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The One-Dimensional Soft-Coulomb Problem and the Hard-Coulomb Limit[1] CHARLES WEATHERFORD, DANIEL GEBREMEDHIN, Physics Department, Florida A&M University — A new and efficient way of evolving a solution to an ordinary differential equation is presented. A finite element method is used where we expand in a convenient local basis set of functions that enforce both function and first derivative continuity across the boundary. We also, for the first time, implement an adaptive step size choice for each element that is based on a Taylor series expansion. This algorithm is used to solve for the eigenpairs corresponding to the one–dimensional soft Coulomb potential, $1/\sqrt{x^2+\beta^2}$, which becomes numerically intractable as the softening parameter (β) approaches zero. We are able to maintain near machine accuracy for β as low as $\beta = 10^{-8}$ using 16 digit precision calculations. Our numerical results provide a new insight into the controversial one dimensional Hydrogen atom which is a limiting case of the soft Coulomb problem as $\beta \to 0$.

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