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Ultracold atoms in an optical quasicrystal

During the last twenty years, optical lattices have emerged as powerful quantum simulators to study the many-body physics of (strongly) interacting particles in, initially, periodic potentials. This has then been extended to 1D quasiperiodic models such as the Aubry-Andre model, mostly to study localisation phenomena.
We have generalized these techniques to an 8-fold rotationally symmetric optical 2D quasicrystal that is realized using four independent 1D lattices overlapped in a plane.
We characterized the optical quasicrystal using matter-wave (Kapitza-Dirac) diffraction and directly observed the self-similarity of this quasicrystalline structure. On short timescales, the diffraction dynamics constitutes a continuous-time quantum walk on a periodic four-dimensional tight-binding lattice.
We furthermore report on the experimental realisation of the 2D Bose glass. By probing the coherence properties of the system, we observe the superfluid to Bose glass transition and map out the phase diagram. Moreover, we reveal the non-ergodic nature of the Bose glass by probing the capability to restore coherence.

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