Using Finite Elements to Solve Kuramoto-Sivashinsky PDE

by

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Kuramoto-Sivashinsky Equation

- Flame Equation

- Non-linear PDE

- Higher-order

- Time-dependent

- Can model Flame Dynamics

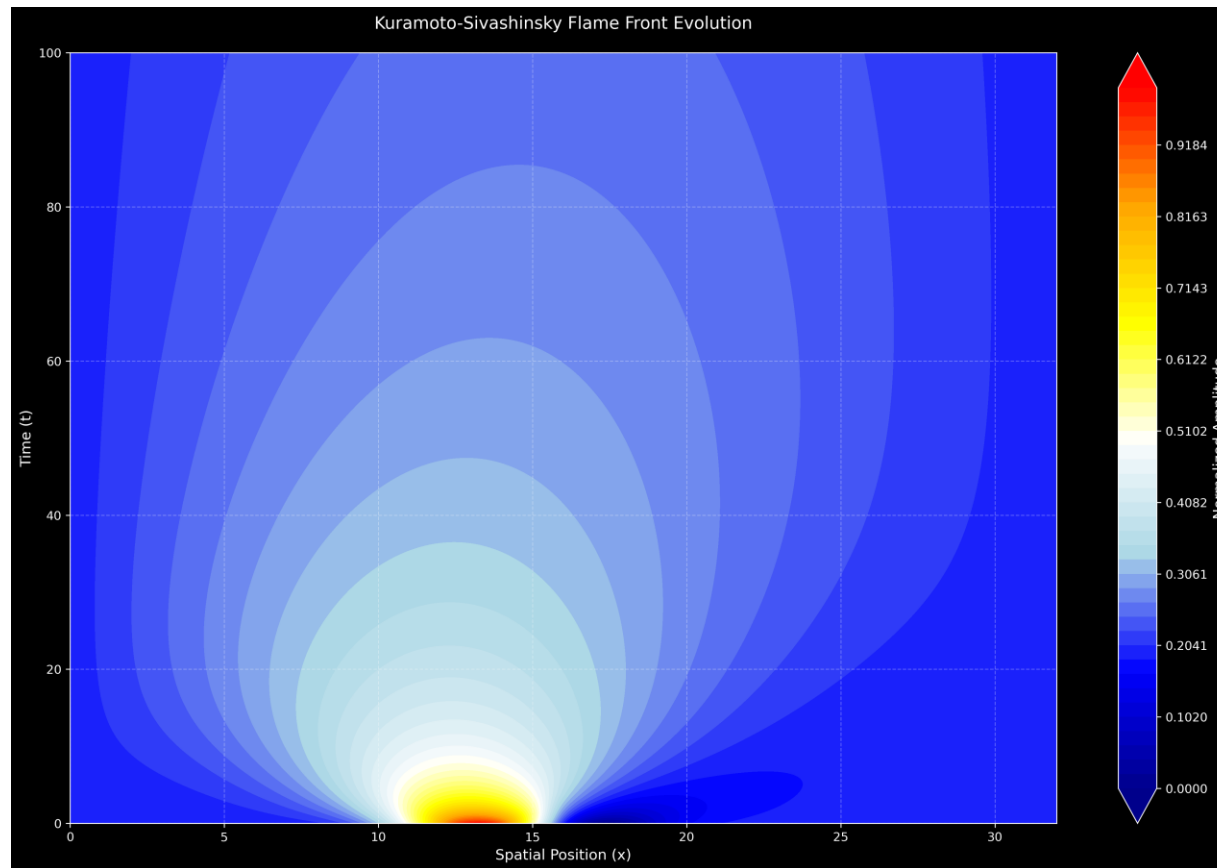- Equation: $u_t + uu_x + u_{xx} + u_{xxxx} = 0$

Weak Form

F = (u_n1 * v * ufl.dx - u_n * v * ufl.dx +

      dt * theta * linear_operator(u_n1) * v * ufl.dx +

      dt * (1 - theta) * linear_operator(u_n) * v * ufl.dx +
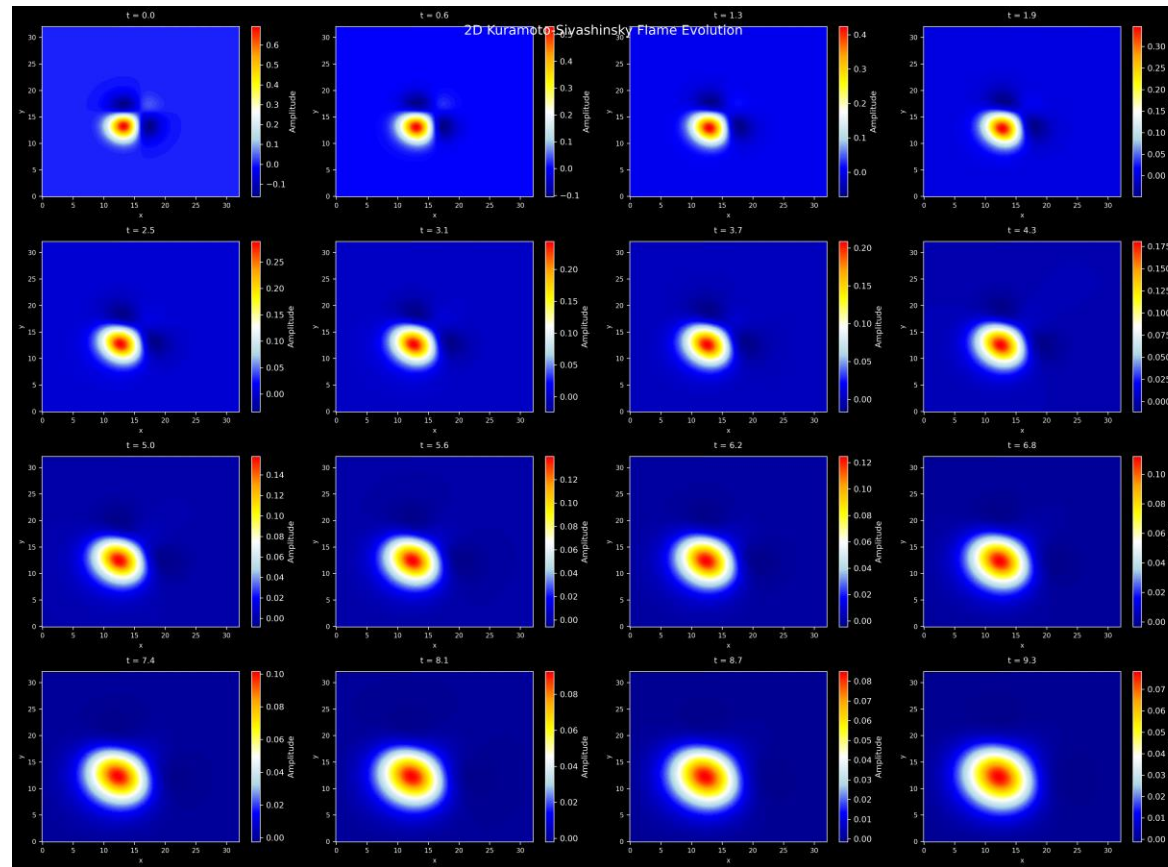
      dt * nonlinear_operator(u_n1) * v * ufl.dx +

   ....)

Solver – Kuramoto-Sivashinsky

- Spatial - Finite Elements
- Time - Crank-Nicholson
- Newton's Method
- GMRES with ILU

1D Results

Kuramoto-Sivashinsky Flame Front Evolution

2D Results

Project Checklist

✓ Non-linear PDE

✓ Derive Weak Form

✓ Time-marching Scheme

✓ Function Spaces

✓ Performance

✓ Verification