Replicating Quantum Holography

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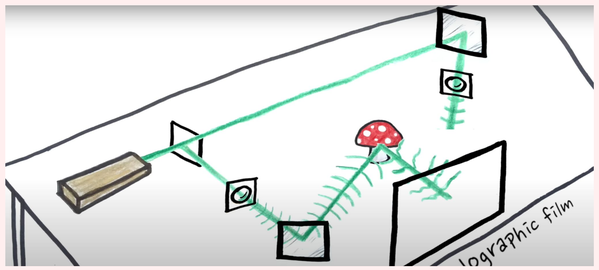
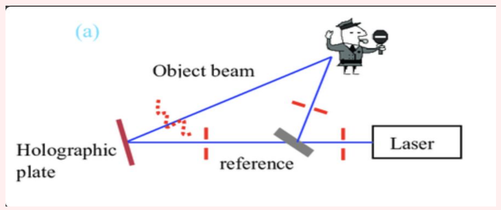
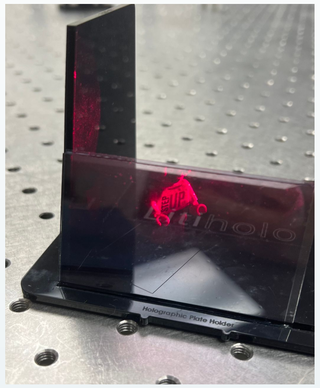
Introduction

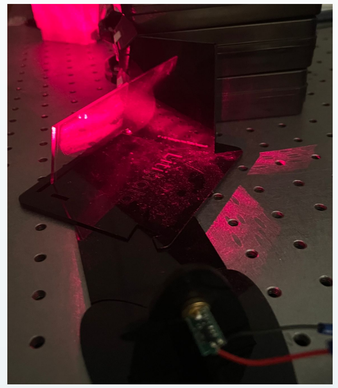
Holography is a method to represent a 3-dimensional object in 2 dimensions. It relies on the principle of interference with the object and the light source. Most holograms seen are created through a classical approach, using two beams that recombine at a camera or a plate to see the final hologram. However, our research focused on quantum holography, an approach that uses quantum entanglement to have the two beams be completely separate the entire time. Our research was based off the paper *Quantum holography with undetected light* by Töpfer et. al. Our novelty stems from this process never being replicated before in a high school setting as well as our idealized experimental setup due to cost constraints.





Typical Classical Hologram Setups





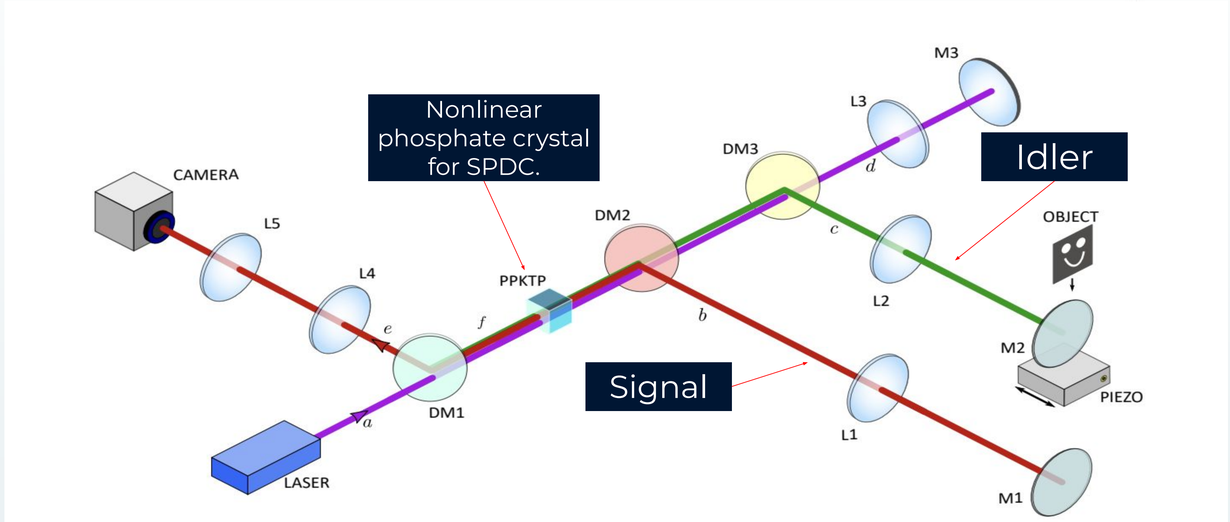
Classical Transmission Hologram Setup

Materials & Methods

We created our own transmission hologram through a LitHolo kit. Using the setup provided, we placed a laser at one end and the object, a Lego figurine, on the other end. A holographic film plate was placed right behind the object to capture the imprinted information given by the interference. For our quantum hologram, we created an experimental setup based off of Töpfer's work, planning to use a ppKTP crystal to perform spontaneous parametric down conversion (SPDC) to generate quantum entangled photons.

Results

We simplified the quantum holography setup by streamlining the optical paths, consolidating the pump, signal, and idler beams into fewer, more direct routes. Additionally, we significantly lowered costs and enhanced operational efficiency.



Quantum Hologram Setup

Discussion

Advancements in quantum holography hold promising implications in various fields. In material sciences, it can reveal structural properties at the quantum level, aiding in the development of materials with enhanced properties. In medical imaging, its high-resolution capabilities can lead to more precise diagnostics, improving disease detection and treatment.

We have established connections with leading researchers like Sebastian Töpfer, compiled a comprehensive materials list, and firmly established our experimental setup.

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Acknowledgements

We would like to thank Mr.Hannum for his guidance in the Quantum Physics and Optics Research Lab. We would also like to thank Mr. Sebastian Töpfer for his help in navigating the Quantum Holography field.