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## Optically synthesized electric and magnetic fields for ultracold neutral atoms

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Ultracold atoms hold great promise in simulating essential models in condensed matter physics. One apparent limitation is the charge neutrality of the atoms, preventing access to a rich source of physics, for example, electrons in magnetic fields. We have circumvented this limitation by generating an effective vector potential with an optical coupling between internal states of the atoms. We have made the first experimental realization of synthetic electric and magnetic fields for ultracold neutral atoms, through the temporal and spatial variation of the vector potential. In our system, we use a two-photon Raman coupling to dress a rubidium 87 Bose-Einstein condensate (BEC), where the momentum difference between two Raman beams results in the modified energy-momentum dispersion of the dressed state, leading to the effective vector potential. We have created a synthetic magnetic field evidenced by the appearance of vortices in the BEC; this field is stable in the laboratory frame and allows for adding optical lattices with ease. Our optical approach is not subject to the limitations of rotating systems; with a suitable lattice configuration, it should be able to create sufficiently large synthetic magnetic fields in the quantum-Hall regime. [Y.-J. Lin, R. L. Compton, K. Jimenez-Garcia, J. V. Porto, and I. B. Spielman, Nature, **462**, 628 (2009).]