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Deconstructing a high dimensional mug into 2 dimensional donuts

From hybrid (spin and orbital angular momentum) entangled states, topological structures emerge when one investigates the mapping of the spatial profile (orbital angular momentum) possessed by one photon to the spin angular momentum on the Poincarè sphere of the other photon. The extraction of topological invariants (in the field of photonics) has been primarily limited to 2-dimensional states, however the extraction of topological invariants for high-dimensional states has seldomly been explored. In this work we will follow a method which can be utilized to extract topological invariants from high-dimensional bi-photon states with the help of the OAM degree of freedom. Experimentally, this technique leverages the capability of a topological structure in a high-dimensional vector space to be decomposed into multiple submanifolds, over which a topological invariants present in a high-dimensional vector space.

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