Q bits & Weird Quantum Effects

Divac 3 photon polarizer exp. 1

Current computers manipulate bits.

A bit is either 0 or 1. Eight bits in a byte.

Q: How many bits in a kilobyte?

A: 1024 bytes in a kilobyte

→ 8192 bits.

Quantum systems are described by wave functions - superpositions of states. Qbits are the quantum version of bits.

Example: Photon polarization

\( E(x,t) = E_0 \cos(kx - wt) \quad \text{'vertical'} \rightarrow 1 \)

\( E(x,t) = E_0 \cos(kx - wt) \quad \text{'horizontal'} \rightarrow 0 \)

One bit/ photon?

Weird. Blocking half the photons lets more through.
Classical polarizer analysis

After A: \( E = E_0 \frac{z}{\sqrt{2}} \cos(kx-wt) \)

After C: \( \frac{z}{\sqrt{2}} = \frac{z + \frac{\sqrt{2}}{2}}{\sqrt{2}} \)

\( E = E_0 \frac{(z + \frac{\sqrt{2}}{2})}{\sqrt{2}} \cos(... \) 

After B: \( E = E_0 \frac{(z)}{\sqrt{2}} \cos(... \) 

Photons act like waves.

Quantum polarizer analysis

<table>
<thead>
<tr>
<th>1/\sqrt{2}</th>
<th>1/\sqrt{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 | 0 (0)</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

After A: \( |4> = |1> \)

After E: \( \frac{4}{E} \) \( \frac{1}{2} \)

After B: \( |4> = |\frac{1}{2} \) 

Dirac: "The state of oblique polarization may be regarded as being partly in the state of vertical polarization and partly in the in some kind of superposition process applied to the two states [vertical and horizontal]."
Q-bits
Dirac & polarizer

Not so surprising?
Heisenberg: The observation process disturbs the quantum state.

Is this why photons get through? Maybe the filter C ‘twists’ the photons?

Replace polarizer C with birefringent material (Calcite)

Calcite doesn’t ‘twist’ the photons. It separates them by polarization without ‘measuring’ them. No transfer of energy, momentum, etc.

But if we block one of the separated beams, N/4 photons get through - just as for the diagonal polaroid.