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A Bose-Einstein Condensate on a Synthetic Hall Cylinder[1]
CHUAN-HSUN LI, YANGQIAN YAN, SAYAN CHOUDHURY, DAVID B. BLASING, QI ZHOU, YONG P. CHEN, Purdue University — Interplay between matter and fields in physical spaces with nontrivial geometries can give rise to many unexpected phenomena. However, their realizations are often impeded by experimental constraints. Here, we realize a Bose-Einstein condensate (BEC) on a synthetic cylindrical surface subject to a net radial synthetic magnetic flux. This cylindrical surface comprises a real spatial dimension and a curved synthetic dimension formed by cyclically-coupled atomic spin states. The BEC on such a Hall cylinder has properties unattainable by its counterpart in a two-dimensional plane. We observe Bloch oscillations of the BEC with doubled periodicity of the band structure, analogous to traveling on a Möbius strip in momentum space, reflecting band crossings protected by a nonsymmorphic symmetry that underlines the emergent crystalline order in the BEC wavefunction. We further demonstrate such topological operations as gapping the band crossings and unzipping the cylinder. Our work opens the door to engineering synthetic gauge fields in synthetic curved spaces with nontrivial geometries and/or topologies and observing intriguing phenomena inherent to such spaces.

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