On the construction of some symplectic P-stable additive Runge – Kutta methods

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Abstract:

Symplectic partitioned Runge–Kutta methods can be obtained from a variational formulation treating all the terms in the Lagrangian with the same quadrature formula. We construct a family of sym- plectic methods allowing the use of different quadrature formula for different parts of the Lagrangian. In particular, we study a family of methods using Lobatto quadrature (with corresponding Lobatto IIIA-IIIB symplectic method) and Gauss–Legendre quadrature combined in an appropriate way. The resulting methods are similar to additive Runge-Kutta methods. The IMEX method, using the Verlet and IMR combination is a particular case of this family.

The methods have the same favourable implicitness as the underlying Lobatto IIIA-IIIB pair. Differently from the Lobatto IIIA-IIIB, which are known not to be P-stable, we show that the new methods satisfy the requirements for P-stability.