Teleportation Is Correlation Obtained by Selection

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Can we obtain 100% correlations of properties that a measured system has not originally possessed?

Yes! In 1993 we discovered that we can get such correlations with quantum systems.

For example, when two unpolarized photons—1_0 and 2_0 shown in the figure on the right—interact at the beam splitter BS then the probability of both detectors, $D1$ and $D2$, detecting them is

$$\frac{1}{2}\sin^2(\theta_1-\theta_2) \qquad (1)$$

where θ_1 and θ_2 are angles by which the polarizers $P1$ and $P2$ are rotated.

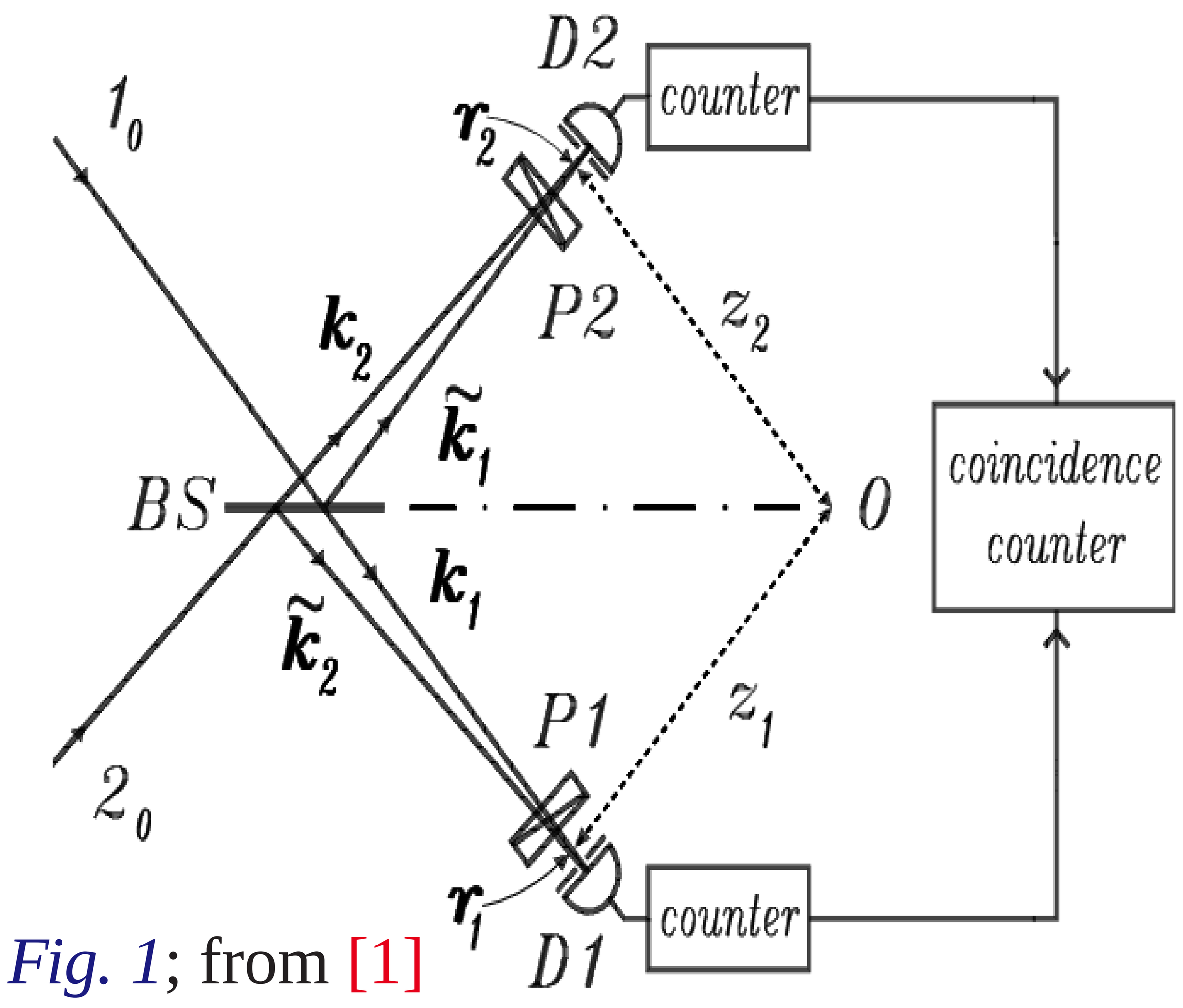

Fig. 1; from [1]

This means that for perpendicularly oriented polarizers whenever one of the detectors detect one photon the other detector must also fire: selected photons show perfect correlation, i.e., they are entangled. When both photons are detected by $D1$ or both by $D2$, then they do not show such correlation, but $[1+\cos^2(\theta_1-\theta_2)]/2$.

[1] Pavičić, M., Spin Correlated Interferometry for Polarized and Unpolarized Photons on a Beam Splitter, *Physical Review*, **A 50,** 3486–3491 (1994).

The photons above interact at a beam splitter! Can we obtain 100% correlations of previously unpossessed properties of systems that nowhere previously interacted and that stem from completely independent sources?

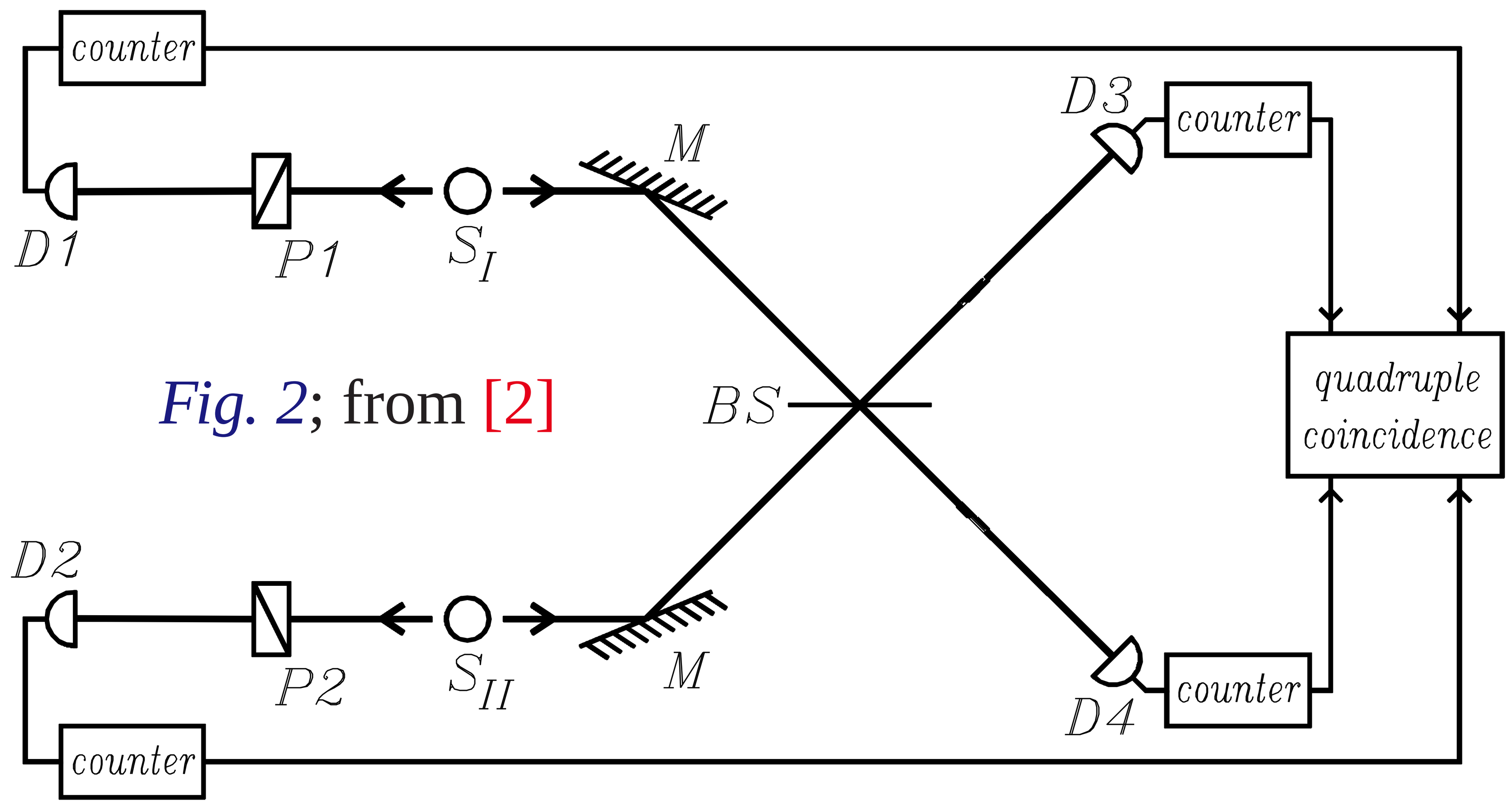

Fig. 2; from [2]

Yes! In 1993 we discovered that this is also possible and that this amounts to teleportation of unknown properties.

[2] Pavičić, M. and J. Summhammer, Interferometry with Two Pairs of Spin Correlated Photons, *Physical Review Letters*, **73**, 3191-3194 (1994)

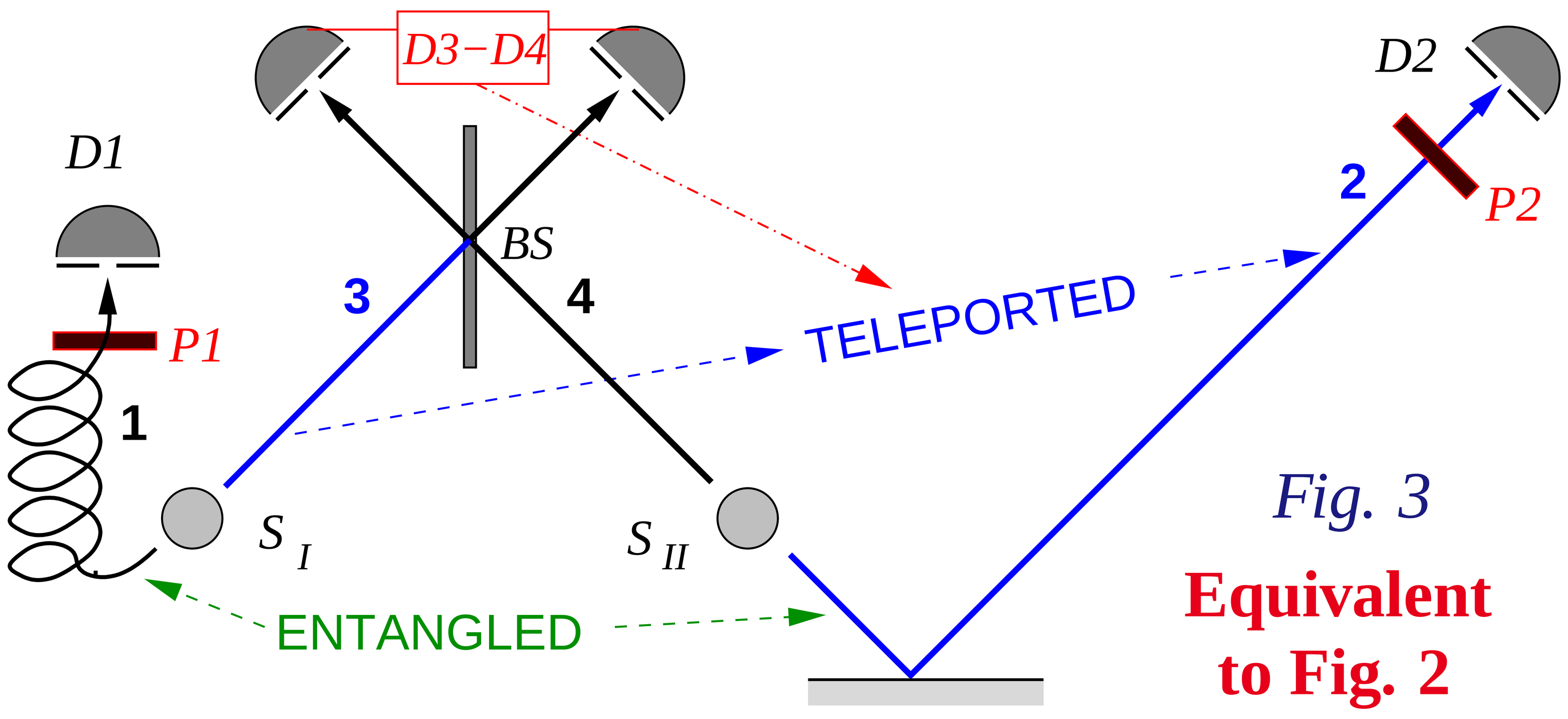

Fig. 3

Equivalent to Fig. 2

Each of the sources S_I and S_{II} spontaneously emits a pair of photons. So, the sources are completely independent. Photons in each pair are mutually correlated and would satisfy Eq. (1) if tested.

Now, our calculations show that if detectors $D3$ and $D4$ fire (almost) simultaneously, they will select those photons 1 and 2 that would be 100% correlated, i.e., entangled in polarization, although there are no polarizers in front of $D3$ and $D4$.

Since photons 1 and 3 are also correlated, we see that the (polarization) states of photons 3 and 2 coincide, i.e., we teleport state of photon 3 to photon 2. We do so even when we do not measure polarization of photon 1 by $P1$ and $D1$. Selection by $D3$ and $D4$ we often call a classical channel.

The teleportation here is not a Star Trek teleportation since we do not teleport photons themselves—only their states.

[3] Pavičić, M., Preselection of Spin-Correlated Photons, *Journal of the Optical Society of America*, **B 12,** 821–828 (1995).

[4] Pavičić, M., *Int. J. Theor. Physics*, **34,** 1653–1665 (1995); [5] Pavičić, M., *Optics Commun.*, **142**, 308–314 (1997).