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Eigenvalues of nonlinear bound states in the Thomas–Fermi approximation

We consider the Gross–Pitaevskii equation with a parabolic potential in the hydrodynamics limit, when a small parameter appears in front of the dispersive term. This limit is referred to as the Thomas–Fermi approximation in the context of nonlinear bound states in parabolically trapped Bose–Einstein condensates. We study the linearization of the nonlinear bound states in the Gross–Pitaevskii equation and convergence of eigenvalues of the point spectrum as the small parameter goes to zero. Various estimates are obtained on the spectrum of the linearized operators and the generalized convergence of the resolvent operator is proved. Analytical results are corroborated with asymptotic and numerical approximations.