1/8/08 Lecture outline

Recall from last quarter that physical observables (scattering probabilities, cross-sections, lifetimes, etc) can be computed from S-matrix amplitudes: observable)$\sim$ $|\langle f|S|i\rangle|^2\cdot$(phase space factors). And the S-matrix amplitudes can be computed via Dyson's formula for the propagator, and Wick's theorem:

$$U(t_2, t_1) = T\exp(-i\int_{t_1}^{t_2} H_{int}(t')dt'),$$

$$T(\phi_1 \dots \phi_n) =: \phi_1 \dots \phi_n : + : \text{all contractions} :$$

This is nicely expressed in terms of Feynman diagams.

• Our first topic is the Feynman path integral. Gives another way to quantize particles, and fields. For particles, consider time evolution operator

$$U(x_a, x_b; T) = \langle x_b|e^{-iHT/\hbar}|x_a\rangle.$$

Satisfies SE

$$i\hbar\partial_T U = HU.$$

Feynman:

$$U(x_a, x_b; T) = \int [dx(t)]e^{iS[x(t)]/\hbar}.$$

• Motivation. • Computation. Integral can be broken into time slices, as way to define it. E.g. free particle

$$\left(\frac{-im}{2\pi\hbar\epsilon}\right)^{N/2} \int \prod_{i=1}^{N-1} dx_i \exp[\frac{im}{2\hbar\epsilon}\sum_{i=1}^{N}(x_i - x_{i-1})^2]$$

Where we take $\epsilon \to 0$ and $N \to \infty$, with $N\epsilon = T$ held fixed.