

# Combining finite elements and geometric wave propagation in 1-D

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We consider the initial value problem for a strictly hyperbolic partial differential equation on the circle. We transform the equation to an operator valued ODE  $du/dt = R(t)u$ , where  $R(t)$  is bounded. The transformation involves applying differential operators, solving an elliptic differential equation, and applying a coordinate transformation involving the characteristics, which can be done at cost  $O(N)$ . The resulting ODE is solved using a multiscale time-stepping method, which results in an algorithm with complexity  $O(N)$  for the original hyperbolic equation.