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VERSITÄT BONN

## COLLOQUIUM „OPTICS AND CONDENSED MATTER“

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### Topological pumping and quantum information

Topological pumps provide a powerful method for transporting particles with remarkable precision by slowly and cyclically modulating a lattice potential. This transport is topologically protected - a feature it shares with the quantum Hall effect - making it inherently robust against noise and experimental imperfections.

In this talk, I will introduce a novel paradigm of this concept: moving beyond the transport of individual particles to the pumping of qubits carrying quantum information. Our experiments, which employ ultracold fermions in dynamical optical lattices [1,2], demonstrate the coherent transport of not only single atoms but also entangled Bell pairs over hundreds of lattice sites. This capability allows us to perform fundamental quantum computations during transport, including high-fidelity two-qubit gates. I will show how we can chain these operations together to build non-local quantum circuits and generate complex entanglement patterns across the lattice.

[1] Zhu et al. PRX (2025) “Splitting and connecting singlets in atomic quantum circuits”

[2] arXiv:2507.22112 “Protected quantum gates using qubit doublons in dynamical optical lattices”

**January 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>

Meeting-ID: 984 4161 2025

Kenncode: 294164