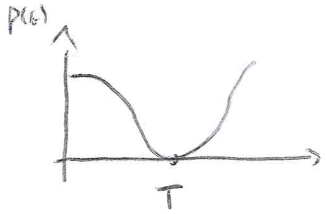
Itano et al, summary and comments...

$$H = \underbrace{M_0|S\rangle\langle S| + \omega|W\rangle\langle W|}_{H_0} + \underbrace{g\left(|S\rangle\langle W| + |W\rangle\langle S|\right)}_{H_1}$$

$t=0$, $|S\rangle$

$$P(t) = |a(t)|^2 = |\langle S|e^{-iHt}|S\rangle|^2 \overset{(a=\pi/4)}{=} \cos^2\left(\frac{\Delta E}{2}t\right)$$



$T = \frac{\pi}{\Delta E} \rightarrow P(T) = 0$ (we have not $|S\rangle$ but $|W\rangle$ with prob. 100%).

So, if we make one measurement at $T \rightarrow P(T) = 0$ ... the state has jumped to $|W\rangle$

Instead, we do N measurements at time intervals Y $\quad T = NY \rightarrow \left(Y = \frac{T}{N} = \frac{\pi}{\Delta E N}\right)$

The probability to find $|S\rangle$ at each of the $|N\rangle$ measurement is $P(Y)^N$

$$P(Y)^N = \left[\cos^2\left(\frac{\Delta E Y}{2}\right)\right]^N = \left[\cos^2\left(\frac{\Delta E}{2}\cdot\frac{\pi}{\Delta E N}\right)\right]^N = \cos^{2N}\left(\frac{\pi}{2N}\right)$$

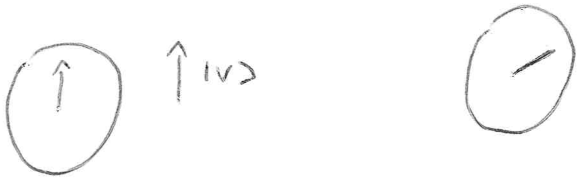
$N \mapsto \infty$ the prob. is "1".

Now, the probability to find $|S\rangle$ only at the very last N-th step is different:

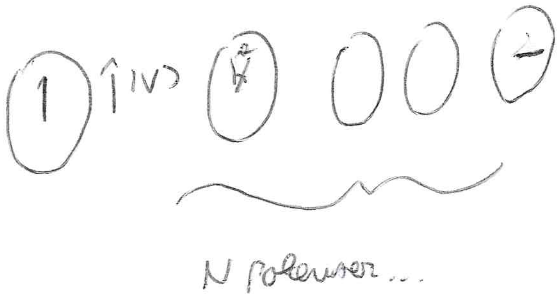
$$\frac{1}{2}\left[1 + \cos^N\left(\frac{\pi}{N}\right)\right]$$

Still, it is "1" for $N \mapsto \infty$. Actually, for "$N \mapsto \infty$" the two expression coincide. But for "small N" they don't.

Experiments of Zeilinger et al including photons...



$T = 0$



$$\boxed{N \cdot \alpha = \frac{\pi}{2}}$$

$$T = \left[\cos^2 \alpha\right]^N = \left[\cos^2\left(\frac{\pi}{2N}\right)\right]^N \longmapsto 1 \text{ for } N = \infty$$

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$$T = \left[\cos^2\left(\frac{\pi}{4}\right)\right]^2 = \left[\frac{1}{2}\right]^2 = \frac{1}{4}$$

This is true for laser with many photons, but also - as probability - for a single photon!

Similarly (and maybe an even better analogy):

Filter which generates a circular polarised photon with probability $\cos^2\theta$ ...

$T = \cos^2\theta$ with prob. $\cos^2\theta$ we have 1 circular polarised γ ...

L = distance

$T = 0$

$\theta \cdot N = \frac{\pi}{2}$

→ more filters ...

$$T = (\cos^2\theta)^N = \left(\cos^2\frac{\pi}{2N}\right)^N \mapsto 1 \text{ for } N \to \infty \ \ldots \ T = 1!!$$

We always pull the γ back to the initial state.