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Solving the Feynman–Gell-Mann Equation for the Electron GRAHAM MILLER, DANIEL FINKENSTADT, U.S. Naval Academy, Physics Department — There are very few cases for which the Dirac equation can be solved exactly. Moreover, the techniques familiar from undergraduate quantum mechanics provide little help in solving its linear differential equations. Working instead with a two-component formalism, the transformed Dirac equation can be solved for cases of constant electric and magnetic fields for an electron. This approach was recommend in the famous 1958 paper by Feynman and Gell-Mann and has the form: $(\imath\hbar\frac{\partial}{\partial t} - V)^2 = -\hbar^2 c^2 |\nabla - \imath\frac{e}{\hbar}\vec{A}|^2 - e\hbar c\vec{\sigma}\cdot(\vec{B}c + \imath\vec{E}) + (mc^2)^2$, when acting on a two component spinor φ. We will show the solution of this equation for the cases of parallel E & B fields, perpendicular fields, perhaps oblique fields and finish with a discussion of the Hydrogen atom. Through taking the nonrelativistic limits, these solutions can be verified for well-known conditions.

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