Special Relativity and Quantum Mechanics: About Dirac Equation and Dirac and Pauli Matrices

Paul-Henry Glinel, Université de Moncton
Supervisor(s): Beaudoin, Normand

The Dirac equation comes from the quantization of the relativistic equation of energy of a free particle. Its algebraic study leads to the prediction of spin and antiparticle of the electron. This prediction is intrinsically linked to the properties of the four Dirac matrices appearing in the Dirac equation, whose linear combination constitute the Dirac Hamiltonian of a free particle. Dirac matrices possess a mutual property of anticommutation. They also possess intrinsic properties: they are unitary, Hermitian, traceless and even-dimensional. A systematic method is proposed to generate a set of Dirac matrices from a set of four random matrices possessing the required intrinsic properties. The Dirac Hamiltonian does not commute with the angular momentum operator while the Schrödinger Hamiltonian does. However, the combination of the angular momentum and a constant operator, corresponding to an intrinsic spin, does. The spin operator is shown to have the accurate eigenvalues, for they are plus or minus half of the reduced Planck constant, which matches with the experimental results of the spin of the electron. The Dirac theory hence leads to the natural prediction of spin while Pauli first introduced it *ad hoc*.