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An improved local error estimator for symmetric time-stepping schemes

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Abstract

We propose a symmetrized version of the defect to be used in the estimation of the local time-stepping error of symmetric one-step methods for the time propagation of linear autonomous evolution equations. Using the anti-commutator of the numerical flow and the right-hand side operator in the definition of the defect of the numerical approximation, a local error estimator is obtained which has higher accuracy asymptotically than an established version using the common defect. This theoretical result is illustrated for a splitting method applied to a linear Schrödinger equation.

Keywords: Numerical time integration, one-step methods, symmetric schemes, local error estimation
2010 MSC: 65L05, 65L50

1. Introduction

Consider the evolution equation

$$u'(t) = H\,u(t), \quad u(0) = u_0, \tag{1}$$

defined on a Banach space $\mathcal{X}$, with a generally unbounded time-independent operator $H\colon \mathcal{D}(H) \subset \mathcal{X} \to \mathcal{X}$ which generates a semigroup. We assume that the problem is well-defined with a sufficiently regular solution u, and denote the

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