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**Transport and Dynamics of a Bose-Einstein Condensate (BEC) 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. Highly controllable atomic systems hold promises to create synthetic quantum matters inaccessible in other systems. We have realized a BEC on a synthetic cylindrical surface, composed of a real spatial dimension and a curved synthetic dimension formed by cyclically-coupled atomic spin states, subject to a net radial synthetic magnetic flux. The BEC on such a Hall cylinder has properties unattainable by its counterpart in a 2D 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, and study other dynamics and transport phenomena such as charge pumping. 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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