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Geometrical models of relativistic spinning particles in d=3 Minkowski space

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The model of classical spinning particle is considered such that quantization of classical model leads to an irreducible representation of the Poincaré group. The class of gauge equivalence of classical particle world lines is shown to form a 2-dimensional world sheet in 3-dimensional Minkowski space, irrespectively to any specifics of classical model. For massive particles, the world sheets are circular cylinders with timelike axes. For massless particle with continuous helicity, the world sheets are parabolic cylinders with lightlike axes. The radius of circular cylinders and the focal length of parabolic cylinders are determined by representation. The position of the world sheet in Minkowski space is determined by momentum and total angular momentum of the particle. Proceeding from the fact that the world lines of irreducible classical spinning particle are cylindrical curves, while all the lines are gauge equivalent on the same world sheet, we deduce a differential equation describing the dynamics of model. The equations of motion are purely geometrical, and they do not involve any variables except the derivatives of space-time coordinates. The geometrical equations of motion are non-Lagragian, but they admit the equivalent second-order formulation involving an auxiliary variable. The second-order formulation agrees with a previously known spinning particle model. The problem of inclusion of consistent interactions with a general electromagnetic field is considered for massive particles.

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