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Exact mappings between quantum relativistic and quantum optical models A. BERMUDEZ, M. A. MARTIN-DELGADO, Universidad Complutense de Madrid, E. SOLANO, Ludwig-Maximilians-Universitat — We develop a novel quantum optical perspective into a couple of quantum relativistic systems: i) First we show how the two-dimensional extension of the harmonic oscillator, known as the Dirac oscillator, can be exactly mapped onto a chiral Anti-Jaynes-Cummings model of quantum optics. This equivalence allows us to predict a series of novel relativistic phenomena, such as spin-orbit *Zitterbewegung*. Furthermore, we also make a realistic experimental proposal, at reach with current technology, for studying the equivalence of both models using a single trapped ion [1]. ii) Second, we show that a relativistic version of Schrödinger cat states, here called *Dirac cat states*, can be built in relativistic Landau levels when an external magnetic field couples to a relativistic spin 1/2 charged particle. Under suitable initial conditions, the associated Dirac equation produces unitarily Dirac cat states involving the orbital quanta of the particle in a well defined mesoscopic regime. These states have a purely relativistic origin and cease to exist in the non-relativistic limit [2].
[1] A. Bermudez et. al, Phys. Rev. A.**76**, 041801(R) (2007).
[2] A. Bermudez et. al, Phys. Rev. Lett.**99**, 123602 (2007).

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