



Institut für
Angewandte Physik



Physikalisches
Institut



RHEINISCHE
FRIEDRICH-WILHELMS-UNI-
VERSITÄT BONN

COLLOQUIUM „OPTICS AND CONDENSED MATTER“

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Quantum Vortices of Photons

Imagine pulling a plate across the surface of a tranquil water pool, creating a mesmerizing trail of a vortex and antivortex. In optics, vortices materialize as phase twists of the electromagnetic field. While traditionally optical vortices arise from interactions between light and matter, we discovered an extreme regime of optical nonlinearity where quantum vortices – phase dislocations in the few-photon wavefunction – form due to effective, strong interactions between the photons. These interactions are realized in a ‘quantum nonlinear optical medium’ based on ultracold Rydberg atoms. Analogous to the water pushed by the plate, the excess phase accumulating due to the photon-photon interaction gives rise to pairs of quantum vortices, vortex lines, and rings, within the photonic wavefunction. The vortex rings are warped due to warping of the underlying dispersion. The ‘conditional’ phase flip enclosed by the vortices can be used for deterministic quantum logic operations. Counter-propagating photons, in a configuration suitable for quantum gates, exhibit even longer-range, richer interactions.

May 13th, starting with discussion at 17:00 h, talk at 17:15 h, live IAP lecture hall or via Zoom

<https://uni-bonn.zoom.us/j/98441612025?pwd=a01SSjlkY1Q3SDFhL09JQk1qc1V6dz09>

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