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Experimental realization of matter wave circuits[1] CHANGHYUN RYU, MALCOLM BOSHIER, Physics Division, Los Alamos National Laboratory, Los Alamos, NM 87545 — A matter wave circuit is a de Broglie wave analog of an integrated optical circuit where coherent matter waves are guided and manipulated by confining potentials. Applications of such circuits include sensing, quantum information processing, and emulation of transport problems. We report the experimental realization of matter wave circuits with the painted potential technique for creating arbitrary and dynamic time-averaged optical dipole potentials. First, a BEC was coupled into a straight waveguide and pushed to move with a chosen velocity. Second, the propagation of matter waves around bent waveguides was studied. Excitations were observed to be dependent on the radius of the bend. A simple theory explains this behavior and suggests ways to control the excitations. Third, a BEC was sent through a Y-junction and splitting of matter waves was shown. Dynamic control of the relative splitting ratio was demonstrated and the coherence between split matter waves was studied. Fourth, propagation of matter waves through a square closed waveguide was demonstrated. With these matter wave circuit elements, it is possible to construct matter wave interferometer circuits. Also the fine control of these elements may enable emulation of conduction problems in condensed matter systems.

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