

Cours de l'Institut de Physique Théorique



Graphical insights, with applications from QCD to cosmology

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The Fridays: 24 February and 3, 10, 17, 24, 31 March 2017, from 10:00 to 12:15

Graphs, at their most abstract, provide a language for describing relationships, one which has long been beneficial for the program of physical prediction. Combined with the Wilsonian understanding of effective field theory, perturbative analysis finds a role in predictions relevant to all scales, from processes describing the scattering of primordial gravitons, to QCD interactions at CERN's Large Hadron Collider, to establishing the astrophysical in-spiral and consequent post-merger ringing out of black holes, to the evolution of the largest scales cosmologically conceivable. Modern advances in scattering amplitude calculation have re-emphasized the role of graphical organization towards efficient prediction, generalizing away from brute Feynman calculation, but yielding structural insights suggestive of a new type of unification touching predictions relevant to all of these scales.

In these lectures I will talk about graphical organization of perturbative prediction, emphasizing scattering amplitudes, but with an eye towards generalization.

- GENERALIZED UNITARITY METHODS. How verification can be inverted towards construction. 1 lecture.
- COLOR-KINEMATICS ("BCJ") DUALITY AND ASSOCIATED DOUBLE-COPY. Exploring both computational advantages as well as unifying structure exposed. Relevant theories include: Chiral Pions, Yang-Mills, QCD, Born-Infeld, Volkov-Akulov, Galileons, Einstein-Hilbert Gravity, Open and Closed string theories. 2 lectures.
- QCD. Generalizations particularly relevant to QCD calculations (massive, non-adjoint representations). 1 lecture.
- GRAVITY/COSMOLOGY. Application of some of these ideas to astrophysical and cosmological classical solutions in gravity. 2 lectures.



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