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Fermion-mass and charge renormalization using relativistic, time-dependent quantum mechanics TIMOTHY KUTNINK, ATHANASIOS PETRIDIS, Drake University — The time-dependent electromagnetically self-coupled Dirac equation is solved numerically by means of the staggered-leap-frog algorithm with reflecting boundary conditions. The stability region of the method versus the interaction strength and the spatial-grid size over time-step ratio is established. The expectation values of several dynamic operators are then evaluated as functions of time. These include the fermion and electromagnetic energies and the fermion dynamic mass. There is a characteristic time-dependence leading to asymptotic constants of these expectation values. In the case of the fermion mass and charge this amounts to renormalization. The dependence of the expectation values on the spatial-grid size is evaluated in detail and result in finite mass and charge. The contribution of positive and negative energy states to the asymptotic values and the gauge fields is analyzed. A statistical method, employing a canonical ensemble whose temperature is the inverse of the spatial-grid size, is used to remove the momentum-dependence and produce a finite result for each spatial-grid size value. The continuum limit is then taken to calculate both the fermion mass and charge. The renormalization mass correction is about 10% while the charge correction is about 30%.

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