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## Stability of the $\theta$-Method for Parabolic Initial-Value Problems

The purpose of this talk is to discuss stability criteria for the $\theta$-Method for parabolic initial-value problems of the form

$$\frac{\partial \mathbf{u}(\mathbf{x},t)}{\partial t} = \sum_{1\leqslant p\leqslant q\leqslant s} A_{pq}\frac{\partial^2 \mathbf{u}(\mathbf{x},t)}{\partial x_p \partial x_q} + \sum_{1\leqslant p\leqslant s} B_p \frac{\partial \mathbf{u}(\mathbf{x},t)}{\partial x_p} + C\mathbf{u}(\mathbf{x},t),$$

$$\mathbf{u}(\mathbf{x},0) = \mathbf{f}(\mathbf{x}), \quad \mathbf{x} = (x_1,\ldots,x_s) \in \mathbb{R}^s, \quad 0 \leqslant t \leqslant T,$$

where $A_{pq}$, $B_p$, and $C$ are constant matrices. This method is a well-known family of finite-difference approximations depending on a parameter $\theta$, $0 \leqslant \theta \leqslant 1$, which includes the Euler Scheme ($\theta = 0$), the Crank–Nicholson Scheme ($\theta = \frac{1}{2}$), and the Backward Euler Scheme ($\theta = 1$). We shall deal with two cases, the classical case where the leading matrix coefficients $A_{pq}$ are Hermitian, and the less conventional case where the $A_{pq}$ are triangular. In the first case, our initial-value problem provides, for example, a model for diffusion of several species where the first- and zero-order terms represent transport and chemical reactions. The second case arises, for instance, in connection with heat and mass transfer with Soret and Dufour cross-effects.