Pendulum Represents Binary Quantum State of Oscillations

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Abstract: There is a straightforward correspondence between superposition of polarization modes of photons and that of classical radio waves. While classical particles cannot be superpositioned, classical waves can be, which is within classical intuition. Even more intuitively, two dimensional oscillations of a pendulum represent oscillating binary quantum states such as polarization states of photons.

1. Introduction

While classical particles cannot be superpositioned, classical waves can be, as is exemplified by superposition of polarization modes of classical radio waves as solutions of Maxwell's equations, which directly corresponds to "quantum" superposition of polarization modes of photons. Thus, "quantum" superposition is not really quantum. As "superposition" apparently means multiplications of some coefficients followed by additions, vectors, in general, can be superpositioned. For example, velocity toward northeast is superposition of velocity toward north and east and, in a sense, simultaneously represents velocity toward north and east.

Note that, while single dimensional vectors of scalars may also be superpositioned, they are not very interesting, because of degeneration between multiplications of coefficients and additions.

2. Intuitive Representation of Binary Quantum State of Oscillations

Binary quantum state of oscillations, such as superposition of polarization modes of photons, have classical representation as polarization state of classical radio waves. Because the state is binary, it is in a two dimensional vector space. However, except for experts on radio or optical communications, polarization state is very poorly intuitive, which should be the reason why quantum physicists misunderstood it something specific to quantum states without corresponding classical states.

If, instead of radio waves, visible light is used, people can see polarization state by their eye. However, their observations are very remote that they can merely see changes in brightness of light through various polarizers. They can't see something oscillating or, in case of circular polarization, circulating.

On the other hand, vectors representing position or velocity is mechanical and, thus, much more intuitive than polarization states. However, as vector space of position or velocity is over $\mathbb{R}$, it is not appropriate to represent binary quantum states of oscillations, which needs vector space over $\mathbb{C}$. To have such a vector space, we need something with phase, that is, something oscillating.

The simplest mechanically oscillating apparatus should be a pendulum. Fortunately, in the three dimensional real world, a pendulum has two orthogonal directions of oscillations, north/south and east/west, which means vector space of its oscillating state is two dimensional over $\mathbb{C}$, which is just enough to represent binary quantum state of oscillations.

Actually, linear oscillations represents linearly polarized quantum states. Oscillations of a pendulum in northeast/southwest direction is superposition of oscillations of the pendulum in north/south and east/west directions. So are left and right circular oscillations, though north/south and east/west oscillations are superpositioned at different relative phase from northeast/southwest oscillations.

With a pendulum, we can actually see the pendulum oscillating and, in case of circular oscillations, which represents circular polarization, circulating. Elliptic movement of the pendulum, which represents elliptic polarization, can also be seen.

3. Conclusion

As "quantum" superposition is not really quantum, and vectors, in general, can be superpositioned, binary quantum state of oscillations can be represented by classical superposition of two orthogonal polarization modes of classical radio waves or mechanical oscillation directions of a pendulum.