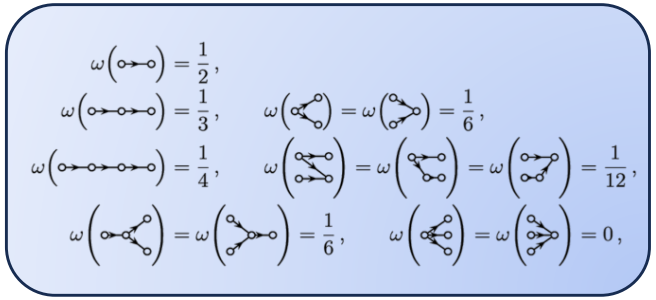
Next: Francesco Campanella

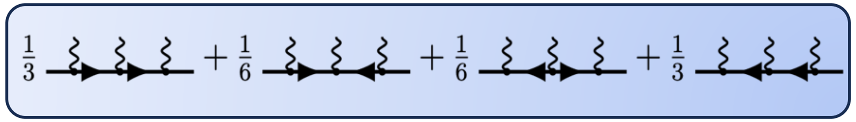
Classical Physics from Magnus Expansion

Sébastien MacDonald

Work in progress with A. Brandhuber, G. Brown, P. Pichini, G. Travaglini, P. Vives Matasan

$$S = e^{iN/\hbar}$$





$$iN^{(n)} = \frac{1}{(i\hbar)^{n-1}} \int \underbrace{[\mathcal{H}_1, [\mathcal{H}_2, [\dots, [\mathcal{H}_{n-1}, \mathcal{H}_n] \dots]]]}_{(n-1)\text{-fold nested commutators} \sim \mathcal{O}(\hbar^{n-1})} \sim \mathcal{O}(1)$$

N is classical:
Explicit examples in a toy model

New properties of
Murua coefficients $\omega(\tau)$

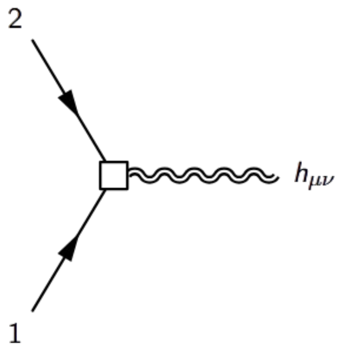
QED and gravity

Francesco Campanella

Next: Sebastiano Bocchia

Gravitational Multipoles in Higher Dimensions from Scattering Amplitudes

Francesco Campanella
La Sapienza, University of Rome



- Three-point function involving a massive spinning field and gravity in arbitrary dimensions to study **stress-energy tensor structure in momentum space**;
- In four dimensions, there are two types of gravitational multipole moments: **Mass** and **Current** moments;
- In four dimensions, the minimal coupling reproduces the Kerr multipolar structure;
- In higher dimensions, additional multipole moments appear: the **Stress** moments;
- In dimensions higher than four, Spin universality is **lost** and the **minimal coupling does not reproduce** Myers-Perry multipolar structure, which is

$$T^{\mu\nu}(q)\big|_{\mathrm{MP}} = m\Omega(d)\zeta^{-\frac{d-2}{2}}\Bigg[u^\mu u^\nu\left(J_{\frac{d-2}{2}}\left(\frac{d-1}{2}\zeta\right) - \frac{\zeta}{2}J_{\frac{d}{2}}\left(\frac{d-1}{2}\zeta\right)\right)$$
$$- \frac{1}{2\zeta}(S\cdot q)^\mu(S\cdot q)^\nu J_{\frac{d}{2}}\left(\frac{d-1}{2}\zeta\right)$$
$$- \frac{i}{2}\left(u^\mu(S\cdot q)^\nu + u^\nu(S\cdot q)^\mu\right)J_{\frac{d-2}{2}}\left(\frac{d-1}{2}\zeta\right)\Bigg]$$

with

$$\zeta \equiv \sqrt{q\cdot S\cdot S\cdot q} = \sqrt{q^\mu S_\mu{}^\nu S_\nu{}^\sigma q_\sigma}$$

References:

- 2605.05067 **FC**, **Riccioni**
- 2412.01771 **Bianchi**, **Gambino**, **Riccioni**
- 1812.08752 **Chung**, **Huang**, **Kim**, **Lee**
- 2403.16574 **Gambino**, **Pani**, **Riccioni**
- 1709.06016 **Vines**
- 2605.29831 **Cangemi**, **Surubaru**

Sebastiano Bocchia

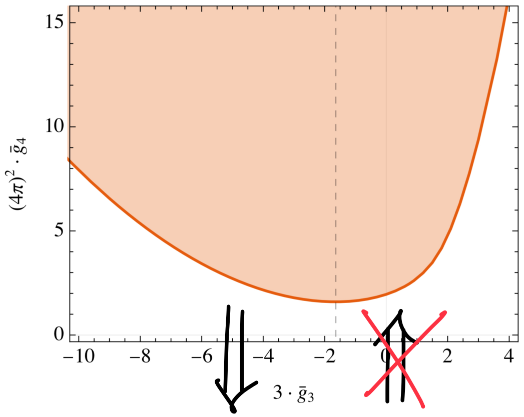
Next: Melvyn Nabavi

Bootstrapping the Spectra of Neutral Goldstones in 4d

$$\mathcal{M}(s,t,u) = g_2\,(s^2+t^2+u^2) + g_3\,(stu) + g_4\,(s^2+t^2+u^2)^2 + \ldots$$

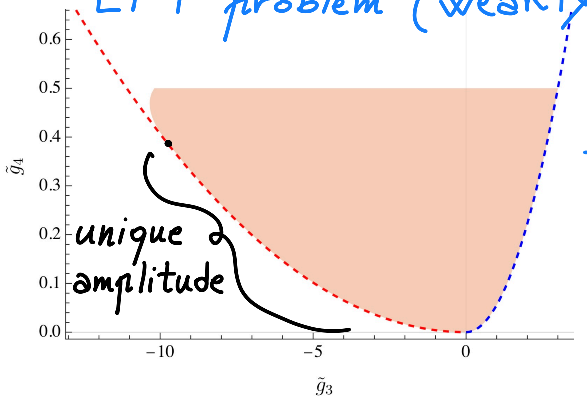
$$- \frac{g_2^2}{480\pi^2}\Big(s^2(41s^2+t^2+u^2)\log(-s\sqrt{g_2}) + (s\to t) + (s\to u)\Big) + \ldots$$

General Problem



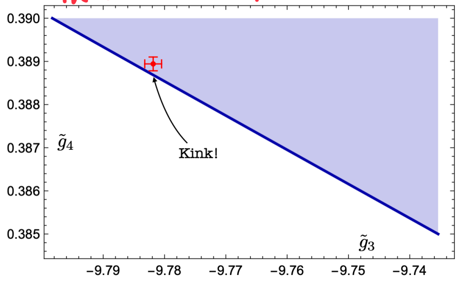
g_2 - cutoff

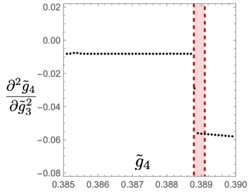
EFT problem (weakly coupled)

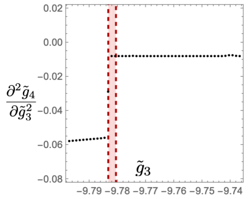


M - cutoff

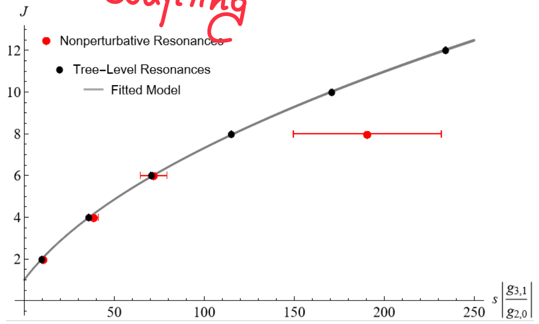
Verified the presence of a Kink in the EFT problem







Only one trajectory survives at weak coupling



SEBASTIANO BOCCHIA

based on the work with A. Guerrieri, K. Häring and D. Karateev

CITY ST GEORGE'S UNIVERSITY OF LONDON

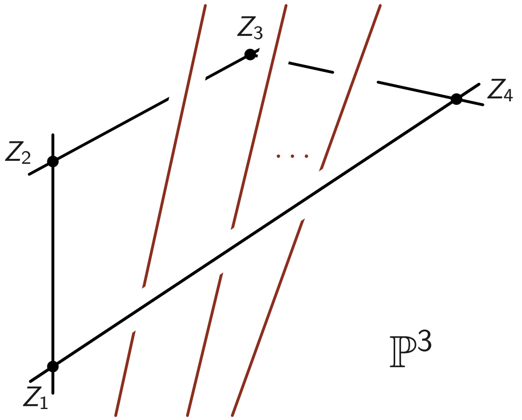
Melvyn Nabavi

Next: Daniel Longenecker

The deformed Amplituhedron at higher loops

Melvyn Nabavi
Johannes Henn, Rourou Ma and Jaroslav Trnka

$\mathcal{N} = 4$ sYM integrand



"canonical form" in $G(2,4)^L$

deforming Z_i's
$\longrightarrow$
to "fat lines"

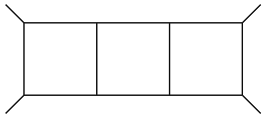
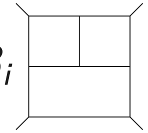
Conjecture:

deformed Amplituhedron:

$\mathcal{N} = 4$ sYM on the Coulomb branch.

IR finite

- 1,2,3 loops ✓ :

$$d\Omega_3 = \sum_i \alpha_i$$  $$+ \sum_i \beta_i$$ 

- Generalizing to all-loops?

Daniel Longenecker

Next: Leonardo Sartori

Uncolored Scalar Kinematics

Daniel Longenecker

The X_{ij} variables trivialize momentum conservation for theories with color.

What about uncolored, permutation-invariant theories? For example, ϕ^3.

Here is a prescription:

Momentum conservation ($\sum_i s_{ij} = 0$) is linear in the space of mandelstams, so we can do an <u>orthogonal</u> <u>projection</u> to kinematic space.

For example, at 4pts, $s \to s - \frac{1}{3}(s+t+u) = \frac{2}{3}s - \frac{1}{3}t - \frac{1}{3}u$.

Using this prescription, we can modify the Koba-Nielsen factor and discover new, permutation covariant coordinates on $\mathcal{M}_{0,n}$ (the integration domain for string tree amps).

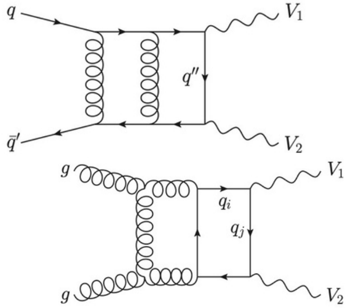
Leonardo Sartori

Next: Marko Beocanin

Preliminary:
Two-loop Massive Top Corrections to Di-Boson Production

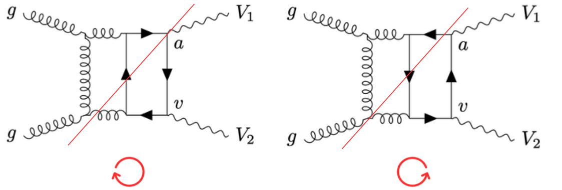
Leonardo Sartori based on current work with **A. Ghira**, **L. Tancredi** and **G. Zanderighi**

only massless quarks in loops:



$$
\begin{aligned}
\tilde{T}_1^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\mu p_1^\nu\,,\\
\tilde{T}_2^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\mu p_2^\nu\,,\\
\tilde{T}_3^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\mu p_1^\nu\,,\\
\tilde{T}_4^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\mu p_2^\nu\,,\\
\tilde{T}_5^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\nu v_A^\mu\,,\\
\tilde{T}_6^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\nu v_A^\mu\,,\\
\tilde{T}_7^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\mu v_A^\nu\,,\\
\tilde{T}_8^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\mu v_A^\nu\,,\\
\tilde{T}_9^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) v_A^\nu v_A^\mu,
\end{aligned}
$$

[Gehrmann, von Manteuffel, Tancredi, 2015]
[Caola, Henn, Melnikov, Smirnov, Smirnov, 2015]



No non-trivial axial-vector contributions

Double-axial = Double-vector

Only Multi-polylog appear

$$G(w_1, w_2, \cdots, w_n; z) \equiv \int_0^z \mathrm{d}t\, \frac{1}{t - w_1} G(w_2, \cdots, w_n; t)\,,$$

---

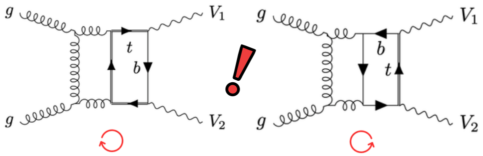
accounting for massive top quark:

$$
\begin{aligned}
\tilde{T}_1^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\mu p_1^\nu\,,\\
\tilde{T}_2^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\mu p_2^\nu\,,\\
\tilde{T}_3^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\mu p_1^\nu\,,\\
\tilde{T}_4^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\mu p_2^\nu\,,\\
\tilde{T}_5^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\nu v_A^\mu\,,\\
\tilde{T}_6^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\nu v_A^\mu\,,\\
\tilde{T}_7^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\mu v_A^\nu\,,\\
\tilde{T}_8^{E,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\mu v_A^\nu\,,\\
\tilde{T}_9^{E,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) v_A^\nu v_A^\mu,
\end{aligned}
$$

$$
\begin{aligned}
\tilde{T}_1^{O,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\mu v_A^\nu\,,\\
\tilde{T}_2^{O,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\mu v_A^\nu\,,\\
\tilde{T}_3^{O,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_1^\nu v_A^\mu\,,\\
\tilde{T}_4^{O,\mu\nu} &= \bar{u}(p_2)\not{p}_3 u(p_1) p_2^\nu v_A^\mu\,,\\
\tilde{T}_5^{O,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\nu p_1^\mu\,,\\
\tilde{T}_6^{O,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_1^\nu p_2^\mu\,,\\
\tilde{T}_7^{O,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\nu p_1^\mu\,,\\
\tilde{T}_8^{O,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) p_2^\nu p_2^\mu\,,\\
\tilde{T}_9^{O,\mu\nu} &= \bar{u}(p_2)\not{v}_A u(p_1) v_A^\nu v_A^\mu\,,
\end{aligned}
$$

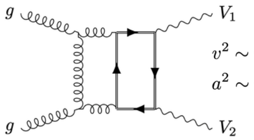
[Melnikov, Dowling, 2015]
[Brønnum-Hansen, Wang, 2020]
[Agarwal, Jones, von Manteuffel, 2020]
(Numerical results)

Axial-vector contributions don't cancel anymore



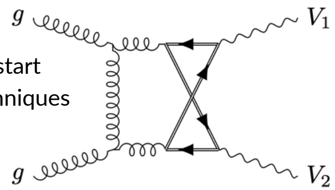
Double-axial and double-vector contributions even have different scalings

Need schemes to handle γ_5 in dimensional regularisation



$v^2 \sim m_t^{-4}$
$a^2 \sim m_t^{-2}$

Elliptic integrals start appearing, new techniques needed

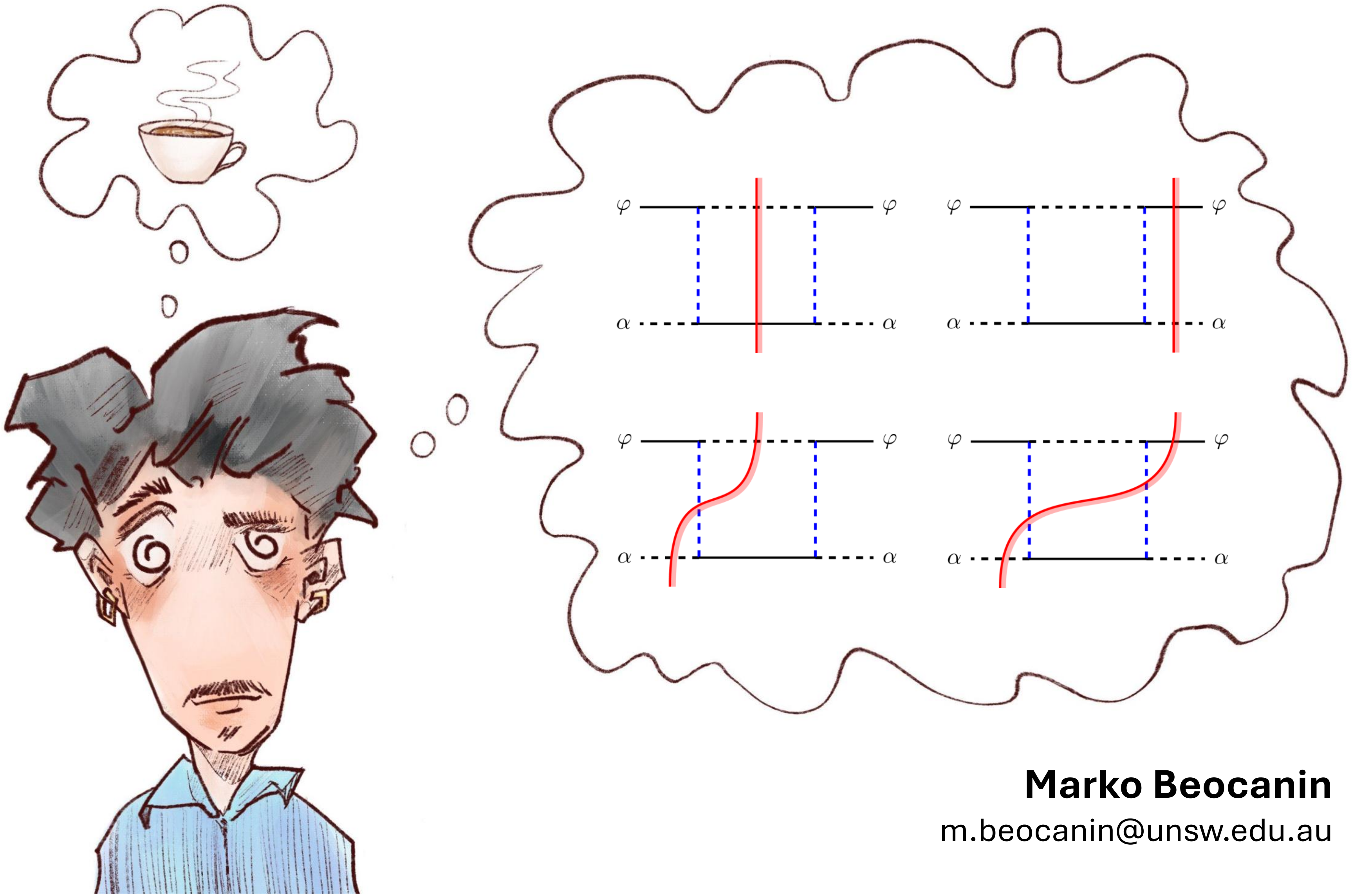


$$I_n^C(a,\epsilon) = \frac{1}{2\sqrt{\pi}} \int_C \mathrm{d}x\, \frac{x^n}{\sqrt{x(1-x)(1-a\,x)}} (x(1-x)(1-a\,x))^\epsilon$$

[Forner, Mella, Nega, Tancredi, Wagner, 2026]

Marko Beocanin

Next: the end



Marko Beocanin
m.beocanin@unsw.edu.au

AMPLITUDES 2026

Thank you for all your wonderful contributions!