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Lie symmetries for systems of evolution equations

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Abstract

The Lie symmetries for a class of systems of evolution equations are studied. The evolution equations are defined in a bimetric space with two Riemannian metrics corresponding to the space of the independent and dependent variables of the differential equations. The exact relation of the Lie symmetries with the collineations of the bimetric space is determined.

Keywords: Lie symmetries; Evolution equation; Collineations

1 Introduction

Lie symmetries is a powerful method for the determination of solutions in the theory of differential equations. A Lie symmetry is important as it provides invariants which can be used to write a new differential equation with less degree of freedom. Furthermore, a solution of such an equation is also a solution of the original differential equation [1, 2]. The reduction process is the main application of Lie symmetries, however, it is not a univocal approach. Symmetries can be used for the determination of conservation currents [3], for the classification of differential equations [4–10] and for the reconnaissance of some well-known systems [11–15].

In the recent literature, it has been shown that there is a close relation between the Lie symmetries of a second order differential equation and the geometry of the space where motion occurs. For example, the conservation of energy and angular momentum in Newtonian Physics is a result of the Lie point symmetries, generated by the Killing vectors of translations and rotations respectively. The general result for a holonomic autonomous dynamical system moving in a Riemannian space is that the Lie point symmetries of the equations of motion

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