Classical Gravitational Scattering from the Eikonal Exponentiation

Carlo Heissenberg

The increasing precision of gravitational-wave detectors calls for equally precise predictions for the trajectories of compact objects subject to gravitational interactions and for their emitted waveforms. Scattering amplitudes provide a useful strategy to tackle this problem analytically in the Post-Minkowskian regime, where gravitational interactions are weak but velocities are not necessarily much smaller than the speed of light. In this context, the eikonal exponentiation serves as a tool to extract observables from the classical limit of gravity amplitudes. In this lecture I will illustrate the eikonal resummation of the two-to-two amplitude describing the interaction of two massive spinless objects and explain how it can be applied to obtain the deflection angle for their collision, highlighting how dissipative radiation-reaction effects emerge in this formalism. Their inclusion is crucial to ensure a smooth behavior of the deflection angle at high energies, where it agrees with the universal massless result up to $\mathcal{O}(G^3)$. I will then discuss how an operator dressing capturing the emission of soft gravitons allows one to calculate the spectra of linear and angular momentum emissions in the zero-frequency limit.