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ETNA
Kent State University
etna@mcs.kent.edu

REDUCIBILITY AND CHARACTERIZATION OF SYMPLECTIC RUNGE–KUTTA METHODS *

PETER GÖRTZ† AND RUDOLF SCHERER†

Dedicated to Professor Wilhelm Niethammer on the occasion of his 60th birthday.

Abstract. Hamiltonian systems arise in many areas of physics, mechanics, and engineering sciences as well as in pure and applied mathematics. To their symplectic integration certain Runge–Kutta–type methods are profitably applied (see Sanz–Serna and Calvo [10]). In this paper Runge–Kutta and partitioned Runge–Kutta methods are considered. Different features of symmetry are distinguished using reflected and transposed methods. The property of DJ–irreducibility ensures symplectic methods having nonvanishing weights. A characterization of symplectic methods is deduced, from which many attributes of such methods and hints for their construction follow. Order conditions up to order four can be checked easily by simplifying assumptions. For symplectic singly–implicit Runge–Kutta methods the order barrier is shown to be two.

Key words. Hamiltonian system, symplectic method, Runge–Kutta and partitioned Runge–Kutta method, DJ–reducibility.

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†Institut für Praktische Mathematik, Universität Karlsruhe, Englerstraße 2, 76128 Karlsruhe, Germany, (`goertz@math.uni-karlsruhe.de`), and (`scherer@math.uni-karlsruhe.de`).