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Bose-Einstein Condensates in Painted Potentials

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We have developed a robust and straightforward method to create arbitrary and dynamic two-dimensional potentials for manipulating Bose-Einstein condensates (BECs) [1]. The technique uses a rapidly-moving laser beam that "paints" a time-averaged optical dipole potential in which we create BECs in a variety of geometries, including toroids, ring lattices, and square lattices. Matter wave interference patterns confirm that the trapped gas is a condensate. We have used the painted potential technique to study the rotation of toroidal BECs. In a toroidal trap, Bose-condensed atoms should flow with a well defined winding number, making it an ideal system to demonstrate the quantized nature of circulation We created BECs in traps rotating at different frequencies and then studied the resulting superfluid flow in time-of-flight images. Our results show that the rotation of a toroidal BEC is indeed quantized, and that our painted torus will support superfluid flows with winding number up to five.

[1] K Henderson, C Ryu, C MacCormick, and M G Boshier, New J. Phys. 11, 043030 (2009)