Lax Scheme for the Advection Equation

Consider the one-dimensional advection equation given by

$$\frac{\partial u}{\partial t} = -c\frac{\partial u}{\partial x}.$$

The explicit Lax scheme for the advection equation is given by

$$u_j^{l+1} = \frac{1}{2}(u_{j+1}^l + u_{j-1}^l) - \frac{c\Delta t}{2\Delta x}(u_{j+1}^l - u_{j-1}^l).$$

Analyze its stability and derive the Courant-Friedrichs-Lewy (CFL) stability criterion, which is widely used in fluid turbulence simulations.

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