







Interaction-Free Ghost Imaging

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What Constitutes a Quantum Measurement?



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Quantum Imaging by Interaction-Free Measurement



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Interaction-Free Measurements and Entangled Photons



- Does an interaction-free measurement constitute a "real" measurement?
- Does it lead to the collapse of the wavefunction of its entangled partner?
- More precisely, does the entire two-photon wavefunction collapse?

Ghost (Coincidence) Imaging



• Obvious applicability to remote sensing! (imaging under adverse situations, bio, two-color, etc.)

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Interaction-Free Ghost Imaging

Experimental Setup



Experimental Results

Interaction-free ghost image of a straight wire



- Note that the interaction-free ghost image is about ten times narrower than full spot size on the ICCD camera
- This result shows that interaction-free measurements lead to wavefunction collapse, just like standard measurements.

We could instead have simply answered the question theoretically (of whether interaction-free measurements lead to wavefunction collapse).

My response: Physics is an experimental science. Theoretical models are developed to explain the results of experiment, and not vice versa.

In their mathematical treatment of interaction-free measurements, Elitzur and Vaidman state: "*Assuming* that detectors cause the collapse of the quantum state . . ." (Emphasis mine.)

Foundations of Physics 23, 987 (1993).

Interaction-free imaging allows us to see what something looks like *in the dark*!

Could be extremely useful for biophysics. What does the retina look like when light does not hit it?

Summary

- Laboratory results show that an "interaction-free" measurement of one member of an entangled two-photon state leads to the collapse of the entire two-photon state.
- As such, it is possible to combine *ghost imaging* with *interaction*-*free imaging* to produce *interaction-free ghost imaging*.
- Interaction-free ghost imaging holds promise for "imaging in the dark," with important implications for biophotonics and surveillance for national security.
- Work is ongoing to achieve greater transverse spatial resolution.

Quantum Imaging Overview



Speaking of Imaging: Why We Shouldn't Trust Google



About 63,300,000 results (0.26 seconds)

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Boyd Quantum Photonics Research Group ... JOSA B July 2014; Robert Boyd awarded honorary doctorate by the University of Glasgow July 2014; Robert Boyd ...

Robert Boyd (anthropologist) - Wikipedia, the free ...

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Robert W. Boyd - Wikipedia, the free encyclopedia

https://en.wikipedia.org/wiki/Robert_W._Boyd - Wikipedia - Robert William Boyd (born 8 March 1948) is an American physicist noted for his work in optical physics and especially in nonlinear optics. He is currently ...

Robert W. Boyd

Robert William Boyd is an American physicist noted for his work in optical physics and especially in nonlinear optics. Wikipedia

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Books

Optics,

1992

Second E ...





detection...

1983



Alone

2005



Mathemat... models of social ev... 2007

