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Particle beams carrying orbital angular momentum, charge, mass and spin TEUNTJE TIJSSEN, H H Wills Physics Laboratory, University of Bristol, ARMEN HAYRAPETYAN, JOERG GOETTE, Max Planck Institute for the Physics of Complex Systems, Dresden, MARK DENNIS, H H Wills Physics Laboratory, University of Bristol — Electron beams carrying vortices and angular momentum have been of much experimental and theoretical interest in recent years. In addition, optical vortex beams are a well-established field in optics and photonics. In both cases, the orbital angular momentum associated with the beams axial vortex has effects on the overall spin of the beam, due to spin-orbit interactions. A simple model of these systems are Bessel beam solutions (of either the Dirac equation or Maxwell equations) with a nonzero azimuthal quantum number, which are found by separation in cylindrical coordinates. Here, we generalize this approach, considering the classical field theory of Bessel beams for particles which are either massive or massless, uncharged or charged and of a variety of different spins (0, $\frac{1}{2}$, 1, $\ldots$). We regard the spin and helicity states and different forms of spin-orbit terms that arise. Moreover, we analyse the induced electromagnetic field when the particles carry charge. Most importantly, this unified field theory approach leads to the prediction of effects for vortex beams of neutrons, mesons and neutrinos.

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