Quantum Vortex Shedding in Atomic Superfluid Gases

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The wake behind a moving obstacle is a classic problem in fluid dynamics. I will present our recent vortex-shedding experiments with weakly interacting atomic Bose-Einstein condensates and strongly interacting fermionic superfluid gases. Highly oblate large atomic samples were prepared and perturbed by translating a repulsive optical obstacle formed by a focused laser beam, and their responses in terms of vortex nucleation were investigated for various sweeping conditions. We observed a regular-to-turbulent transition of vortex shedding pattern as the obstacle velocity increases, resembling the universal behavior of classical fluids[1]. We observed development of spatial pair correlations of vortices and antivortices in the turbulent superfluid containing many vortices[2]. In the experiments with strongly interacting atomic Fermi gases, we investigated the critical vortex shedding across the BEC-BCS crossover and observed a qualitative change of the dependence of v_c on the sweeping distance, which is attributed to the participation of pair breaking in the vortex shedding dynamics[3]. Finally, I will discuss the extension of the vortex-shedding experiment to a spinor superfluid which has mass and spin superfluidities simultanesouly[4].

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