Strong-field and non-perturbative Amplitudes

Anton Ilderton

The presence of strong fields can generate nonlinear and nonperturbative physical effects in a system. Strong fields arise in many contexts -- in astrophysics, in terrestrial collider and intense laser collisions, and of course in gravity as e.g., nontrivial curvature effects. A defining feature of a strong field is that it cannot be accurately treated in perturbation theory -- other methods are required to correctly capture effects which are all-orders in the coupling, or explicitly nonperturbative.

In these lectures I will give an introduction to various strong field effects, and the methods used to treat them. The presentation will be based on observables and scattering amplitudes on curved backgrounds, drawing examples from both gravity and gauge theory. Methods to be discussed include the Furry expansion (background field perturbation theory), applications of coherent states, worldline QFT, and the perturbiner approach, which provides a definition of scattering amplitudes even when an S-matrix does not exist, such as on black hole spacetimes.