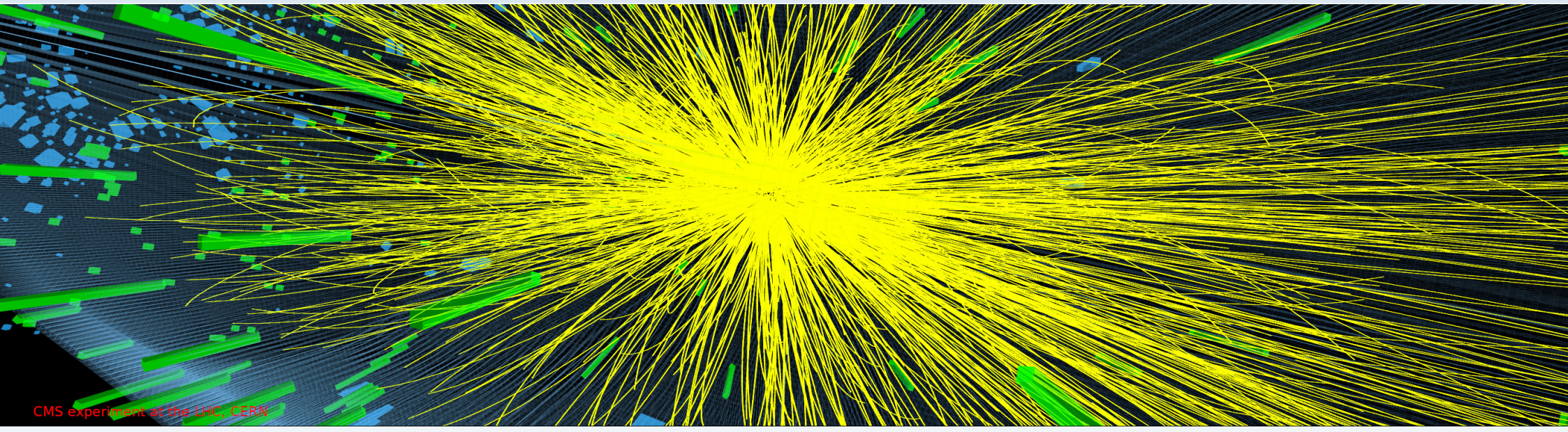
Institut de Physique Théorique

Theoretical physics courses



The analytic S-matrix

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November 19th 2021 at 10:00, 24th at 15:15, 26th at 10:00. December 3rd at 10:00, 8th at 15:15.

The course will be broadcast and, if allowed, will also take place in person at the IPhT. Interactive videoconference: compulsory registration on the website `courses.ipht.fr`, to receive videoconference link. Open, non-interactive livestream at `youtube.com/ipht-tv`. Please, stay updated (change of schedule, sanitary constraints...) by checking the course website.

The bootstrap approach asserts that certain physical theories can be strongly constrained, and sometimes even be solved, using general principles only. We review old and new results obtained from applying this approach to the scattering of relativistic particles in flat space.

The S-matrix describes transitions between states of freely moving particles in the far past and the distant future. Conventionally such transitions, or scattering amplitudes, are computed in perturbation theory. The S-matrix bootstrap is a program of constructing scattering amplitudes nonperturbatively, based on the general principles of special relativity and quantum mechanics.

The aim of the course is two-fold. First, we review the basic concepts of S-matrix theory (analyticity, unitarity, crossing) and their connection to the basic principles of relativistic QFT, such as causality, locality and unitarity. This will lead us to the formulation of the S-matrix bootstrap problem, and to the derivation of various results of S-matrix theory that concern nonperturbative properties of scattering amplitudes. Second, we go over various approaches to constructing scattering amplitudes that satisfy the desired properties, and more humbly obtain rigorous nonperturbative bounds on such amplitudes. These include both ideas from half a century ago (when many of the results were first derived), as well as some of the recent work on the S-matrix bootstrap program.

Plan of the course:

1. Introduction to S-matrix theory.
2. Kinematics (Mandelstam plane, unitarity, crossing, partial waves).
3. Analyticity (field theory analyticity, unitarity extension of analyticity, Landau equations, maximal analyticity).
4. Universal Bounds (Froissart-Gribov formula, Mandelstam kernel, Martin-Froissart bound, Gribov's theorem, Dragt bootstrap).
5. Bootstrap Methods (primal/dual problems, fixed point method, coupling maximization).

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