INHOMOGENEOUS VORTEX PATTERNS IN ROTATING BOSE-EINSTEIN CONDENSATES

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A Bose-Einstein condensate of trapped ultracold atoms exhibits remarkable phenomena intrinsic to its quantum nature. Among these is its superfluidity, spectacularly demonstrated in a number of experiments by the observation of quantized vortices in rotating Bose gases. We consider a 2D gas described by the so-called Gross-Pitaevskii (GP) theory and investigate the properties of the ground state of the theory for rotation speeds close to the critical speed for vortex nucleation. While it could be argued that the vortex distribution should be homogeneous within the condensate we rigorously prove by means of an asymptotic analysis in the strongly interacting regime that it is not. More precisely we rigorously derive a formula due to Sheehy and Radzihovsky for the vortex distribution, a consequence of which is that the vortex distribution is strongly inhomogeneous close to the critical speed and gradually homogeneizes when the rotation speed is increased. From the mathematical point of view, a novelty of our approach is that we do not use any compactness argument in the proof, but instead provide explicit estimates on the difference between the vorticity measure of the GP ground state and the minimizer of a certain renormalized energy. Collaboration with Michele Correggi.