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Quantum analogues of classical wakes in Bose-Einstein condensates GEORGE STAGG, NICK PARKER, CARLO BARENGHI, Newcastle University — We show that an elliptical obstacle moving through a Bose-Einstein condensate generates wakes of quantum vortices which resemble those of classical viscous flow past a cylinder or sphere. Initial steady symmetric wakes, similar to those observed in classical flow at low Reynolds number, lose their symmetry and form clusters of like-signed vortices, in analogy to the classical Bénard–von Kármán vortex street. The key ingredient to produce classical-like wakes is that vortices are generated at a sufficiently high rate that they undergo strong interactions with their neighbours (rather than being swept away). The role of ellipticity is to facilitate the interaction of the vortices and to reduce the critical velocity for vortex nucleation. Our findings, demonstrated numerically in both two and three dimensions, confirm the intuition that a sufficiently large number of quanta of circulation reproduce classical physics. The effects which we describe (dependence of the critical velocity and cluster size on the obstacle's size, velocity and ellipticity) are also relevant to the motion of objects (such as vibrating wires, grids and forks) in superfluid helium, as the obstacle's ellipticity plays a role which is analogous to rough boundaries.

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