Polarization heralded imaging with plasmonic metasurfaces
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Heralded imaging [1] is a technique that, similar to the well-known ghost imaging technique, uses correlated detection to generate an image from transmission masks. This technique is generally used with a photon pair source, whereby one photon of the pairs, namely the signal photon interacts with the transmission mask and is detected by a camera, while the other photon of the pairs, namely the heralding photon, is detected by a ‘single pixel’ bucket detector.

Here, we replace conventional bulk transmission masks with plasmonic metasurfaces [2] with a type-II spontaneous parametric down-conversion source. By acting on the polarization state of the heralded photon (that never interacts with the metasurfaces), we are able to change the recorded images from the metasurfaces. Thus, contrary to previous works in polarization metasurfaces, we demonstrate the polarization dependence of metasurfaces without changing the polarization states of incident light (i.e., signal photons).

In this work we use two types of metasurfaces. The first metasurface is made of only horizontal and vertical slit antennas superposed over the same surface area on a 100 nm thick layer of gold. The horizontal slits make up the shape of a star while the vertical slits make up the shape of a triangle. The second metasurface is a phase and amplitude modulating plasmonic array that produces a clean hologram of Einstein only for horizontally polarized light, and a ‘scrambled’ hologram for vertically polarized light.

In this work, we highlight the benefits of using nanostructured metasurfaces with quantum states of light which could lead to novel implementations in quantum information protocols.