1094-35-182 **Parimah Kazemi*** (kazemip@beloit.edu), Department of Mathematics, Beloit College, 800 College Street, Beloit, WI 53511. *Numerical methods for finding stationary states of the Gross-Pitaevskii equation.*

We present results for the numerical optimization of the Gross-Pitaevskii functional with rotation

$$E(u) = \int_D \frac{|\nabla u|^2}{2} + \frac{C_{trap}|u|^2}{2} + \frac{C_g|u|^4}{4} - \Omega L_z(u)$$

where L_z gives the third component of angular momentum. One seeks a minimum subject to the constraint $\int_D |u|^2 = 1$. Our numerical scheme involves time discretization of a dynamical system resulting from a gradient flow. We compare computational performance as well as stability of different schemes in consideration with varying physical parameters of the system such as rotation frequency. The Gross-Pitaevskii equation is used to model stationary states and time evolution for Bose-Einstein condensates, a gas of non interacting particles at very low temperatures in which the atoms in the condensate follow the same complex wave function. Our results our novel in the sense that we make successful use of operator preconditioning for nonlinear systems to improve computational performance. The preconditioner that we use incorporates physical parameters of the problem. (Received August 22, 2013)