Abstract

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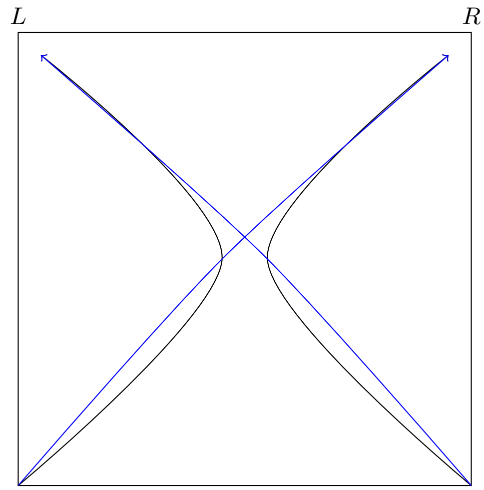
1 Indistinguishabe Particles



In this diagram, we cannot tell the difference between the black and blue particles, which means $|L, R\rangle$, $|R, L\rangle$ can't be the right states. It must be some superposition of these two states that gives us indistinguishability. Makes a lot of sense that it shouldl be eigensttates ofthe permutation operator. For the two particle system, these eigenstates are given by

$$|\psi_{\pm}\rangle = \frac{1}{\sqrt{2}}(|LR\rangle \pm |RL\rangle)$$

1.1 Bosons + Fermions

- Bosons: Wavefunction must be symmetric under permutation. (Photons, Higgs Boson, Composite particles (^{4}He, Mesons)
- Fermions: Wavefunction is antisymmetric under permutation (Most fundamental particles, electrons protons neutrons, neutrinos, quarks)

Consider the case with two fermions. The only legal state of these is then

$$\frac{1}{\sqrt{2}}(|\alpha_1, \alpha_2\rangle - |\alpha_2, \alpha_1\rangle)$$

if we let $\alpha_1 = \alpha_2$ exactly, we immediately get the probability of finding two fermions in the same state as 0, which is just the **pauli exclusion principle**.