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# Strong stability preserving transformed DIMSIMs

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**Abstract**

In this paper we investigate the strong stability preserving (SSP) property of transformed diagonally implicit multistage integration methods (DIMSIMs). Within this class, examples of SSP methods of order $p = 1, 2, 3$ and 4 and stage order $q = p$ have been determined, and also suitable starting and finishing procedure have been constructed. The numerical experiments performed on a set of test problems have shown that SSP transformed DIMSIMs can be more accurate and competitive with SSP Runge-Kutta methods of the same order.

*Keywords:* General linear methods, DIMSIMs, transformed methods, monotonicity, strong stability preserving, construction of methods.

## 1. Introduction

For the numerical solution of the initial-value problem for a system of ordinary differential equations (ODEs)

$$\begin{cases} y'(t) = f\big(y(t)\big), & t \in [t_0, t_{end}], \\ y(t_0) = y_0 \in \mathbb{R}^m, \end{cases} \tag{1.1}$$

where the function $f : \mathbb{R}^m \to \mathbb{R}^m$ is sufficiently smooth, we consider the class of diagonally implicit multistage integration methods (DIMSIMs). These methods were introduced by Butcher [8] (see also the monograph [45]), and on the uniform grid $t_n = t_0 + nh$, $n = 0, 1, \ldots, N_t$, $N_t h = t_{end} - t_0$, they take the form

$$\begin{cases} Y_i^{[n]} = h\displaystyle\sum_{j=1}^{s} a_{ij} f\big(Y_j^{[n]}\big) + \sum_{j=1}^{r} u_{ij} y_j^{[n-1]}, & i = 1, 2, \ldots, s, \\ y_i^{[n]} = h\displaystyle\sum_{j=1}^{s} b_{ij} f\big(Y_j^{[n]}\big) + \sum_{j=1}^{r} v_{ij} y_j^{[n-1]}, & i = 1, 2, \ldots, r, \end{cases} \tag{1.2}$$

$n = 1, 2, \ldots, N_t$. Here, the internal approximations or stages approximate the solution $y$ to (1.1) at the points $t_{n-1} + c_i h$, i.e.,

$$Y_i^{[n]} = y(t_{n-1} + c_i h) + O(h^{q+1}), \quad i = 1, 2, \ldots, s, \tag{1.3}$$