THE UNIVERSITY
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at CHAPEL HILL

Undergraduate Research Seminar

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3:00 - 4:00 p.m.
Zoom

One-dimensional hydrogenic ions with screened nuclear Coulomb field

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Abstract. We study the spectrum of the Dirac Hamiltonian in one space dimension for a single electron in the electrostatic potential of a point nucleus, in the Born-Oppenheimer approximation where the nucleus is assumed fixed at the origin. The potential is screened at large distances so that it goes to zero exponentially at spatial infinity. We show that the Hamiltonian is essentially self-adjoint, the essential spectrum has the usual gap $(-m, m)$ in it, and that there are only finitely many eigenvalues in that gap, corresponding to ground and excited states for the system. We find a one-to-one correspondence between the eigenfunctions of this Hamiltonian and the winding number of heteroclinic saddle-saddle connectors for a certain dynamical system on a finite cylinder. We use this correspondence to study how the number of bound states changes with the nuclear charge.