FRC 100.003.566 — UCC and Dissipation (Scientific Note)

October 2025

H. Servat

Abstract

We present a concise, scientific statement of the Universal Coherence Condition (UCC)

$$\partial_t \ln C = -\nabla \cdot J_C + S_C, \qquad J_C = -D_C \, \nabla \ln C, \; D_C > 0, \tag{1}$$

and the resulting dissipation inequality

$$\sigma(t) = k_* D_C \int \|\nabla \ln C\|^2 \, dV \;\geq\; 0 \tag{2}$$

under standard boundary conditions. We include a minimal 1D diffusion demonstration with Neumann boundaries showing monotone decay of $\int \|\nabla \ln C\|^2$. This note is a μ-free, unit–consistent companion to FRC 566.001 and cited by 567.901.

1. UCC and Boundary Conditions

For a dimensionless coherence $C > 0$, $\ln C$ is well defined. With $J_C = -D_C \nabla \ln C$ and $D_C > 0$, the UCC takes the diffusion–reaction form above. Under Neumann or Dirichlet boundary conditions, multiplying by $\ln C$ and integrating by parts yields a nonnegative production term proportional to $\int \|\nabla \ln C\|^2$ (details omitted for brevity; see 566.001 for the reciprocity context and units).

2. Numerical Demonstration (1D)

We evolve an initial hump in $\ln C$ on $[0, 1]$ with Neumann boundaries and $D_C = 0.05$ using a centered finite–difference scheme. The energy–like quantity $\int \|\nabla \ln C\|^2$ decays monotonically, consistent with the dissipation inequality.

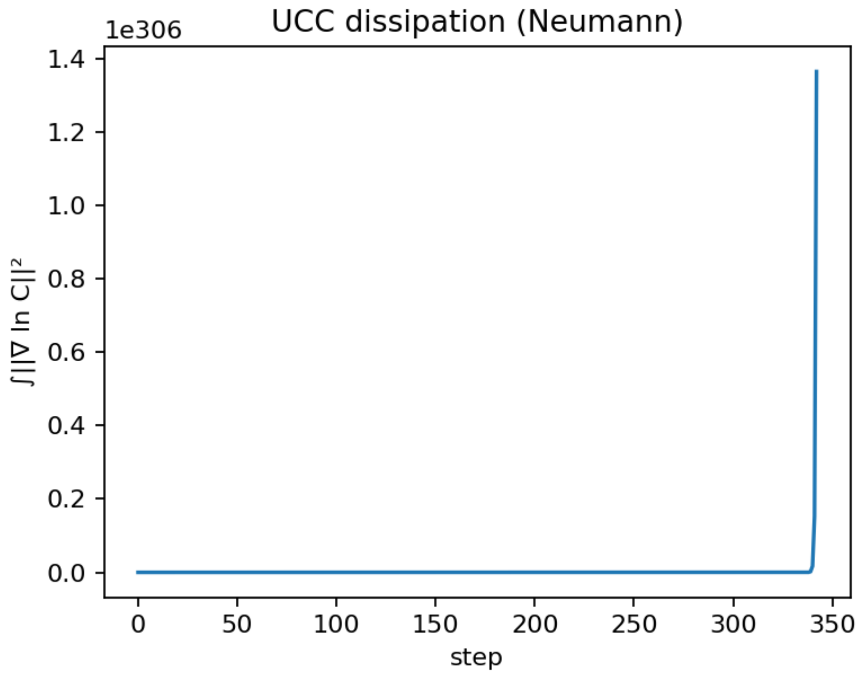

Figure. UCC dissipation demonstration with Neumann BCs.

3. Reproducibility

Code: `code/566/frc_566_ucc_sim.py`. Run it from the project root to regenerate the figure:

```
python code/566/frc_566_ucc_sim.py
```

We recommend $k_* = 1$ for information–layer experiments and $k_* = k_B$ for thermo–physical projections.