

Comment on “A simpler solution of the Dirac equation in a Coulomb potential,” by Bernard Goodman and Siniša R. Ignjatović [Am. J. Phys. 65 (3), 214–221 (1997)]

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In a recent paper, Goodman and Ignjatović¹ have presented a method of finding bound state solutions of the Dirac–Coulomb problem which is conceptually much simpler than one described in standard textbooks on quantum mechanics. It has been shown that differentiation of a pair of coupled first-order radial Dirac–Coulomb equations yields a set of two second-order equations which may be separated by a suitable nonorthogonal matrix transformation. Since decoupled equations happen to be of the same form as the nonrelativistic Schrödinger–Coulomb equation, they are readily soluble and details of a solution procedure have been described.

After analysis of the contents of Ref. 1 and of the list of references cited therein, a reader who is not sufficiently familiar with the subject may be left with the impression that the approach used in that paper is new. That is, however, not the case and the purpose of this comment is to locate Goodman and Ignjatović’s article against a background of other researchers’ work. The origins of the decoupling procedure used by these authors may be traced back to the works of Martin and Glauber² and of Biedenharn.³ In a not widely known paper published in 1966, Kolsrud⁴ used exactly the same method as the one described in Ref. 1 to find bound and free solutions of the relativistic Kepler problem. In the eighties, Karwowski and co-workers^{5,6} used the transformation under discussion in the quasirelativistic theory of atomic structure (some other relevant references may be found in

Refs. 5 and 6). In 1995 Salvat *et al.*⁷ applied Kolsrud’s results to obtain regular and irregular solutions of the Dirac–Coulomb equation and very recently we⁸ have used the same approach to find Sturmian functions for the Dirac–Coulomb problem. This brief survey shows that the procedure described in Ref. 1 is well known in relativistic atomic physics.

¹Bernard Goodman and Siniša R. Ignjatović, “A simpler solution of the Dirac equation in a Coulomb potential,” *Am. J. Phys.* **65**, 214–221 (1997).

²P. C. Martin and R. J. Glauber, “Relativistic theory of radiative orbital electron capture,” *Phys. Rev.* **109**, 1307–1325 (1958).

³L. C. Biedenharn, “Remarks on the relativistic Kepler problem,” *Phys. Rev.* **126**, 845–851 (1962).

⁴M. Kolsrud, “On the solution of Dirac’s equation with Coulomb potential,” *Phys. Norvegica* **2**, 43–50 (1966).

⁵J. Karwowski and J. Kobus, “The Dirac second-order equation and an improved quasirelativistic theory of atoms,” *Int. J. Quantum Chem.* **30**, 809–819 (1986).

⁶J. Kobus, J. Karwowski, and W. Jaskólski, “Matrix elements of r^q for quasirelativistic and Dirac hydrogenic wavefunctions,” *J. Phys. A* **20**, 3347–3352 (1987).

⁷F. Salvat, J. M. Fernández-Varea, and W. Williamson, Jr., “Accurate numerical solution of the radial Schrödinger and Dirac wave equations,” *Comput. Phys. Commun.* **90**, 151–168 (1995).

⁸Radosław Szmytkowski, “The Dirac–Coulomb Sturmians and the series expansion of the Dirac–Coulomb Green function: Application to the relativistic polarizability of the hydrogen-like atom,” *J. Phys. B* **30**, 825–861 (1997) [Erratum: **30**, 2747 (1997)].

THREE EXPERIMENTS PER LIFETIME

As experiments in their field become more complex and take longer to build, many young high-energy physicists wonder how they will ever acquire the experience, recognition, and publication record that helped their mentors land faculty jobs decades ago.

“When you think about it, I’m going to do three experiments in my life—just three,” says Mr. Mansour, a postdoctoral researcher from Michigan State University who is working on Fermilab’s Collider Detector Facility, or CDF, a particle detector involving nearly 400 scientists. “I did my thesis experiment. Now, I’m working on CDF. And then there’s going to be an experiment at the Superconducting Supercollider. Three experiments. I look at my adviser, and he has a *list* of experiments. You don’t get that anymore.”

Kim A. McDonald, “Physicists in Large Collaborations Find that ‘Big’ Is Not Always Better,” *The Chronicle of Higher Education*, 9 December 1992.