Gong Show

International School on

Amplitude and Cosmology,
Holography and Positive Geometries

Lecce – ex-Convitto Palmieri

International School on Amplitudes and Cosmology, Holography and Positive Geometries

Lecce, May 2019

- **Vangelis Alexopoulos**, MSc. Student,
  National Technical University of Athens

Current Research

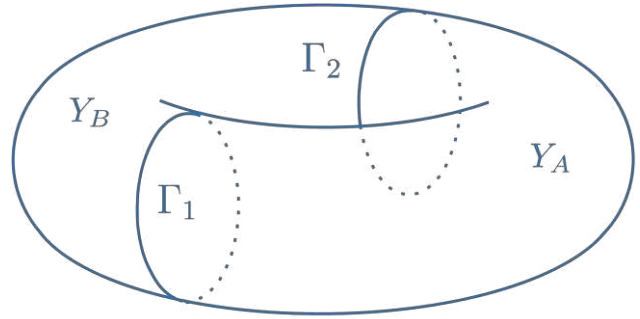
Reduction of Couplings in Particle Physics

Research interests

(Beyond)Standard Model, Supersymmetry, Scattering Amplitudes, Dark Matter,EFT

Entanglement Entropy of the Quantum Lifshitz Model

Juanfernando Angel, University of Iceland



QLM action: $S[\phi] = \frac{1}{2} \int\limits_M \mathrm{d}^d x \, \mathrm{d}t \left[(\partial_t \phi)^2 - g^2 \left(\nabla^z \phi \right)^2 \right]$

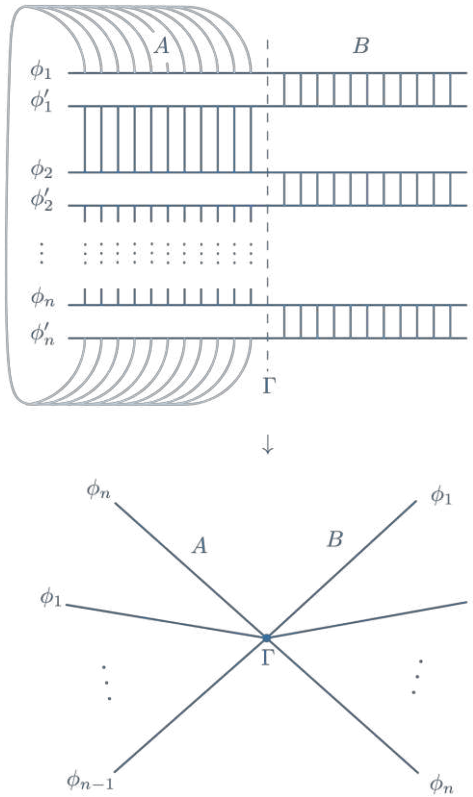
$$\Longrightarrow$$

Excited states: $\left| (m_{\lambda_1}, \ldots, m_{\lambda_\nu}) \right\rangle = \left(A^\dagger_{\lambda_1} \right)^{m_{\lambda_1}} \cdots \left(A^\dagger_{\lambda_\nu} \right)^{m_{\lambda_\nu}} |\psi_0\rangle$

Density Matrix: $\rho = \left| (m_{\lambda_1}, \ldots, m_{\lambda_\nu}) \right\rangle \left\langle (m_{\lambda_1}, \ldots, m_{\lambda_\nu}) \right|$

$$\Longrightarrow$$

Cut manifold M into A and B, replica trick calculation to evaluate $\mathrm{Tr}\left(\rho_A^n\right)$



$$\Longrightarrow$$

Entanglement Entropy: $S[A] = -\lim\limits_{n \to 1} \mathrm{Tr}\left(\rho_A^n\right) = -\mathrm{Tr}(\rho_A \log \rho_A)$

Anupam A H,Institute Of Mathematical Sciences, India

- Interests
  - Asymptotic symmetries and relationship with soft theorems in gauge theories and gravity.
  - Modern amplitude techniques like positive geometries , CHY formalism
  - Construction of IR finite S-matrix in gauge theories using Fadeev-Kulish Approach
- Recent and Ongoing Work and Results
  - Relating BMS Symmetries in gravity to consecutive Double soft theorems.
    - Nested Ward Idenitities of the form $\langle \text{out} | \left[Q_1, \left[Q_2, \mathcal{S} \right] \right] | \text{in} \rangle = 0$ lead to consecutive double soft theorem at leading and subleading level.
  - Formulation of Fadeev-Kulish type states in QCD using Large gauge symmetries in QCD.
    - Recent work by Strominger et al and Akoury et al showed that it is possible to recover FK states from asymptotic symmetries
    - Extending this idea to QCD. Unlike QED and gravity, multiple soft theorem is needed to be taken into account for FK construction.

Maor Ben-Shahar, Uppsala University, Sweden

- Masters thesis: $\mathcal{N} = 2$ homogeneous supergravities at one loop [1812.00402], using the double copy method (gravity=gauge$\otimes$gauge)
- PhD in Sweden, soon.

Sebastian Bramberger

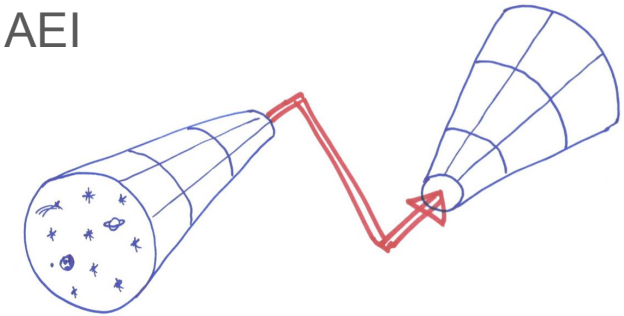
Theoretical Cosmology

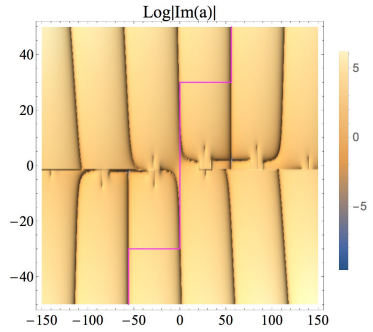
Cosmological Singularity Resolution / Avoidance

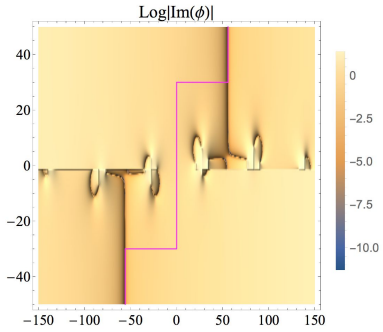
- In classical GR
- In semi-classical GR
- Using modified gravity (Horava Lifshitz)

1503.02317 McGill

1605.02751
1701.05399
1701.05753
1709.07084
1901.10198
1904.07285
} AEI







Yvonne Calo’

University of Edinburgh 1st year PhD student

Advisor: Prof. Jose’ Figueroa-O’Farrill

MsC at the University of Salento

Thesis: Relation between symmetry groups
of asymptotically flat spacetimes (1805.07814[gr-qc])

Possible PhD project: Homogeneous Kinematical Spacetimes, supergravity and carrollian structures

Gong Show

International School on Amplitudes and Cosmology, Holography and Positive Geometry

WHO? Francesca Caloro

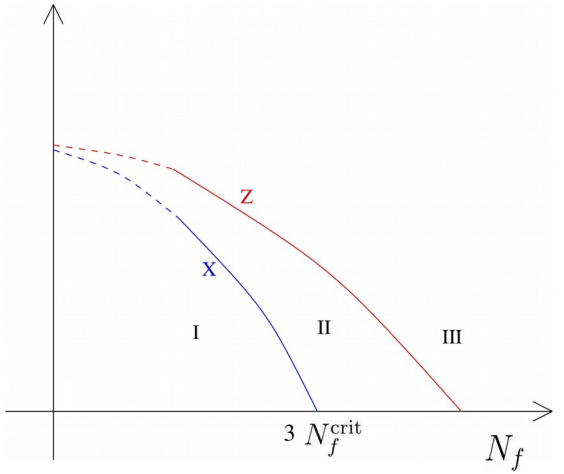
WHERE?

- Department of Mathematics and Physics "Ennio De Giorgi", Università del Salento, Lecce
- Coming soon: Ph.D. at Newcastle University

WHAT?

Current research

- Chiral symmetry of QCD and its breaking
- Chiral effective field theories
- Investigate the consequences on baryon dynamics of $N_f = 3$ being a point close to a chiral phase transition producing large vacuum fluctuations of quark-antiquark pairs



Research interests

- Symmetries and their breaking
- Theoretical cosmology
- The early universe as a Hologram

Federico Capone

University of Southampton & STAG Research Centre

Gong Show
ID Card
Lecce, 27/05

Research interests: holographic dualities in string theory...and beyond ?

PhD Advisor: Marika Taylor

Current projects:

1) BMS symmetries, soft theorems and scattering amplitudes: flat holography?
What is the role of BMS *superrotations* in the phase space of allowed solutions?

Superrotations of asymptotically flat spacetimes in d=4 are interpreted as including cosmic strings within the phase space [A. Strominger, A. Zhiboedov, 1610.00639]

Cosmic branes and asymptotic structure, F.C., M.Taylor [1904.04265 [hep-th]]

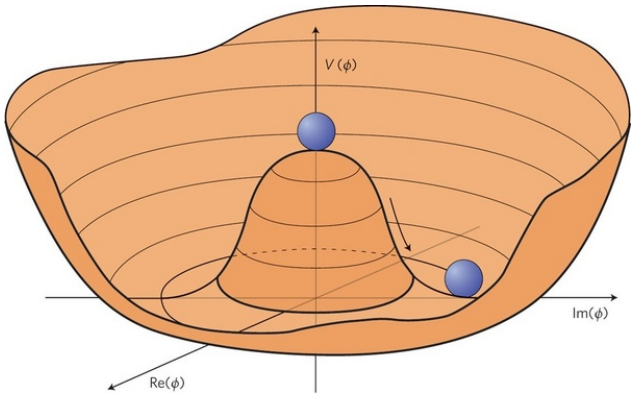
Define the phase space of ***locally* asymptotically flat** spacetimes in d > 4 allowing for **cosmic (d-3)-branes.** Transformations analogous to superrotations?

2) Bulk dual of the SYK model from string theory?

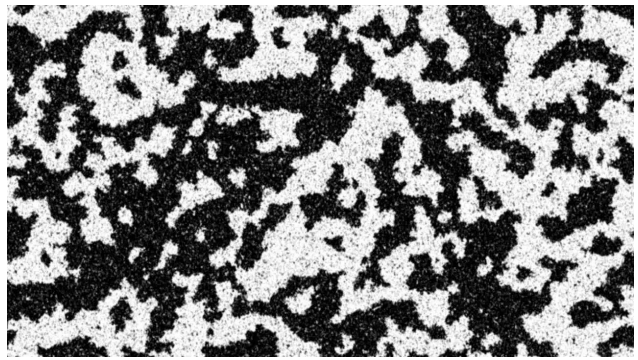
Martino Centonze

My main interests in physics:
QFT, *Cosmology* & Statistical mechanics, complex systems.

Higgs field phase transition:



Ising model near the critical point:



My current area of research: statistical mechanics of spin glasses, with particular focus on neural networks.
Incoming paper:

Deep Learning and Dense Associative Memories:
detecting the undetectable through redundant representation

Elena Agliari*
Dipartimento di Matematica, Sapienza Università di Roma

Francesco Alemanno†
Dipartimento di Matematica e Fisica Ennio De Giorgi, *Università del Salento and C.N.R. Nanotec*

Adriano Barra,‡ Martino Centonze,§ and Alberto Fachechi¶
Dipartimento di Matematica e Fisica Ennio De Giorgi, *Università del Salento*
(Dated: May 20, 2019)

The Abdus Salam
International Centre
for Theoretical Physics

Constraints on holographic multi-field inflation and models based on the Hamilton-Jacobi formalism

In collaboration with A. Achucarro A. Davis, and Gonzalo Palma

1809.05341 (published in PRL)

Sebastian Cespedes
ICTP

Detecting

$$\langle\zeta^3\rangle_{q\to 0} \propto P_\zeta(k)P_\zeta(k')\left(\frac{q}{k}\right)^{3/2}\cos(i\nu\log\frac{q}{k})$$

will rule out a large class of models

Nikolaos Chatzifotis

MSc Physics & Technological Applications
School of Applied Mathematical & Physical Sciences
National Technical University of Athens

MSc Thesis:

Magnetic monopoles in curved spacetime

General -*future*- interests:

- **Gravitation and cosmology**
- **Gravitational waves**

Research interests of David Damgaard

Positive Geometries

- Amplituhedron constructions in spinor-helicity variables 1905.04216
- Positive geometries for other theories than $\mathcal{N} = 4$ SYM and in cosmology

Other interests

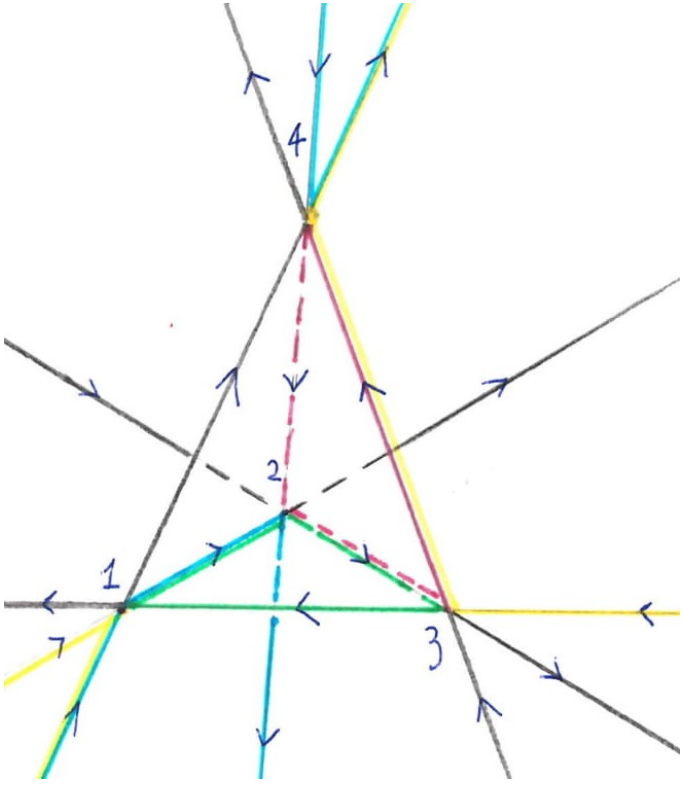
- CHY rules for superstring amplitudes
- Relating gauge theories and gravity amplitudes through the double copy construction
- Efficiently calculating scattering amplitudes in different theories

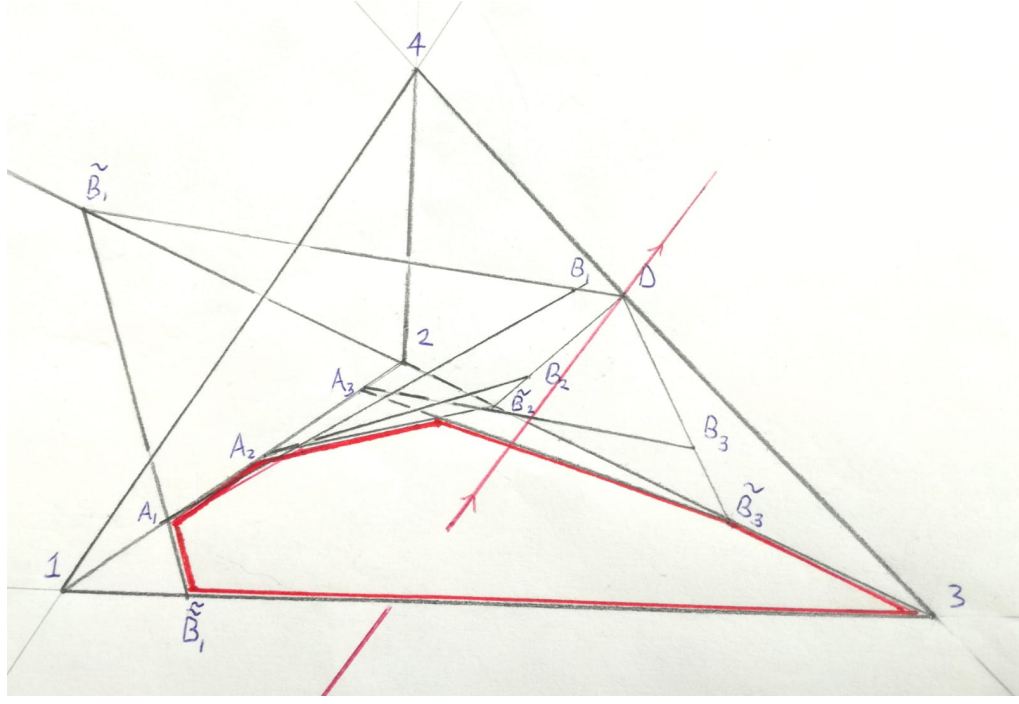
LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Gabriele Dian

Non Maximal Sign-flips
Squared Amplituhedron

$N = 4$ SYM MHV External Cuts





Durham University

SAGEX
Scattering Amplitudes:
from Geometry to Experiment

Alice Di Tucci
Albert Einstein Institute

arXiv:1806.07134
arXiv:1903.06757

Goal

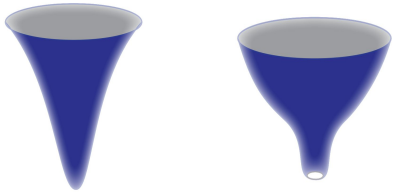
- Quantum effects in the early universe
- What are the initial conditions for the universe?

Tool

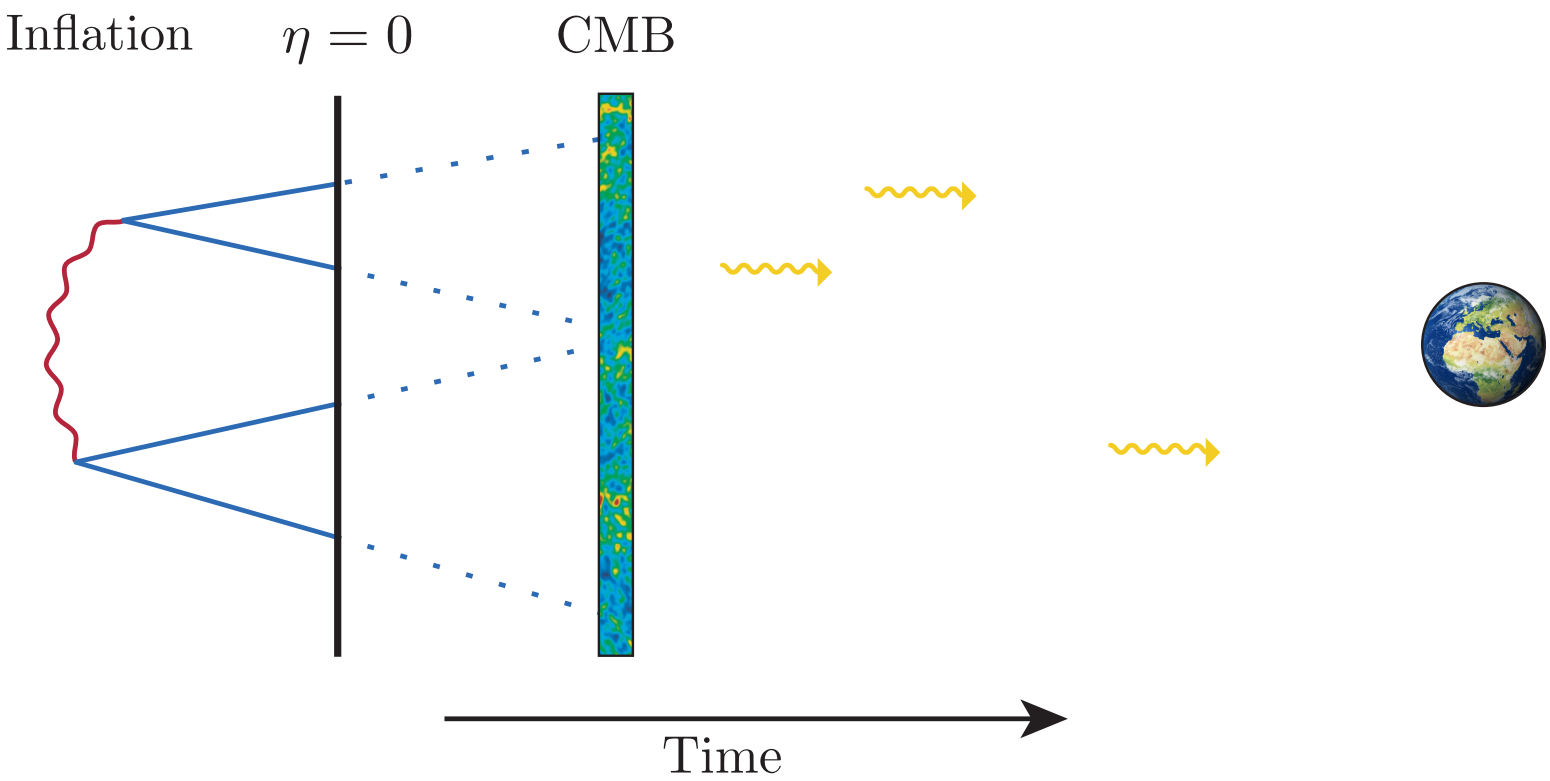
Quantum state of the universe calculated from Feynman's path integral $\Psi = \int_? \delta g_{\mu\nu}\, e^{iS/\hbar}$

Current research

No-boundary proposal as a path integral with Robin boundary conditions



The Cosmological Bootstrap



Deriving inflationary correlators from symmetries and first principles, instead of usual time evolution computations

Physics of the early universe - Inflation

- Quantum field theory in (quasi) de-Sitter.

$\rightarrow$ IR effects.

- Theory of cosmological perturbations.

$\rightarrow$ Loop corrections to primordial power spectra.

$\rightarrow$ Particle content of inflation.

$\rightarrow$ Connection with the observations.

Master thesis project: 1-loop correction to graviton propagator in de Sitter due to MNMC fields.

PhD research proposal: Higher spin fields during Inflation. [along with Y.Wong and E.Dimastrogiovanni]

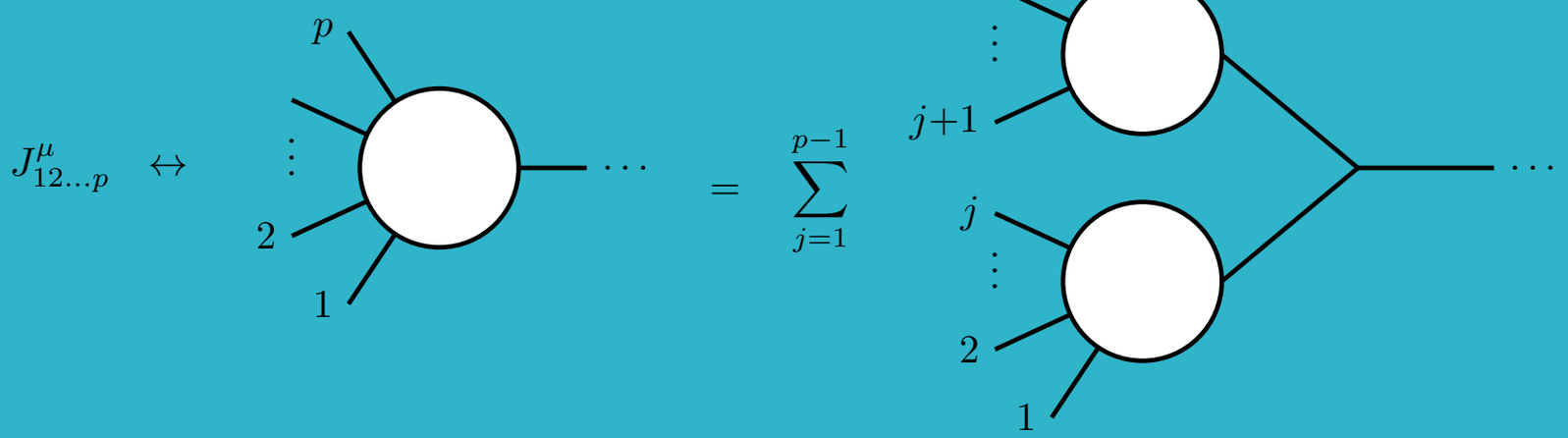
Lucia Garozzo - Uppsala University

Double copy with higher dimensional operators

1809.08103
L.G., L. Queimada, O. Schlotterer

$$(YM + \alpha' F^3 + \alpha'^2 F^4)^2 \sim \underbrace{GR + \alpha' R^2 + \alpha'^2 R^3}_{\text{Accessible via double copy}}$$

Off-shell currents as building blocks:



Gauge transformation

↓

BCJ numerators

Open string effective action from field theory

(work in progress)
L.G., A. Guevara, O. Schlotterer

$$\underbrace{(DF)^2 + YM}_{\text{(1803.05452 - T. Azevedo, M. Chiodaroli, H. Johansson, O. Schlotterer)}} \xrightarrow{\int D\left[\begin{smallmatrix}\text{Massive}\\ \text{fields}\end{smallmatrix}\right]} \underbrace{YM + \alpha' F^3 + \alpha'^2 F^4 + \ldots}_{S^{eff.}_{open\ bosonic}}$$

Tanguy Grall - DAMTP

Non-Linearly Realized Symmetries in Cosmology

- Symmetries are essential for model-independent results in Cosmology.
- Spontaneously broken symmetries escape field theory no-go theorems e.g. Coleman-Mandula
- This work: classification of all possible symmetries of Poincaré invariant scalar field theories

$$S = \int \mathrm{d}^d x \sqrt{-g} P(X, \phi)$$

where $X = -g^{\mu\nu}\partial_\mu\phi\partial_\nu\phi$ c.f. k-inflation, k-essence models

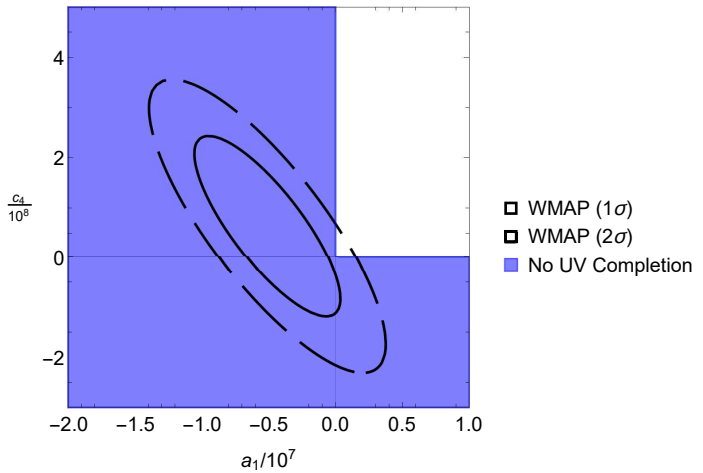
- Only 4 possible classes of theories: DBI, Scaling, Conformal and Cuscuton !

TG, Jazayeri, Pajer - In Prep

Positivity Bounds and the EFT of Multi-Field Inflation

- *The Effective Field Theory for Multi-Field Inflation*: generically couples light scalars to the inflaton.
- *Positivity Bounds:* Necessary conditions for Unitary, Lorentz invariant, Local and Causal UV completion:

$$\text{“}\ \mathcal{L}_{EFT} = \sum_n \frac{c_n}{\Lambda^n}\mathcal{O}^{(n)} \Rightarrow \quad c_n > 0\ \text{“}$$



TG, Melville 1906.XXXXX

Discontinuities of Wave-Function of the Universe

Aaron Hillman

- For a conformally coupled scalar in dS_{d+1}, can study "wave-function of the universe"

$$\Psi[\Phi] = \int \mathcal{D}\phi e^{iS[\phi]} = e^{i\sum_n \frac{1}{n!}\int d^d z_i \psi_n(z\text{'s})\Phi(z_i)}$$

  in Bunch-Davies vacuum by computing the $\psi_n(p\text{'s}, \eta)$ perturbatively.

- Focusing on ϕ^3 in dS_4, we understand facorization properties of integrand, what about discontinuities of the polyogarithmic answers?

- Discontinuities of full answer exhibit factorization, with the discontinuity equal to products of sums of lower point answers. The precise rule can be used to immediately write down the symbol with no spurious terms.

George Katsianis, University of Southampton
Supervisors: Kostas Skenderis, Marika Taylor

Research interests: QFT, anomalies, supersymmetry, holography, localization.

Project: 'Anomalies and supersymmetry'.

- *Motivation:* Holographic computations showed the existence of supersymmetric anomalies in 4d N=1 supersymmetric quantum field theories with anomalous global R-symmetry [I. Papadimitriou 2017, O. S. An 2017]. Reproduce the results using quantum field theory techniques.

- *Results:* A perturbative computation in the free superconformal WZ model shows that the following Ward identity is anomalous. This is a consequence of the anomalous <JJJ> correlator. The result in perturbation theory matches exactly the holographic one. The same result can be also obtained through the WZ consistency conditions.

$$\frac{\partial}{\partial x_1^\mu}\langle Q^\mu(x_1)\bar{Q}^\nu(x_2)J^\kappa(x_3)J^\lambda(x_4)\rangle = \delta(x_1-x_2)\langle\delta\bar{Q}^\nu(x_2)J^\kappa(x_3)J^\lambda(x_4)\rangle$$
$$+\delta(x_1-x_3)\langle\bar{Q}^\nu(x_2)\delta J^\kappa(x_3)J^\lambda(x_4)\rangle+\ldots+A_Q^{\nu\kappa\lambda}$$

- *Implications*: Phenomenology, localization.

- *References*: GK, I. Papadimitriou, K. Skenderis, M. Taylor
  -Anomalous supersymmetry, 1902.06715 (PRL)
  -Computation of supersymmetric anomalies, to appear.

International School on:

Amplitudes and Cosmology, Holography and Positive Geometries

Lecce, ex-Convitto Palmieri

27th May – 1° June 2019

Who am I?

Francesco Loparco

from 1st November 2018, PhD student (XXXIV cycle)

Institution

Università degli Studi di Bari

INFN (BA)

Supervisors

Pietro Colangelo

Fulvia De Fazio

My master thesis

«Hadron configurational entropy in a holographic model of QCD»

Results

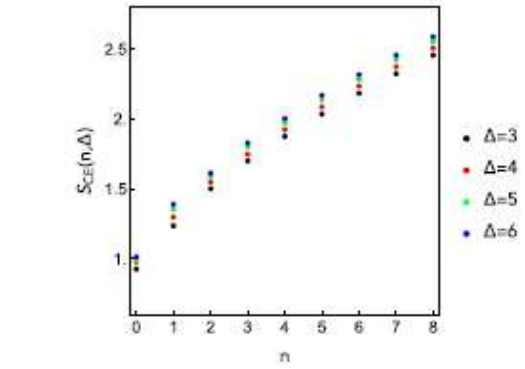


Fig. 1. Configurational Entropy of $J^{PC} = 0^{++}$ mesons described by the QCD operators in Eq. (48) with different Δ. n is the radial quantum number.

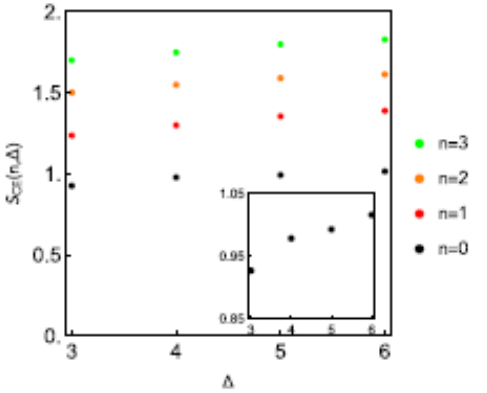


Fig. 2. Configurational Entropy of scalar mesons as in Fig. 1, plotted versus the QCD operator dimension Δ. The results for the radial number $n = 0$ are magnified in the inset.

«Configurational Entropy can disentangle conventional hadrons from exotica»
P. Colangelo and F. Loparco,
Phys.Lett. B788 (2019) 500

PhD project

Standard Model
Physics Beyond the Standard Model

Starting Point: B anomalies

MATTEO MARIA MAGLIO

(UNIVERSITÀ DEL SALENTO, INFN SEZIONE DI LECCE)

MATTEOMARIA.MAGLIO@LE.INFN.IT

ON SOME HYPERGEOMETRIC SOLUTIONS OF THE CONFORMAL WARD IDENTITIES OF SCALAR 4-POINT FUNCTIONS IN MOMENTUM SPACE ARXIV:1903.05047

THE GENERAL 3-GRAVITON VERTEX TTT OF CONFORMAL FIELD THEORIES IN MOMENTUM SPACE IN D=4 10.1016/J.NUCLPHYSB.2018.10.007

EXACT CORRELATORS FROM CONFORMAL WARD IDENTITIES IN MOMENTUM SPACE AND THE PERTURBATIVE TJJ VERTEX 10.1016/J.NUCLPHYSB.2018.11.016

RENORMALIZATION, CONFORMAL WARD IDENTITIES AND THE ORIGIN OF A CONFORMAL ANOMALY POLE 10.1016/J.PHYSLETB.2018.04.003

TTT IN CFT: TRACE IDENTITIES AND THE CONFORMAL ANOMALY EFFECTIVE ACTION 10.1016/J.NUCLPHYSB.2019.03.019

ELETTROWEAK CORRECTIONS TO PHOTON SCATTERING ... 10.1007/JHEP01(2015)091

- CFT IN MOMENTUM SPACE
- CONFORMAL ANOMALY
- ANOMALOUS TRANSPORT DUE TO THE CONFORMAL ANOMALY

- SCATTERING AMPLITUDES
- THEORETICAL COSMOLOGY
- HOLOGRAPHIC DUALITIES

Map between Stokes Polytopes: Kinematic & Worldsheet

Sujoy Mahato, IMSc. Chennai

Polytopes are positive geometries that have a unique form defined on it.

Nima et al.(2017) has shown that the canonical form defined on a special kind of polytope (Associahedron) is directly related to the scattering amplitude of bi-adjoint ϕ^3 theory.

More recently this result has been generalized to planar ϕ^4 theory [Laddha et al. 2018] where Associahedron was replaced by *Stokes Polytope*.

Worldsheet Associahedron —Scattering Equations / acts as Diffeomorphism→ Kinematic Associahedron

[Nima et al. 2017]

Bi-adjoint CHY Formula can be derived as a consequence of this map.

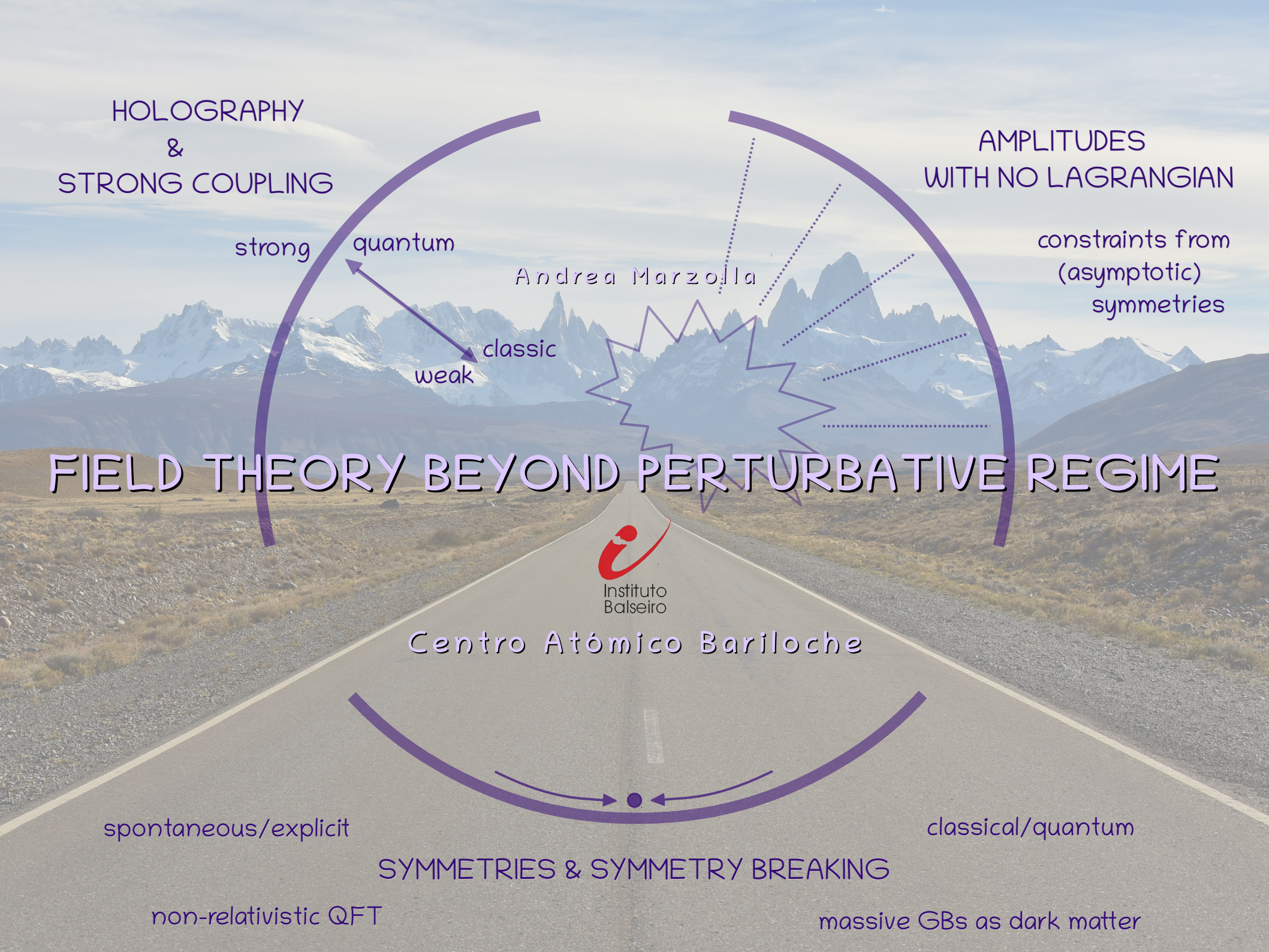
We want to verify if this map is valid for Stokes Polytope

Does the ϕ^4 CHY formula come out of it ?

A Manu

Chennai Mathematical Institute,Chennai, India

- Interests
  - Classical Physics from Scattering Amplitudes
  - Modern Amplitude techniques like Positive Geometry and the CHY Formalism
- Ongoing Work and Results
  - Deriving the Classical Double Copy of Goldberger and Ridgeway from the Colour Kinematics Duality for Soft Factors


HOLOGRAPHY
&
STRONG COUPLING
strong
quantum
classic
weak
AMPLITUDES
WITH NO LAGRANGIAN
constraints from
(asymptotic)
symmetries
Andrea Marzolla
FIELD THEORY BEYOND PERTURBATIVE REGIME
Instituto
Balseiro
Centro Atómico Bariloche
spontaneous/explicit
classical/quantum
SYMMETRIES & SYMMETRY BREAKING
non-relativistic QFT
massive GBs as dark matter

Rashmish K. Mishra

Scuola Normale Superiore, Pisa, Italy

Research interests:

- Holography and its applications to information puzzle.
- BSM model building and collider phenomenology.

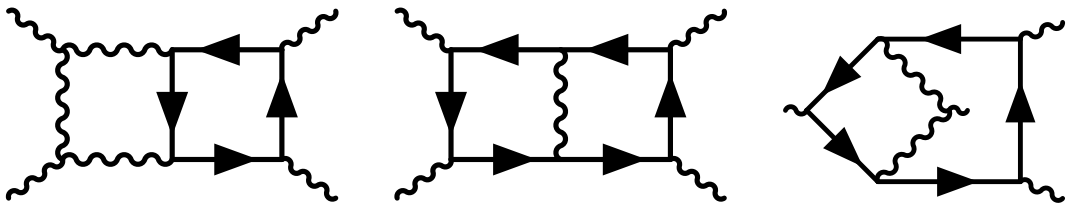
Relevant publication:

- Asymptotic symmetries, holography and topological hair, JHEP 1801 (2018) 014
- Conformal dark sectors: cosmological and collider constraints on the minimal structure, *in progress*

Cosmology is increasingly important from phenomenological point of view, as well as for the theoretical challenges involved in understanding various aspects of inflation, QFT in de-sitter space, dS holography and so on. I am interesting in learning more about these topic, to be able to apply them in my future research.

Gustav Mogull
Uppsala University, Sweden

1. **Two-loop amplitudes in $\mathcal{N}=2$ supersymmetric QCD**
   - Ongoing work with Claude Duhr, Henrik Johansson, Gregor Kälin, Alexander Ochirov, Bram Verbeek.
   - A "halfway house" between $\mathcal{N}=4$ SYM and QCD.



   - Interested in IR structure, BCJ double copy to obtain supergravities, transcendentality structure of integrated amplitudes.
2. **Conformal supergravity amplitudes**
   - Ongoing work with Henrik Johansson & Fei Teng.

$$\mathcal{S} = -\frac{1}{\varkappa^2}\int \mathrm{d}^D x\sqrt{-g}\left[2(R_{\mu\nu})^2 - \frac{2}{3}R^2\right] + \text{SUSY}$$

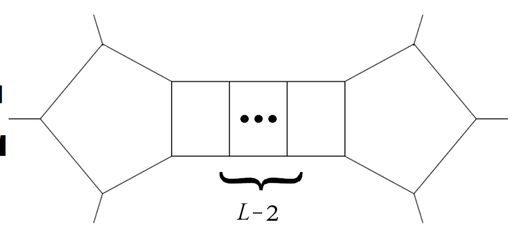
   - Amplitudes arise in Witten's twistor string, for which we provide both Lagrangian and double copy origins.
   - Understanding the full spectrum is challenging, as the theory has four derivatives. We test the limits of tree-level amplitudes technology.

The Double Pentaladder Integral

Henrik Munch @ the Niels Bohr Institute

Double Pentaladder

$$\Omega = \sum_{L}^{\infty}$$



Family of Feynman diagrams which appear in 6-point amplitudes in planar $\mathcal{N} = 4$ SYM.

A chance to study non-perturbative QFT

- The authors of [1] found the *finite-coupling* formula

$$\Omega(x, y, z, g^2) = \int_{-\infty}^{\infty} \frac{d\nu}{2i} z^{i\nu/2} \frac{F_{+\nu}(x)F_{+\nu}(y) - F_{-\nu}(x)F_{-\nu}(y)}{\sinh(\pi\nu)}$$

- $F \sim$ hypergeometric functions, $(x, y, z) \sim$ kinematic variables.
- Find a basis of functions for $\Omega \longrightarrow$ learn about the space of functions for amplitudes in general
- For $g^2 \ll 1$, L loops and particular limits of (x, y, z), the authors of [1] could write Ω in terms functions called *multiple polylogarithms.*
- How does one do this for general (x, y, z)?

My master's thesis: a summation algorithm

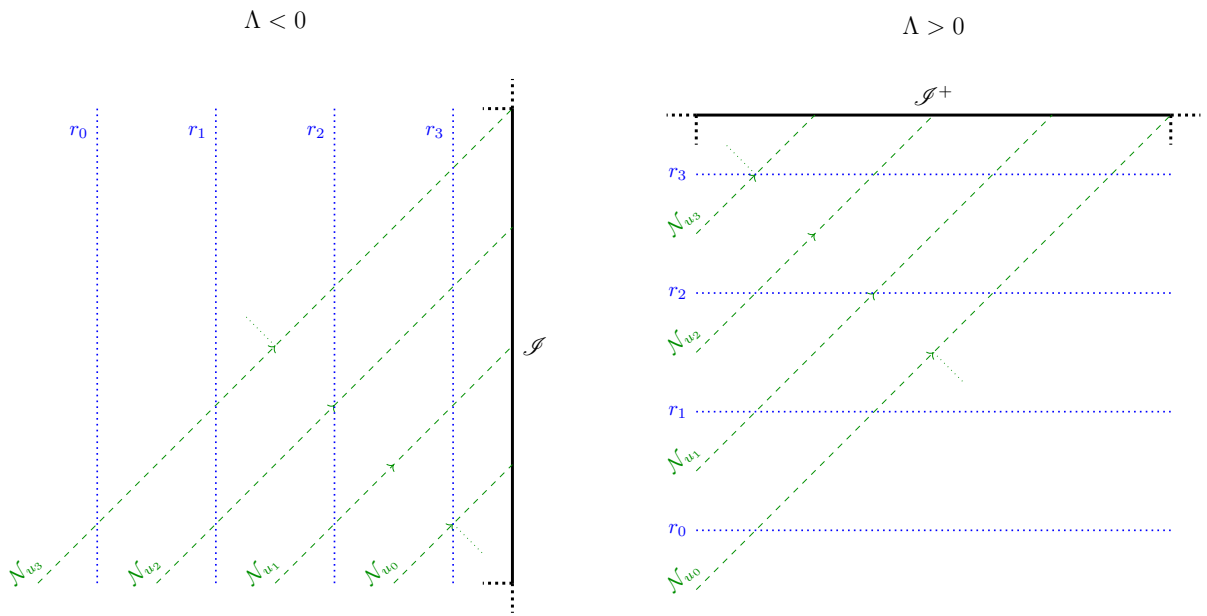
- The authors of [2] present a well-suited algorithm
- 1) Express $\Omega^{(L)}$ in terms of *nested sums*
- 2) *Telescoping*
  - Example: $\sum_n \sum_m f_n(m)$
  - Recursion over m: $f_n(m) - f_n(m-1) = \textbf{easy}_n(m)$.
  - Observe: $f_n(m) = \big[f_n(m) - f_n(m-1)\big] + \big[f_n(m-1) - f_n(m-2)\big] + \ldots + \big[f_n(2) - f_n(1)\big] + f_n(1)$
  - So $\sum_m f_n(m) = \sum_m \sum_{i=1}^{m} \big[\textbf{easy}_n(i)\big] + f_n(1) = \textbf{still easy}_n + f_n(1)$
  - Original sum is now doable: $\sum_n \big[\textbf{still easy}_n + f_n(1)\big]$
- 3) Results from step 2) are easily converted into multiple polylogarithms.
- 4) Celebrate!

References

- [1] Dixon et. al. **The Double Pentaladder Integral to All Orders**. *arXiv:1806.01361*
- [2] Sumino et. al. **Algorithms to Evaluate Multiple Sums for Loop Computations**. *arXiv:1211.5204*

(A)dS$_4$ in Bondi gauge

- Aim to gain an understanding of classical gravitational wave physics using holographic intutition
- Using the dictionary of AdS/CFT, we studied the case of "(A)dS$_4$ in Bondi gauge" 1812.05369 **[AP, Skenderis, Taylor '18]**
- Look at null foliations of asymptotically locally (A)dS spacetimes



- Solve the field equations ($R_{\mu\nu} = \Lambda g_{\mu\nu}$) in Bondi Sachs gauge

Renjan Rajan John
University of Turin, Italy

- I have mostly worked on non-perturbative aspects of $\mathcal{N} = 2$ gauge theories with surface defects in four dimensions.
- Surface defects: generalizations of 't -Hooft operators with support on a two dimensional sub-manifold D of the space-time.
- Monodromy defects: described by singularities in the four dimensional gauge field configuration along D.
- Effective action: determined by $\mathcal{F}$ and $\mathcal{W}$ obtained from $\mathcal{Z}_{\text{inst}}$ computed via. equivariant localization.
- Coupled 2d/4d theories where the 2d theory is supported on D and has a flavour symmetry G which is gauged in four dimensions.
- We matched $\mathcal{W}$ obtained via. localization with the effective twisted superpotential evaluated on solutions of the twisted chiral ring equations of the 2d/4d coupled system.
- We further showed that the different Jeffrey-Kirwan residue prescriptions in the localization description correspond to Seiberg-dual quivers in the 2d/4d picture.

UNIVERSITÀ DI PISA

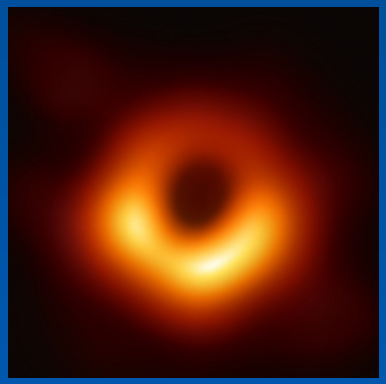
SCUOLA NORMALE SUPERIORE

Francesco Serra

Supervisor : Enrico Trincherini

Research :

- Black holes ;
- Scalar hair ;
- Massive vector hair ;



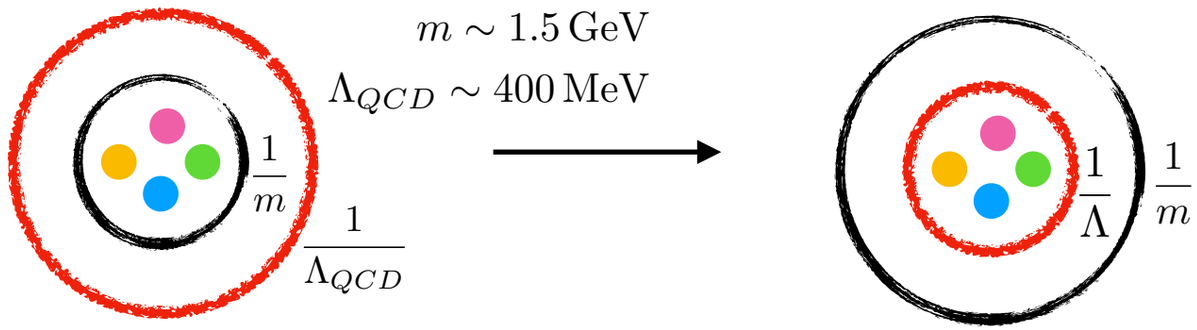
Event Horizon Telescope - 2019

Other interests :

- Gauge-gravity duality ;
- Scattering amplitudes ;

EFT of Massive Higher Spins

B.Bellazzini, F.Riva, J.Serra, F.Sgarlata 1903.08664

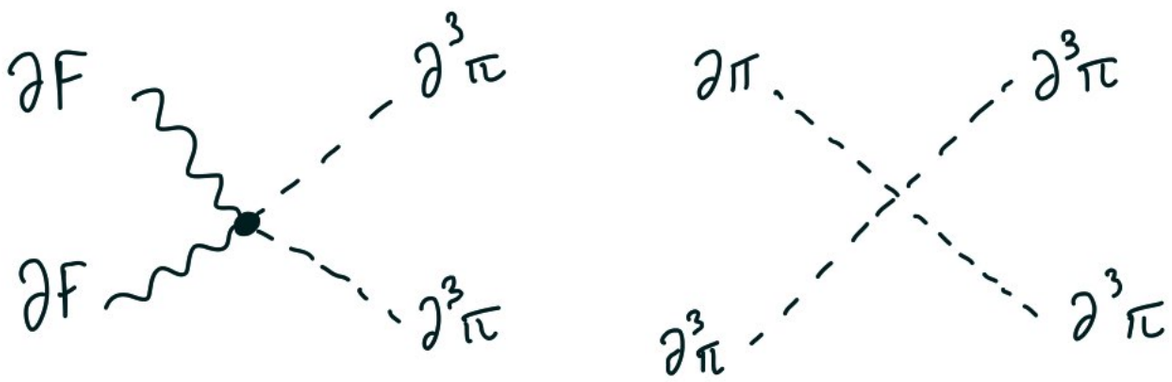


- Unitarity, analyticity of S-matrix and locality constrain the EFT

- We find cut-off and mass parametrically close

$$\Lambda \leq m \left(\frac{16\pi^2}{g}\right)^{\frac{1}{8s-4}}$$

- Spin-3 decoupling limit : massless scalar-vector interactions



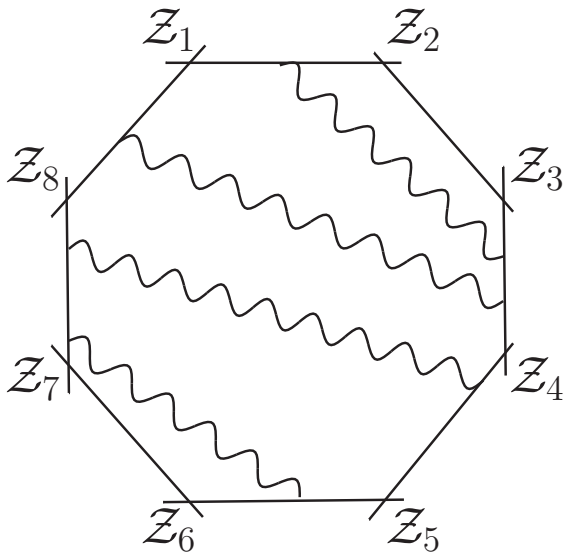
Soft Bootstrap

(Work in progress)

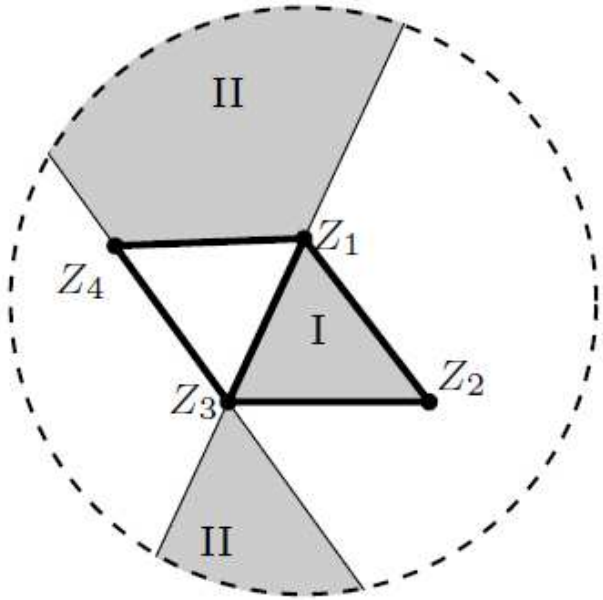
$$\lim_{p\to 0} \mathcal{A}_n = p^\sigma S(0)$$

Alastair Stewart, Durham University

'The Twistor Wilson Loop and the Amplituhedron' [AS, Heslop, P]



8−point N^4MHV contribution.



Toy example of 'bad' geometry.

Other work:

- 1/2-BPS operators for gauge groups $U(N)$ and $SU(N)$.
- Now: trying to calculate f−graph coefficients using information from the 'deepest cut' by Arkani-Hamed *et al.*

Jakub Supeł - Soft Theorems in an Open Universe

In 2003, J. Maldacena proved his cosmological soft theorem

$$B(\vec{q}_L, \vec{q}_S, -\vec{q}_S) \sim (1 - n_s) P(q_L) P(q_s) \qquad \text{as} \qquad q_L \to 0$$

How do we derive such theorems? Answer: consider a residual diff that remains even after we gauge fix the metric. This diff affects all perturbations and generates a new (adiabatic) mode Phi. The key is that physics must be invariant under the diff.

Open universe (K < 0) We wanted to see if corrections due to nonvanishing K can ever be relevant.

$$\langle \zeta_L \zeta_S \zeta_S \rangle$$

There is no diff that generates a physical scalar perturbation! In some models, O(K) correction can be enhanced.

$$\langle \gamma_L \zeta_S \zeta_S \rangle$$

We derived a tensor soft theorem. O(K) correction is always small.

with G. Avis, S. Jazayeri & E. Pajer (to be published)

Ph. D. Student in Physics and Nanosciences, Department of Mathematics and Physics "Ennio De Giorgi", University of Salento, Lecce, May 27, 2019

Current research

- extension of axion model through description of axion-like particle
- embedding of axion-like particle in large SO(10) group structure, beyond SM
- study of anomalous action and detection of ghosts in the spectrum

Other research interests

- study of axion BEC
- research of Dark Matter candidates, such as fuzzy Dark Matter

Fei Teng *Postdoc @ Uppsala University*

- The origin of color-kinematics duality
  - IBP reduction: from string integrand to CHY integrand *[1812.03369]*
  - Logarithmic functions and their dual kinematic factors *[1703.01269, 1703.05717, 1708.03058]*
- Application to higher-derivative theories
  - DF2 theory and conformal gravity *[1806.05124]*
- Massive and higher-spin states *[work in progress]*

International School on Amplitudes and Cosmology, Holography and Positive Geometries: Gong Show

- **Dimosthenis Theofilopoulos**, PhD candidate
  University of Salento, dimostheof@gmail.com

Current Research

Analysis of tensorial 4-point functions in momentum space, Ghost condensation

Research interests

CFT, OPE in momentum space, Holography, dilaton and axion condensation, Scattering Amplitudes, Breaking of conformal symmetry and implications in SM

(Holographic) Scattering Amplitude

Non-perturbative Gravitational S-matrix

- *S-matrix asymptotes to 1 (Regge limit)*
- *No higher spin states required.*

arxiv: ***1902.08409***

Higher Spin Theories

$s = 1,2,\ldots,\infty$

S=1 (flat space)

UV finite

Coupling Conspiracy

Tung Tran

AdS extension
in momentum space

$A_\infty \setminus L_\infty$

Weak gravity conjecture with radiative corrections

Gong Show

W. Wayne Zhao

Leece, Puglia, Italy
2019.05.27

Weak gravity conjecture

- Weak gravity conjecture: $\exists q \gtrsim m$
- Positivity of coefficients of higher dimension operators in EFTs
- $\exists$ versions of WGC are stable under KK compactification
- Massive amplitudes in 4D:

$$p_{\alpha\dot{\alpha}} = \epsilon_{IJ}\lambda_{\alpha}{}^{I}\tilde{\lambda}_{\dot{\alpha}}{}^{J}$$

- x-factor:

$$p^{(2)}_{\alpha\dot{\alpha}}\left(\lambda_{(1)}\right)^{\alpha\, I} = mx\left(\lambda_{(1)}\right)_{\dot{\alpha}}{}^{I}$$

  x appears in three point amplitudes with equal mass m particles, BHs.
- 5D amplitudes $p_{AB} = \epsilon_{ab}\lambda_{A}{}^{a}\tilde{\lambda}_{B}{}^{b}$ with $\Omega^{AB}p_{AB} = 0$.
- WIP: 5D x-factor to find on-shell 3-point amplitude, as a formal tool for generating 5D amplitudes and for loop corrections to test weak gravity