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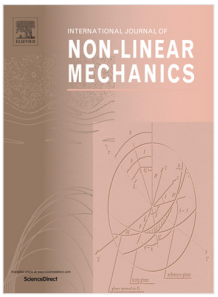

Lie symmetry perturbation and adiabatic invariants for dynamical system with non-standard Lagrangians

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Lie symmetry perturbation and adiabatic invariants for dynamical system with non-standard Lagrangians

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Abstract: This paper focuses on studying the Lie symmetry perturbation and the adiabatic invariants for a dynamical system with non-standard Lagrangians. First, the Euler-Lagrange equations for dynamical systems with two kinds of non-standard Lagrangians that are exponential Lagrangian and power-law Lagrangian are given in the undisturbed case and the disturbed cases, respectively. Secondly, the determining equations of Lie symmetry for undisturbed system and disturbed system are established, and the definitions of the Lie symmetry are given. Thirdly, the exact invariants of Noether type and Hojman type led by Lie symmetry for the undisturbed system are given. Fourthly, the adiabatic invariants of Noether type and Hojman type led by Lie symmetry and the conditions that need to be satisfied for the disturbed system are obtained. Finally, some examples are given to illustrate the application of the results.

Keywords: perturbation; adiabatic invariant; Lie symmetry; non-standard Lagrangians

1. Introduction

It is one of the modern development directions of mathematical physics, especially analytical mechanics, to find the conserved quantity of mechanical system by symmetry method. The symmetry method mainly includes Noether symmetry [1-8], Lie symmetry [3-4, 9-17] and Mei symmetry [4, 18-21]. Lie symmetry [9-10] is the invariance of differential equations under infinitesimal transformations of groups. Lutzky [11] introduced Lie method into the field of mechanics research, and first studied the Lie symmetries and conserved quantities of second order dynamical systems, and the conserved quantity obtained is Noether conserved quantity. In 1992, Hojman [22] presented a conservation theorem, whose conserved quantity is only dependent on symmetric transformation of the differential equations of motion without using the Lagrangian or Hamiltonian structure of the system. The conserved quantity can be called Hojman conserved

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