Fetter
Title: Rapidly rotating Bose-Einstein condensates

Abstract: Dilute Bose-Einstein condensates are characterized by a macroscopic wave function (an order parameter) that obeys a nonlinear Schrodinger equation. In the usual situation of a quadratic trap and a large interaction parameter, the repulsive interactions expand the condensate well beyond the the harmonic oscillator length that gives the noninteracting size. When a superfluid rotates, the condensate acquires angular momentum by nucleating singly quantized vortex lines. The stability and dynamics of a single vortex depends on its energy in the rotating frame. At larger rotation rates Ω, the number of vortices increases, forming a dense triangular lattice. The mean superfluid velocity then approximates solid-body rotation. In this case, the centrifugal forces dramatically deform the condensate, making it broader and flatter. Eventually, when Ω equals the trap frequency, the centrifugal potential cancels the confining quadratic trap potential.

An additional quartic potential can confine the condensate even if Ω exceeds the trap frequency. Two associated transitions are predicted to occur: First, the condensate develops a hole and becomes annular; second, the vortices disappear from the condensate, leading to a giant vortex with pure irrotational flow.