Lecture 13 Oct. 17, 2013

Cross Sections and the S matrix

We have derived an elegant formulation for calculating the n-point corrolation function. Today we will discuss how to relate that to observable quantities. This means, principally, cross sections for various processes. We will carefully define how cross sections are abstracted from actual measurable quantities, and then how they are related to the S-matrix and the *invariant matrix element* $\mathcal{M}$.

In discussing scattering cross sections in classical mechanics, we relate the output trajectory to the inpact parameter by the equations of motion, and then consider that the incident beam is not aimed precisely at the target but has a spread of impact parameters, which is what produces the spread of output trajectories.

Quantum mechanically, we may view the incident particle(s) as wave packets centered around definite momenta, which means each scattering involves a coherent sum over initial coordinates perpendicular to the beam. But there is still a spread of transverse positions of the centers of the particle wavepackets in the beam, which means there is an incoherent sum over impact parameters in Eq. 4.75. The interplay is carefully considered in P&S pp 105-6.

Read Peskin and Schroeder, pages 99-108.

Next time we will relate the invariant matrix element to the n-point corrolation functions and express them, in a perturbation expansion, as a sum of Feynman diagrams.