GRAMPA 2025 at Institut Henri Poincaré

Tuesday 1 July 2025 - Friday 4 July 2025

Institut Henri Poincaré

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Seminar: Soft theorems for scattering on plane wave backgrounds

We have seen in the last few years that our understanding of scattering amplitudes in flat space can be leveraged for high-precision calculations in classical GR. In this talk I will motivate why you should also care about the structures of amplitudes on non-trivial backgrounds - not just flat space! One structure that is fundamental in our study of flat space amplitudes is soft factorisation. Here, I present how the leading soft theorems of amplitudes are modified when we consider scattering on plane wave backgrounds, and why this is crucial when calculating observables on these backgrounds.

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Seminar: Time-dependent solutions of Biadjoint Scalar Field Theories

Biadjoint scalar field theories appear in the study of scattering amplitudes and classical solutions in gauge, gravity and related theories. In this talk, we present new exact solutions of biadjoint scalar field theory, showing that time-dependent solutions are possible and analytically tractable. We generalise the theory to include mass and / or quartic terms, and also a coupling to a constant current. This allows for more exact solutions, which make contact with previous soliton literature.

We also find bounded solutions, in contrast to all known previous examples. Our results may be useful for the study of non-perturbative aspects of the double copy b

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Seminar: Scattering Waveforms with QFT and WQFT

What can scattering amplitudes teach us about the gravitational waves we hope to hear? This talk outlines why accurate waveform models are vital for upcoming gravitational wave detectors and how the post-Minkowskian (PM) expansion supports that goal.
I present the computation of the waveform observable through order $G^3 S^2$ within the PM framework, comparing two strategies: a traditional QFT treatment and a worldline QFT formalism. Special emphasis is put on the worldline QFT construction that lets us lift seven-point tree amplitudes to the one-loop integrand, and on the cross-checks against standard scattering-amplitude. I conclude with a discussion on the IR- and UV-divergent terms, tracing their origins and showing how they cancel to leave a finite, physical waveform.

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Soft theorems and radiative observables from amplitudes

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Soft theorems and radiative observables from amplitudes

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Seminar: Supertranslations from Scattering Amplitudes

On-shell methods have found a new application to local observables such as asymptotic radiation fields and gravitational waveforms. While these observables are invariant under small gauge transformations, they are known to depend on a choice of asymptotic gauge; in gravity on asymptotically Minkowski spacetimes, this is a choice of BMS frame. In this talk, I will describe a method for capturing these supertranslations, to all orders in perturbation theory, using the on-shell framework of scattering amplitudes.

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Seminar: Analytic Gravitational Waveforms: A Combined Fourier–Loop Amplitude Framework

Accurate modelling of gravitational-wave signals is essential for extracting masses, spins, and strong-field dynamics from detector data. Within the observable-based formalism, scattering waveforms are expressed as the Fourier transform of a five-point scattering amplitude in impact-parameter space. In this talk, I will introduce a novel approach to compute analytic waveforms, where we combine the Fourier integrals with loop integration. This allows us to apply scattering-amplitude techniques such as generalised unitarity and integration-by-parts identities in frequency domain. The method yields the first fully analytic, velocity-exact two-body waveform at second post-Minkowskian (one-loop) order and paves the way for systematic spin and higher-order extensions.

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Lecture

Soft theorems and radiative observables from amplitudes

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Seminar: On-shell approaches for spinning binaries beyond GR

The detection of gravitational waves by the LIGO-VIRGO collaboration has marked a transformative era in astronomy, providing groundbreaking insights into the cosmos and creating new pathways for exploration. At the same time, advancements in the classical limit of quantum scattering amplitudes, particularly through the KMOC formalism, have enriched our understanding of compact binary systems.

In this talk, we will discuss the application of these techniques to scalar-tensor theories of gravity, where long range interactions are mediated by a massless scalar in addition to the graviton. Such theories include the Einstein-scalar-Gauss-Bonnet and Dynamical Chern-Simons theories and are of both theoretical and phenomenological interest.
We will start by providing an overview of how amplitude techniques are used to derive predictions for gravitational waves from binary systems of black holes and neutron stars. We will then proceed to give a purely "on-shell" description of arbitrarily spinning bodies with and without scalar hair, an effect which is often present in these theories and can lead to important modifications in the gravitational wave signal. We will discuss how all the required amplitudes can be calculated in a straightforward manner by using the on-shell and spinor-helicity techniques, which can be in turn used to directly compute waveforms for spinning binary systems. Finally, we will briefly discuss potential UV completions of these models, treating them as Effective Field Theories and leveraging modern amplitude methods for further insight.

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Seminar: Perturbative Computations from Curved Spacetimes

Given the impressive results for classical observables obtained by field theoretic approaches to gravitational systems, we can ask if these tools can help us in other regimes and problems of interest. Amplitude tools are particularly well suited to derive observables for the binary system in a post-Minkowskian expansion, where they have achieved complete results to fourth order in Newton's constant. From the perspective of perturbative quantum field theory, classical solutions in general relativity are remarkable objects; they make manifest a resummation of an infinite series of Feynman diagrams encoding information to all orders in Newton's constant. I will describe an effective field theory formalism tailored for computations about nontrivial classical backgrounds, and present the potential, and hurdles, in combining advantages from classical gravitational and field theoretic techniques to address questions related to the binary inspiral problem.

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Poster session