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Matsyuk, R. Ya. (2-AOSUK-A2)
Lagrangian analysis of invariant third-order equations of motion in relativistic classical particle mechanics. (Russian)
Dokl. Akad. Nauk SSSR **282** (1985), *no. 4,* 841–844.

The author discusses the classical motion of scalar and spin particles in gauge and gravitational fields, a topic in which there has been increasing interest. The problem of the existence of the covariant third-order Euler-Poisson equations in pseudo-Euclidean space is investigated and a method for finding them is proposed.

The author proves that there is a unique one-parameter family of covariant third-order Euler-Poisson equations in three- dimensional pseudo-Euclidean space. These equations describe the flat motion of a free particle with mass $m=m_0/|\sigma|$ and spin σ orthogonal to the plane of the motion. For the case $m_0=0$ this equation is equivalent to that for geodesic circles.

It is shown that one cannot build up the third-order Euler-Poisson equations in four-dimensional pseudo-Euclidean space. But in this case there is a covariant family of Euler-Poisson equations. These equations describe the motion of free particles with mass $m=m_0[1-(\boldsymbol{\sigma}\cdot\mathbf{u})^2/(\boldsymbol{\sigma}\cdot\boldsymbol{\sigma})(\mathbf{u}\cdot\mathbf{u})]^{-3/2}$ and with constant spin four-vector. For massless particles these equations, with an additional condition $(\boldsymbol{\sigma}\cdot\mathbf{u})=0$, describe the motion of timelike particles.

The author proves that one cannot build up the invariant Lagrange function for the third-order Euler-Poisson equations in the pseudo-Euclidean space of dimension $l>2$ and signature $s\neq 2$.

The author shows that the given method of finding the covariant Euler-Poisson equations is more general than the method for the Lagrange equations.

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