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Ground states in the energy-supercritical Gross-Pitaevskii equation with a harmonic potential

The energy super-critical Gross–Pitaevskii equation with a harmonic potential is revisited in the case of cubic focusing nonlinearity and dimension $d \geq 5$. In order to prove the existence of a ground state (a positive, radially symmetric solution in the energy space), we develop the shooting method and deal with a one-parameter family of classical solutions to an initial-value problem for the stationary equation. We prove that the solution curve (the graph of the eigenvalue parameter versus the supremum norm) is oscillatory for $d \leq 12$ and monotone for $d \geq 13$. Compared to the existing literature, rigorous asymptotics are derived by constructing different families of solutions to the stationary equation with functional-analytic rather than geometric methods.