Hi

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Formulation

We are now considering states that are labeled by where they are located.

For example, state $|3\rangle$ means that the particle is located at $x = 3$. In other words, we are considering wave functions that are on a real line.

Now, let us first consider the scenario that there is only one particle locating at $x = 1$. It is totally fine to change the name of the location to, for example, $x = 0$. In this sense, we may say that the two representations of this particle $|1\rangle$ and $|0\rangle$ are **equivalent**! Technically, we are in a space that is translationally-invariant. So relabelling does not change the physics.

Let us now consider two particles. Particle A is in the state of $|0\rangle$ and particle B is in the superposition $\frac{1}{\sqrt{2}}\{|-1\rangle + |1\rangle\}$. In other words, we are now considering a composite system $|0\rangle_A \otimes (|-1\rangle + |1\rangle)_B$ if we omit the normalizing factor.