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Quantum phases of dipolar bosons in multi-layered optical lattice geometries

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Dipolar interactions are responsible for stabilizing novel quantum many-body states in ultracold systems. In this talk we consider dipolar bosons trapped in $N \geq 2$ optical lattice layers. These configurations provide an ideal setup to explore novel physics resulting from the long range and anisotropic character of the dipolar interaction. We present results based on Path Integral Quantum Monte Carlo by the two-worm and a novel N-worm algorithm for dipolar hard-core bosons whose dipole moments are aligned perpendicularly to the optical lattice layers. Several non-trivial phases are stabilized. For two-dimensional bi-layer geometries these phases include pair-superfluidity, pair-supersolidity, and solid phases. For stacks of one-dimensional layers (tubes) superfluidity of multimers, solids, countersuperfluids are stabilized and they have a threshold-less nature with respect to the dipolar interaction.