Line Integral Methods able to preserve all invariants of conservative problems

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Abstract

Recently, the class of Hamiltonian Boundary Value Methods (HB-VMs) [1] has been introduced with the aim of preserving the energy associated with polynomial Hamiltonian systems (and, more in general, with all suitably regular Hamiltonian systems). However, many interesting problems admit other invariants besides the Hamiltonian function. It would be therefore useful to have methods able to preserve any number of independent invariants. This goal is here achieved by generalizing the line-integral approach which HBVMs rely on, thus obtaining a number of generalizations which we collectively name *Line Integral Methods*. In fact, it turns out that this approach is quite general, so that it can be applied to any numerical method whose discrete solution can be suitably associated with a polynomial, such as a collocation method, as well as to any conservative problem. In particular, a completely conservative variant of both HBVMs and Gauss collocation methods is presented. A few numerical experiments confirm the effectiveness of the proposed methods.

[1] *The Hamiltonian BVMs (HBVMs) Homepage:*
     http://web.math.unifi.it/users/brugnano/HBVM/

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